

Designing IPAER Learning Model in IPAS Learning: an Effort to Improve Critical Thinking Skills in Elementary School

Nasyariah Siregar^{1*}, Syahrial Syahrial¹, Sofyan¹, Bunga Ayu Wulandari¹

¹Department of Education, Jambi University, Indonesian.

Received: March 26, 2025

Revised: May 15, 2025

Accepted: June 25, 2025

Published: June 30, 2025

Corresponding Author:

Nasyariah Siregar

nasyariahsiregar@uinjambi.ac.id

DOI: [10.29303/jppipa.v11i6.11721](https://doi.org/10.29303/jppipa.v11i6.11721)

© 2025 The Authors. This open access article is distributed under a (CC-BY License)



Abstract: Critical thinking skills are important for students today. Teachers play an important role in developing students' abilities in the classroom. However, it is often found that students' critical thinking skills are low, due to the use of inappropriate learning models. Therefore, this study aims to design an IPAER learning model as an alternative to dealing with these problems. This research is a research and development, referring to the ADIIE model. Data collection uses a needs analysis instrument, IPAER learning model feasibility instrument, IPAER learning model practicality instrument, and IPAER learning model effectiveness instrument in improving critical thinking skills. The results showed that the IPAER model had been declared valid by experts and had been adjusted to empirical theory.

Keywords: IPAER learning model; critical thinking; elementary school

Introduction

21st century education requires students to have high-level skills, one of which is the ability to think critically (Aswanti & Isnaeni, 2023; Fitriyadi & Wuryandani, 2021). In the context of the Merdeka curriculum, critical thinking skills are part of the six main dimensions of the Pancasila profile, which must be developed since the primary school level (Kemendikbudristek, 2022; Saido et al., 2015). This dimension focuses on students' ability to analyze, evaluate, and responsibly deal with the complexity of social life and the development of science.

Critical thinking skills are very important in dealing with the swift flow of information and the complexity of problems in the digital era (OECD, 2022). Various studies show that the critical thinking skills of primary school students in Indonesia are still in the low category (Maylia et al., 2024; Maysarah et al., 2024; Pamungkas et al., 2019). Students need to be trained to assess arguments, analyze information, and make the right decisions (Leibovitch et al., 2025). Therefore, teachers have a central role in designing learning that

can foster and develop students' critical thinking skills. Teachers need to design learning that allows students to explore, investigate, criticize, and reflect, both in academic contexts and everyday life (Supena et al., 2021).

These needs are in line with learning in Natural and Social Sciences (NSP) subjects in elementary schools. IPAS subjects, which are an integration of the basic concepts of science and social studies, are designed to train students to think scientifically and socially through observation, investigation, and analysis of daily life phenomena. The problem of students' low critical thinking skills in primary schools is not only caused by learning methods and approaches that are less contextualized, but also the lack of learning models that systematically train students to think critically (Lombardi et al., 2021; Lombardi et al., 2022).

The results of field observations on the learning of natural and social sciences (IPAS) in elementary schools show that students' critical thinking skills in IPAS learning are low. This is reinforced through teacher and student interviews which indicate the need for an

How to Cite:

Siregar, N., Syahrial, S., Sofyan, & Wulandari, B. A. (2025). Designing IPAER Learning Model in IPAS Learning: an Effort to Improve Critical Thinking Skills in Elementary School. *Jurnal Penelitian Pendidikan IPA*, 11(6), 333–339. <https://doi.org/10.29303/jppipa.v11i6.11721>

adaptive learning model to student needs that can improve students' critical thinking skills. Correspondingly, Tresnawati et al., (2021) emphasized that learning models have an important role in shaping students' mindsets and thinking skills. The right model can encourage active student involvement, student cooperation, and stimulate higher-level thinking skills. The models that are widely used today to encourage critical thinking skills are PBL and PjBL, but they have not maximized critical thinking due to the lack of students' prior knowledge (Hermansyah, 2020; Jones, 2006; Zheng et al., 2023). Therefore, there is a need for a learning model that is not only innovative in design, but also in accordance with the needs of students and relevant to the characteristics of IPAS learning which is integrative and exploratory.

Various previous studies have proven the importance of developing cognitive process-based learning models and active inquiry to improve critical thinking skills (Vong & Kaewurai, 2017). Furthermore, research conducted by Herianto (2024) produced a STEM-EDELACY model that proved effective in improving 21st century skills. Similarly, research conducted by Priyambodo & Paidi (2024) through the ECLIPSE model emphasizes ethnoecology in developing collaboration and critical thinking of students.

However, most of the models that have been developed previously are mostly aimed at secondary or higher education. Relevant learning models for elementary school level are still limited. Barokah et al. (2024) emphasized the effectiveness of project-based science learning models to improve the critical thinking skills of elementary school students. Meanwhile, Winanto & Prasetyo (2023) developed a science model based on the C-TPACK framework that integrates character values and 21st century skills. However, the study focused on the integration of TPACK and character values rather than systematic critical thinking.

Based on this gap, this research aims to develop a new learning model called IPAER. The IPAER learning model (identifying, planning, acting, evaluating, reflecting) was conducted to respond to the need for a learning model that can improve students' critical thinking skills in IPAS learning. The principle of progressivism became the foundation in this research to develop a new learning model, namely the IPAER model. Progressivism emphasizes the importance of continuous change through actions that are constructive, reformist, active, innovative, and dynamic (Albeta et al., 2023). In this view, progress is always related to change, and every change leads to the creation of novelty (Pathak, 2012). The novelty of the IPAER model lies in the systematic structure of five stages that explicitly lead students through the entirety of critical thinking. This

model is contextualized with IPAS learning characteristics and 21st century skills.

Method

This research is a research and development (Sugiyono, 2024) by adapting the ADDIE model (Branch, 2009), which consists of five stages: analyze, design, develop, and evaluate. The analyze stage has six activities, namely validating the critical thinking gap, determining instructional objectives, confirming the intended audience, identifying the resources needed, determining potential delivery (costing), and creating a project management plan. The design stage has four activities, namely, conducting a task inventory, compiling performance objectives, creating a testing strategy, calculating investment. The development stage has six activities, namely, developing content, developing products, developing teacher guides, developing student guides, formative revision, and conducting trials. The implement stage has two activities, namely, preparing teachers and preparing students. Furthermore, the evaluate stage has three activities, namely determining evaluation criteria, selecting evaluation tools, and conducting evaluations. The following are the stages of research and development of the ADDIE model.

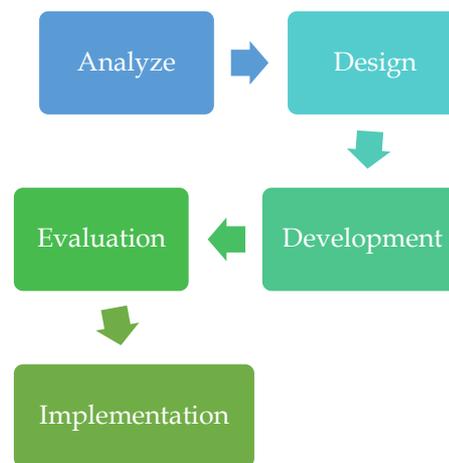


Figure 1. ADDIE Development Model

This study was conducted in Jambi, Indonesia. A total of 2 elementary schools were involved in this study, namely SDN 131/IV Jambi City and SDN 28/IV Jambi City. The schools involved in this study were selected by purposive sampling. The involved parties were explained systematically and in detail about the procedures, objectives, impacts and benefits of this study. They were also informed about the flow of data recording, such as audio recording during interviews

and observations. This research has four types of instruments in data collection, including needs analysis instruments, IPAER learning model feasibility instruments, IPAER learning model practicality instruments, and IPAER learning model effectiveness instruments in improving critical thinking skills.

Result and Discussion

The design of the IPAER learning model (identifying, planning, acting, evaluating, reflecting) was carried out to respond to the need for a learning model that could improve students' critical thinking skills in IPAS learning. This need is in line with the demands of the independent curriculum which requires students to have critical thinking skills. This design process begins with analyzing the needs of teachers and students, formulating learning objectives, preparing model syntax and designing teaching tools that support the application of the model in a systematic and structured manner. The analysis begins with field observations at SDN 131/IV Jambi City and SDN 28/IV Jambi City. In addition, in-depth interviews with classroom teachers were conducted, as well as literature studies on IPAS learning in elementary schools.

The observation results show that the learning model used in IPAS learning has not been able to fully improve students' critical thinking skills. Students are not given enough space to analyze, evaluate and also solve problems (Amelia et al., 2024; Lestari et al., 2024). The purpose of this design is to design a learning model that is able to facilitate the active involvement of students in the process of problem identification, solution planning, action implementation, evaluation of results and reflection on the thinking process that has been carried out. This thinking process is designed so that students not only understand superficial concepts, but also apply concepts in real life critically and creatively (Dewi, 2020; Oktaviani & Tari, 2018).

The design of the IPAER model is based on cognitive theory, constructivism, problem-based learning approach, and critical thinking theory from experts such as Ennis (1996). In the initial stage, the needs of teachers and students were analyzed through classroom observations, interviews with teachers and literature review which showed that IPAS learning still focused on memorizing concepts and did not provide much space to develop critical thinking skills. This analysis emphasizes the importance of learning models that are exploratory and reflective, and place students as active subjects in the learning process. The IPAER model is very relevant to IPAS learning which demands interdisciplinary understanding and contextual problem solving (Rohmaya, 2022).

Based on the results of the analysis that has been carried out, a learning model structure is designed which consists of five integrated learning stages, including: Identifying, which involves identifying in determining goals, needs or problems that need to be solved; Planning, which is planning learning strategies to achieve goals, needs and solve problems that have been found; Actioning, which is the implementation or execution of plans that have been carefully designed to achieve goals; Evaluating, which is assessing the results of actions against predetermined goals; and Reflecting, which is reflecting on the learning process and results. This learning syntax is designed to encourage students' critical thinking process systematically. The following is the syntax of the IPAER learning model.

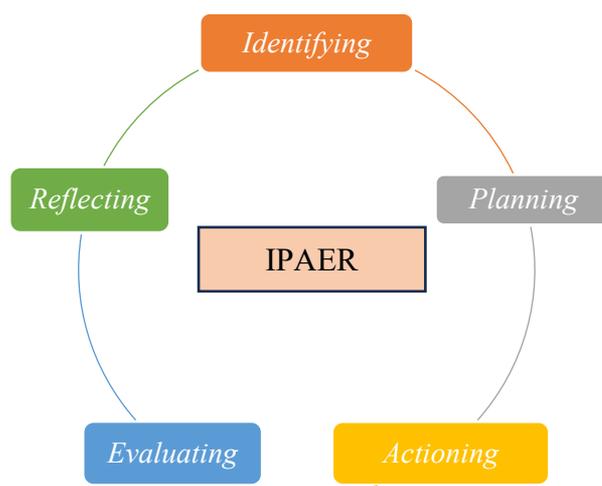


Figure 2. IPAER Learning Model Syntax

The implementation of the IPAER model is supported by teaching tools that are in accordance with the stages of the model, such as teaching modules, Learner Worksheets (LKPD), visual and digital learning media, and critical thinking assessment rubrics. All tools are designed to be in line with the principles of active, contextual, and collaborative learning. These tools are also adapted to the characteristics of elementary school students who are at the concrete operational stage (Piaget, 1973). The IPAER learning model also considers the current curriculum, namely the independent curriculum (Abdul Fattah Nasution et al., 2023). The design of the IPAER model is also supported by several empirical theories. The following is a table of empirical theory support used in designing the IPAER model.

Table 1. syntax of the IPAER learning model

Phase	Syntax Explanation
Identifying	Constructivism Theory, finding and understanding information with the help of the teacher as a facilitator, forming knowledge actively (Theodoridis & Kraemer, 1995).
	Cognitive Theory, identifying and integrating new information with existing material (Piaget, 1973). Constructing new knowledge by linking it to previous experience and (Bruner, 1975). Phase I in the syntax of PBL and PjBL models 3C and 3R Theory, able to identify problems to research (Hung, 2006). Content can be changed or customized to meet individual learning needs (Robert et al., 2009)
Planning	Constructivism Theory, forming new schemas according to new knowledge or modifying them (Piaget, 1973). Cognitive Theory, information processing in planning a solution to a problem. Phase II of the PjBL syntax plans solutions for project work for authentic learning (Markham et al., 2003). Phase II of PBL syntax emphasizes learning through actual problem- solving (Barrows, 1980). Theory of Constructivism: Teachers act as facilitators who create an environment that supports knowledge construction (Theodoridis & Kraemer, 1995). Cognitive Theory designs stimuli and tasks that trigger student activity (Piaget, 1973). Phase IV and VII of PBL syntax conduct experiments, research or further exploration to support the implementation of Barrows (1980). plan. Phase III of the PjBL syntax actively works on projects collaboratively according to the application of knowledge in the context of a broader task (Turnipseed & Hammond, 2015). Accommodates various learning styles (Yadav, 2020).
Actioning	Provide diverse tasks or projects, according to students' interests and readiness (Tomlinson, 1999). Success in learning is strongly influenced by learning motivation (McDonald, 1961). PBL and PjBL models, reflection is carried out to assess the learning experience and how these results can be applied to other Barrows (1980)
Evaluation	Cognitive Theory, the ability of individuals to realize and evaluate their own thinking processes (Piaget, 1973).

One of the advantages of the IPAER learning model is its flexibility to be applied in various IPAS learning topics, both environmental, energy, technology, and social themes. The syntax of the IPAER model guides students to practice critical thinking at each IPAER stage. After the design is complete, the initial product of the IPAER model is prepared for the validation process by experts. The following presents the results of validation by material experts.

Table 2. IPAER learning model validation results

Feasibility Aspect	Max. Score	Obtained Score	Percentage (%)	Category
Content Feasibility (According to BSNP)	60	53	88.33	Highly Valid
Presentation Feasibility	45	44	97.78	Highly Valid
Language Feasibility (Clarity, communicative, appropriate to student development)	45	41	91.11	Highly Valid
Contextual Assessment	40	38	95.00	Highly Valid
Overall Total	190	176	90.26	Highly Valid

There are four types of validation used, namely material validation, educational technology, language, and research instruments. The aim is to ensure that the designed model is not only conceptually effective, but also feasible and practical to be applied in the field. After going through the validation stage, the IPAER learning model was tested in the one-to one trial, small group trial, and field trial stages. This stage is a trial before proceeding to the implementation stage syntax explanation.

Conclusion

The research was conducted in 2 elementary schools in Jambi, which became a place to conduct trials related to the need for learning models that can improve students' critical thinking skills. The research findings show that elementary schools in Jambi need an IPAER learning model to support students' critical thinking skills. The IPAER learning model is an extension of the PBL and PjBL learning models to make it easier to facilitate critical thinking skills through all stages that have been systematically designed. The design of the IPAER learning model is supported by empirical theory

and in accordance with the developmental stages of elementary school students.

Acknowledgments

The authors would like to thank the parties involved and have helped and the preparation of this scientific article.

Author Contributions

The authors listed in this article have contributed to the preparation of this article. The authors involved have approved the publication of this article.

Funding

This research is not funded by outside parties, pure financing from the author.

Conflicts of Interest

All authors have no conflict of interest in the publication of this article.

References

- Albeta, S. W., Firdaus, L. N., Copriady, J., & Alimin, M. (2023). TPACK-Based Blended Learning As An Implementation Of Progressivism Education: A Systematic Literature Review. *Jurnal Pendidikan Vokasi*, 13(1), 44–59. <https://doi.org/10.21831/Jpv.V13i1.51287>
- Amelia, O., Sundari, P. D., Mufit, F., & Dewi, W. S. (2024). Analisis Kebutuhan Pengembangan E-Modul Dengan Pendekatan Contextual Teaching And Learning Untuk Meningkatkan Pemahaman Konsep Pada Materi Energi Terbaru. *Jurnal Ilmiah Profesi Pendidikan*, 9(1), 34–39. <https://doi.org/10.29303/Jipp.V9i1.1849>
- Aswanti, N. H., & Isnaeni, W. (2023). Analysis Of Critical Thinking Skills, Cognitive Learning Outcomes, And Student Activities In Learning The Human Excretory System Using An Interactive Flipbook. *REID (Research And Evaluation In Education)*, 9(1), 37–48. <https://doi.org/10.21831/Reid.V9i1.53126>
- Barokah, A., Damayanti, A., Setiawan, A. A., & Darmawan, A. S. (2024). Model Pembelajaran Sains Untuk Mengembangkan Kemampuan Berpikir Kritis Siswa Sekolah Dasar. 4, 13443–13449. <https://doi.org/10.31004/Innovative.V4i4.13252>
- Barrows, H. S., & Tamlyn, R. M. (1980). *Problem-Based Learning: An Approach To Medical Education*. Springer.
- Branch, R. M. (2009). *Instructional Design: The ADDIE Approach* (Vol. 722). Springer Science & Business Media. <https://doi.org/10.1007/978-0-387-09506-6>
- Bruner, J. S. (1975). The Ontogenesis Of Speech Acts. *Journal Of Child Language*, 2(1), 1–19. <https://doi.org/10.1017/S0305000900000866>
- Dewi, D. T. (2020). Penerapan Pembelajaran Problem Based Learning Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *ACTION: Jurnal Inovasi Penelitian Tindakan Kelas dan Sekolah*, 1(12), 149–157. <https://doi.org/10.51878/Action.V1i2.637>
- Ennis, R. H. (1996). *A Critical Thinking*. Freeman.
- Fitriyadi, N., & Wuryandani, W. (2021). Is Educational Game Effective In Improving Critical Thinking Skills? *Jurnal Prima Edukasia*, 9(1), 107–117. <https://doi.org/10.21831/Jpe.V9i1.35475>
- Herianto. (2024). Pengembangan Model Pembelajaran STEM-EDELCY (Engineering Design Learning Cycle) Untuk Meningkatkan Keterampilan Abad 21 Peserta Didik SMP. In *Universitas Negeri Yogyakarta*. Universitas Negeri Yogyakarta.
- Hermansyah. (2020). Problem Based Learning In Indonesian Learning. *Social, Humanities, And Educations Studies (Shes): Conference Series*, 3(3), 2257–2262. <https://doi.org/10.20961/shes.v3i3.57121>
- Hung, W. (2006). The 3C3R Model: A Conceptual Framework For Designing Problems In PBL. *Interdisciplinary Journal Of Problem-Based Learning*, 1(1), 5–22. <https://doi.org/10.7771/1541-5015.1006>
- Jones, R. W. (2006). Problem-Based Learning: Description, Advantages, Disadvantages, Scenarios and Facilitation. *Anaesthesia and Intensive Care*, 34(4). <https://doi.org/10.1177/0310057X0603400417>
- Kemendikbudristek. (2022). *Panduan Pembelajaran Dan Asesmen*. Badan Standar, Kurikulum, Dan Asesmen Pendidikan Kementerian Pendidikan, Kebudayaan, Riset, Dan Teknologi Republik Indonesia. Retrieved from <https://kurikulum.kemdikbud.go.id/wp-content/uploads/2022/06/Panduan-Pembelajaran-dan-Asesmen.pdf>
- Leibovitch, Y. M., Beencke, A., Ellerton, P. J., McBrien, C., Robinson-Taylor, C. L., & Brown, D. J. (2025). Teachers' (Evolving) Beliefs About Critical Thinking Education During Professional Learning: A Multi- Case Study. *Thinking Skills And Creativity*, 56(September 2024). <https://doi.org/10.1016/J.Tsc.2024.101725>
- Lestari, I.B.P. Arnyana, & I.M. Candiasa. (2024). Pengembangan Media Interaktif Berbasis Web Untuk Meningkatkan Hasil Belajar Sistem Organ Manusia. *PENDASI Jurnal Pendidikan Dasar Indonesia*, 8(1), 54–68. https://doi.org/10.23887/Jurnal_Pendas.V8i1.3127
- Lombardi, L., Mednick, F. J., De Backer, F., & Lombaerts, K. (2021). Fostering Critical Thinking Across The Primary School's Curriculum In The European Schools System. *Education Sciences*, 11(9).

- <https://doi.org/10.3390/Educsci11090505>
Lombardi, L., Mednick, F. J., De Backer, F., & Lombaerts, K. (2022). Teachers' Perceptions Of Critical Thinking In Primary Education. *International Journal of Instruction*, 15(4), 1-16. <https://doi.org/10.29333/Iji.2022.1541a>
- Markham, T., Larmer, J., & Ravitz, J. (2003). *Project-Based Learning: A Guide To Standards-Focused Project-Based Learning For Middle And High School Teachers (2nd Ed.)* (2nd Ed.). Buck Institute For Education.
- Maylia, E. C., Amelia, A. P., Suwarna, D. M., Muyassaroh, I., & Jenuri, J. (2024). Strategi Pembelajaran Inkuiri Terhadap Kemampuan Berpikir Kritis Siswa SD. *Jurnal Review Pendidikan Dasar : Jurnal Kajian Pendidikan Dan Hasil Penelitian*, 10(1), 32-41. <https://doi.org/10.26740/Jrpd.V10n1.P32-41>
- Maysarah, Aisah, S., Alamha, & Dewi, T. P. (2024). Peningkatan Kemampuan Berpikir Kritis Pada Siswa Sekolah Dasar: Literatur Review. *Jurnal Pendidikan Tematik Dikdas*, 9(2), 114-125. <https://doi.org/10.22437/Jptd.V9i2.38375>
- Mcdonald, F. J. (1961). Motivation And The Communication Processes. *Audiovisual Communication Review*, 9(5), 57-67. <https://doi.org/10.1007/BF02769478>
- OECD. (2022). Pisa 2022. In *Perfiles Educativos* (Vol. 46, Issue 183). <https://doi.org/10.22201/Issue.24486167e.2024.183.61714>
- Oktaviani, L., & Tari, N. (2018). Penerapan Model Pembelajaran Berbasis Masalah Untuk Meningkatkan Kemampuan Pemecahan Masalah Ipa Pada Siswa Kelas Vi Sd No 5 Jineng Dalem. *Pedagogia*, 16(1), 10. <https://doi.org/10.17509/Pdgia.V16i1.10718>
- Pamungkas, D., Mawardi, M., & Astuti, S. (2019). Peningkatan Keterampilan Berpikir Kritis Dan Hasil Belajar Matematika Pada Siswa Kelas 4 Melalui Penerapan Model Problem Based Learning. *Jurnal Ilmiah Sekolah Dasar*, 3(2), 212. <https://doi.org/10.23887/Jisd.V3i2.17774>
- Pathak, R. P. (2012). *Philosophical and Sociological Principles of Education*. India: Pearson Education
- Piaget, J. (1973). *To Understand Is To Invent: The Future Of Education*. Virginia: Grossman Publishers.
- Priyambodo, P., & Paidi, P. (2024). Pengembangan Model Pembelajaran ECLIPSE (Exploring, Compiling, Linking, Producing, Sharing, Evaluating) Berbasis Isu Etnoekologi Untuk Meningkatkan Keterampilan Kolaborasi Dan Keterampilan Berpikir Kritis Mahasiswa. In *Universitas Negeri Yogyakarta*. Universitas Negeri Yogyakarta. Retrieved from <https://eprints.uny.ac.id/81598/>
- Robert J., Marzano, & John L. Brown. (2009). *The Art And Science Of Teaching*. ASCD.
- Rohmaya, N. (2022). Peningkatan Literasi Sains Siswa Melalui Pembelajaran Ipa Berbasis Socioscientific Issues (SSI). *Jurnal Pendidikan Mipa*, 12(2), 107-117. <https://doi.org/10.37630/Jpm.V12i2.553>
- Saido, G. M., Siraj, S., Nordin, A. B. B., & Al_Amedy, O. S. (2015). Higher Order Thinking Skills Among Secondary School Students In Science Learning. *The Malaysian Online Journal Of Educational Science*, 3(3), 13-20. Retrieved from <https://ijie.um.edu.my/index.php/MOJES/article/view/12778>
- Sugiyono. (2024). *Metode Penelitian Kuantitatif Kualitatif Dan R&D*. Bandung: Alfabeta.
- Supena, I., Darmuki, A., & Hariyadi, A. (2021). The Influence Of 4C (Constructive, Critical, Creativity, Collaborative) Learning Model On Students' Learning Outcomes. *International Journal Of Instruction*, 14(3), 873-892. <https://doi.org/10.29333/Iji.2021.14351a>
- Theodoridis, T., & Kraemer, J. (1995). *Constructivism In Education*. Psychology Press
- Tomlinson, C. A. (1999). Differentiated Classroom. In *Association For Supervision And Curriculum Development*, 37(3). Retrieved from <https://www.scirp.org/reference/ReferencesPapers?ReferenceID=2464899>
- Tresnawati, N., Saleh, I., Sudarmin, & Wardani, S. (2021). Science Batik Ciwaringin: The Implementation Of Ethno-STEM Pjbl Model In Learning Biotechnology At PGSD Students. *Journal Of Physics: Conference Series*, 1842(1). <https://doi.org/10.1088/1742-6596/1842/1/012063>
- Trilling, B., & Fadel, C. (2009). 21st Century Skills Learning For Life In Our Times. In *Jossey-Bass*. Jossey-Bass.
- Turnipseed, S., & Darling-Hammond, L. (2015). Accountability Is More Than A Test Score. *Education Policy Analysis Archives*, 23, 11. <https://doi.org/10.14507/Epaa.V23.1986>
- Vong, S. A., & Kaewurai, W. (2017). Instructional Model Development To Enhance Critical Thinking And Critical Thinking Teaching Ability Of Trainee Students At Regional Teaching Training Center In Takeo Province, Cambodia. *Kasetsart Journal Of Social Sciences*, 38(1), 88-95. <https://doi.org/10.1016/J.Kjss.2016.05.002>
- Winanto, A., & Prasetyo, Z. K. (2023). *Pengembangan Model Pembelajaran Ipa Sd Berbasis Kerangka Kerja C-TPACK Untuk Meningkatkan Nilai-Nilai Karakter Dan Keterampilan Abad 21*. Universitas Negeri Yogyakarta. Retrieved from <https://eprints.uny.ac.id/77739/>

- Yadav, A. B. (2020). Differentiating Instruction 21st Century Classrooms. *SSRN Electronic Journal*, 1(1), 53–59. <https://doi.org/10.2139/Ssrn.3512793>
- Zheng, Q. M., Li, Y. Y., Yin, Q., Zhang, N., Wang, Y. P., Li, G. X., & Sun, Z. G. (2023). The Effectiveness Of Problem-Based Learning Compared With Lecture-Based Learning In Surgical Education: A Systematic Review And Meta-Analysis. *BMC Medical Education*, 23(1), 1–11. <https://doi.org/10.1186/S12909-023-04531-7>