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Ethno-Biology Learning Model Based on Design Thinking to Improve Students' Critical Thinking Skills

Linda Winiasri[1], Tomi Apra Santosa[2*], Yohandri[3], Abdul Razak[3], Festiyed[3], Zulyusri[3]

[1] Surabaya Aviation Polytechnic, Surabaya, Indonesia.
[2] Civil Engineering Lecturer, Adikarya Engineering Academy, Jambi, Indonesia.
[3] Postgraduate Lecturer, FMIPA, Padang State University, Padang, Indonesia.

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Corresponding Author:
Tomi Apra Santosa
santosa2021@gmail.com

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Abstract: This study aims to investigate the effect of an ethnobiology learning model based on design thinking on students' critical thinking skills. The research is a type of quasi-experimental research with a randomized control group pretest-postest design. The population of this study came from SMA Negeri 12 Kerinci. The research sample came from two classes, namely class XI MIPA (experimental class) and class MIPA 3 (control class) totaling 42 students. The experimental class group used the ethnobiology learning model while the control class group used the conventional learning model. The sampling technique is random sampling. The research instrument was an objective test of critical thinking skills. Data analysis was quantitative statistical analysis with the help of SPSS version 26. The results of this study showed that the average value of posttest and N-gain critical thinking skills of classes that obtained ethnobiology learning based on design thinking was better than classes that used conventional learning. The t-test results show that the ethnobiology learning model based on design thinking has an effect on critical thinking skills sig. < 0.05 (0.00 < 0.05). Students' thinking skills in the experimental class obtained an average score of 82.30 with an N-gain value of 0.72.

Keywords: Ethno-Biology; Ethnosains; Critical thinking; Design thinking; Learning

Introduction

Critical thinking is a very important skill for a student in facing Revolution 4.0 (Amin et al., 2020; Rijal et al., 2021). Critical thinking skills are a student's ability to analyze a problem systematically (Samaras et al., 2022; Redhana, 2013). Critical thinking skills have a very important role for students in solving problems in learning (Zanden et al., 2020; Kanmaz, 2022; Hazaymeh & Alomery, 2021). In addition, critical thinking skills are important for students in developing their cognitive potential (Herzon et al., 2018). Critical thinking skills are needed for students to think scientifically in solving problems in science learning, especially in biology (Syawaludin et al., 2019; Al-shaye, 2021).

Biology as part of Natural Sciences (IPA) has not been able to develop students' critical thinking skills. Many problems in science are considered to be a difficult and boring subjects for students (Yaki, 2022). This causes students to be less stimulated to think critically. According to the 2018 Program For International Students (PISA) study, Indonesian students' science literacy score of 382 ranked 64 out of 65 countries (Razak et al., 2021; Hamdani et al., 2022; Marudut, 2020; Elfira et al., 2023; Suharyat et al., 2023). This shows that the ability of students to think critically in Indonesia is still relatively low (Yustiana el al., 2022). Furthermore, in the learning process students are less actively involved, learning is only memorizing, the teaching and learning process is still centered on the teacher (centered teacher) (Fitriani, 2020), the teaching materials used by the teacher are less interesting and the learning model is not appropriate (Sutiani et al., 2021).

The ethno-biology learning model based on design thinking is able to make students more active. Ethno-biology learning is a learning model that reconstructs local wisdom into biology (Santoro et al., 2018; Ludwig & Charbel, 2023). The ethno-biology

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model can create a more interesting learning atmosphere by combining local wisdom with science (Ardianti & Raida, 2022). Ethno-biology model based on design thinking makes it easier to think critically and understand the lesson more easily (Nuralita, 2020; Padhy et al., 2015; Hikmawati et al., 2020). Ethno-biology learning based on design thinking helps students to improve learning outcomes, critical and creative thinking (Damayanti et al., 2017; Dewi et al., 2021).

Previous research by Sudarmin et al. (2018) ethnoscience learning can influence students' cultural awareness. Design thinking-based learning model helps students in problem solving and critical thinking in elementary school students (Brown, 2020; Welsh & Dehler, 2019). Research by Pande et al. (2020) Design thinking-based learning is able to develop thinking with the principle of constructivism in students. Zidny & Eilks (2022) ethnoscience learning model helps students to connect culture with subject matter at school. The ethno-biology learning model based on design thinking is very good for developing students' critical thinking in biology learning. Research on the application of ethnoscience learning models in biology improves critical thinking skills (Temuningsih et al., 2017). Based on these problems, this study aims to investigate the effect of ethno-biology learning model based on design thinking on students' critical thinking skills.

Method

This research is a type of quasi-experimental research with randomized control group pretest-posttest design (Table 1). The research was conducted at SMA Negeri 2 Kerinci using ethno-biology learning based on design thinking in the experimental class and conventional learning in the control class according to the chosen model. The independent variable is the ethno-biology learning model based on design thinking. The dependent variable is critical thinking skills. The population in this study came from all students of class XI IPA SMA Negeri 12 Kerinci consisting of 4 classes. The research sample came from class XI MIPA 1 as an experimental class and class XI MIPA 3 as a control class totaling 42 people. The sample technique is random sampling.

The data collection technique is a test. The instrument used is a critical thinking test consisting of 20 multiple choice questions that have been tested for validity and reliability. This test serves to determine students' critical thinking skills in learning biology. Data analysis is quantitative descriptive analysis by conducting T- test and N-gain test with the help of SPSS version 26 application with hypothesis test criteria H0 is rejected and H1 is accepted if the sig value. < 0.05. The N-gain criteria can be seen in Table 2.

Table 1. Randomized Control Group Pretest-Posttest Design (Lufri & Ardi, 2017)

Class	Pretest	Treatment	Posttest
Experiment	T1	X	T2
Control	T1		T2

Description:
T1 : Pretest for Experimental class
T2 : Pretest for control class
X : Ethnobiology Learning Model based on design thinking
T2 : Posttest for experimental class
T2 : Posttest for control class

Table 2. N-gain Criteria of Ethno-Biological Learning Model (Hake, 1998)

Coefficient Value	Criteria
0.70 > N-gain	Hight
0.30 ≤ N-gain < 0.70	Medium
N-gain < 0.30	Low

Result and Discussion

The results of the research on the application of ethno-biology learning model based on design thinking to improve students' critical thinking skills in SMA Negeri 2 Kerinci students can be seen in Table 3.

Table 3. Students' Critical Thinking Ability Score on Pretest and Posttest of Experimental and Control Classes

Class		N	Mean	SD	N-gain
Experiment	Pretest	21	45.17	7.12	0.72 (High)
	Posttest		82.40	8.65	
Control	Pretest	21	31.20	6.32	0.56
	Posttest		70.60	7.10	(Medium)

Based on Table 3 Shows the pretest value of students in the experimental class of 45.17 while the posttest value of experimental class students is 82.40. The pretest value of control class students was 31.20 while the posttest value of control class students was 70.65. This explains that the value of critical thinking skills of experimental class students who use ethnoscience learning based on design thinking is higher than control class students who use conventional learning. Ethnoscience learning based on design thinking encourages students to improve cognitive abilities and critical thinking in students (Muhamad et al., 2018; Setiawan et al., 2017). Thinking skills are very important for students in solving problems in everyday life (Shaw et al., 2019; Ma et al., 2021; Oktarina et al., 2021; Razak et al., 2021). Therefore, the design thinking-

based ethno-biology learning model provides opportunities for students to think critically to implement ethnoscience-based biology learning (Agustin et al., 2018; Sumarni et al., 2022). Ethno-biology learning model based on design thinking students are more innovative and creative in learning to find new ideas. So this ethno-biology learning model makes it easier for students to understand the subject matter directly with nature (Nuroso et al., 2018; Tresnawati et al., 2020; Vandebroek et al., 2020).

The application of ethnobiology-based learning models is more effective in fostering students' critical thinking skills. When compared to other conventional learning, the ethnobiology learning model allows students to interact with their local wisdom. This can encourage students' critical thinking skills in learning (Dewi et al., 2021; Arfianawati et al., 2016). Furthermore, Figure 1 explains that there is a significant increase in the value of critical thinking skills of experimental class students compared to the value of critical thinking skills of the control class. According to Atchia (2021) design thinking-based learning can improve student learning outcomes and students are able to develop their ideas.

The results in Table 3. Shows that students' critical thinking skills in the experimental class increased 0.72 with a high category and in the control class increased 0.56 with a moderate category. Rini et al. (2021) Design thinking-based learning improves students' critical thinking skills in science learning. The ethno-biology learning model based on design thinking in the student learning process is carried out by linking learning materials with local wisdom related to biology (Padhy et al., 2017; Fasasi, 2017). According to Yuliana et al. (2021) ethnoscience learning model based on design thinking fosters students' critical thinking skills and science literacy in learning. This helps students in fostering critical thinking skills because students interact directly with nature. Students who gain knowledge directly with their environment are able to develop their critical thinking skills (Risdianto et al., 2020; Izalia & Wisnuadi, 2020).

Students' critical thinking skills in ethno-biology learning based on design thinking pay attention to the indicators of critical thinking skills. Ennis (1985) found indicators of critical thinking skills, namely the ability to provide simple explanations (elementary classification), build students' basic skills (Basic support), provide inference, the ability to make further explanations (Advances classification), and provide strategies and tactics. The value of critical thinking skills of experimental and control classes seen in each indicator can be seen in Table 4-5.

Table 4. Students' Critical Thinking Skills Based on Indicators in the Experiment Class

Indicator	Experiment Mean		N-gain	Category
	Pretest	Posttest		
Elementary clasification	45	80	0.76	Hight
Basic support	50	85	0.83	Hight
inference	40	75	0.88	Hight
Advances clasification	40	80	0.72	Hight
Strategies and Tactics	35	85	0.91	Hight
Average score	42	81	0.82	Hight

Table 5. Students' Critical Thinking Skills Score Based on Indicators in the Control Class

Indicator	Control Mean		N-gain	Category
	Pretest	Posttest		
Elementary clasification	45	70	0.51	Medium
Basic support	30	75	0.67	Medium
inference	40	65	0.71	Hight
Advances clasification	40	70	0.59	Medium
Strategies and Tactics	30	80	0.79	Hight
Average score	37	72	0.68	Medium

Tables 4 and 5, shows the average value of pretest and posttest critical thinking skills based on each indicator of experimental classes that use ethnobiology learning models based on design thinking better than control classes that use conventional learning. This can be seen from the average pretest of experimental and control classes. The experimental class had an average pretest score of 42 and a posttest score of 81 with an n-gain of 0.82 in the high category. The control class had an average pretest score of 37 and a posttest score of 72 with an n-gain of 0.68 in the medium category. ethnobiological learning models improve critical thinking skills and understanding of student concepts in learning (Ardianti & Raida 2022; Untari et al., 2020). Not only that, the ethnobiology learning model encourages critical thinking skills in students Sudarmin (2018). The ethonobiology learning model helps students be more active in learning activities and students are able to apply learning concepts to everyday life (Sudarmin et al., 2019; Zaenuri et al., 2017).

Figure 2, shows the n-gain value of critical thinking skills of the experimental class is higher than the control class. Based on the indicators of critical thinking ability from the results of the student critical thinking ability test, the average n-gain value of the experimental class is higher than the control class. This is due to one factor, namely the application of the design

thinking-based ethnobiology learning model carried out in the experimental class so that it can foster students' thinking skills in biology learning (Munirotus et al., 2020) stated that students who only receive knowledge from teachers without involving critical thinking skills will make teaching and learning activities less effective. The teaching and learning process with the ethnobiology learning model based on design thinking stimulates students' critical thinking skills in learning biology (Rahmawati & Subali, 2019; Sari & Wilujeng, 2023; Hidaayatullaah et al., 2021). Students who have critical thinking skills can solve problems that occur in learning activities (Djamas et al., 2018; Ramli et al., 2020). In addition, the application of the right model in the learning process will be able to encourage students to be more active and creative in learning (Festiyed et al., 2022; Santosa et al., 2021). This causes students' critical thinking skills in the experimental class to be higher than the control class.

To see the effect of ethnobiology learning model based on design thinking on critical thinking skills, hypothesis testing with T-test was conducted. The results of the hypothesis test of students' critical thinking skills can be seen in Table 6.

Table 6. Independent sample T-test Hypothesis Test Results

	t-test for equality of means			Conclusion
	t	df	Sig. (2-tailed)	
Equal variances assumed	3.023	42	0.000	H1 accepted
Equal variances not assumed	3.120	43.199	0.000	

Based on Table 6, shows the sig value. <0.05 or 0.00 <0.05, so H0 is rejected and H1 is accepted. This explains that the design thinking-based ethnobiology learning model has a significant effect on students' critical thinking skills in learning biology. Ethnoscience learning supports the quality of student learning in fostering students' critical thinking skills (Ibe & Nwosu, 2017; Zidny & Eilks, 2022; Suastra & Pujani, 2021). In addition, the learning process that applies ethnobiology learning is more effective in helping students apply local wisdom in learning materials (Parmin et al., 2017; Kik et al., 2021). The learning process through the design thinking-based ethnobiogical learning model helps students develop knowledge in understanding local wisdom. This has a positive impact on students in developing the potential to think critically in learning biology. In addition, learning with ethnoscience students care more about nature (Yulkifli et al., 2022).

Conclusion

Based on this research, it shows that the average value of posttest and N-gain critical thinking skills of classes that get ethno-biology learning based on design thinking is better than classes that use conventional learning. The t-test results show that the ethno-biology learning model based on design thinking has an effect on critical thinking skills sig. < 0.05 (0.00 < 0.05). Ethnobiology learning model based on design thinking is effective to be applied in learning biology. This learning model can stimulate students' critical thinking skills. not only that, design thinking-based ethnobiology learning fosters students' caring attitude towards the environment. So, through the design-based ethnobiology learning model becomes one of the effective learning models to improve student thinking and biology learning.

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References

Agustin, N., Susilogati, S., & Addiani, K. (2018). desain Instrumen Tes Bermuatan Etnosains Untuk Mengukur Kemampuan Berpikir Kritis Siswa sma. *Jurnal Inovasi Pendidikan Kimia*, *12*(2), 2159 – 2169. https://doi.org/10.15294/jipk.v12i2.15475

Al-shaye, S. (2021). Digital storytelling for improving critical reading skills, critical thinking skills, and self-regulated learning skills. *Cypriot Journal of Educational Sciences*, *16*(4), 2049–2069. Retrieved from https://www.ceeol.com/search/article-detail?id=1013147

Amin, S., Utaya, S., Bachri, S., & Susilo, S. (2020). Effect of problem-based learning on critical thinking skills and environmental attitude. *Journal for the Education of Gifted Young Scientists*, *8*(2), 743–755. https://doi.org/10.17478/jegys.650344

Ardi, L. &. (2017). *Metode Penelitian*. UNP Press.

Ardianti, S. D., & Raida, S. A. (2022). The Effect of Project

Based Learning with Ethnoscience Approach on Science Conceptual Understanding. *Journal of Innovation in Educational and Cultural Research*, *3*(2), 207–214. https://doi.org/10.46843/jiecr.v3i2.89

Atchia, S. M. C. (2021). Integration of ' design thinking ' in a reflection model to enhance the teaching of biology. *Journal of Biological Education*, *00*(00), 1–15. https://doi.org/10.1080/00219266.2021.1909642

Aza Nuralita. (2020). Analisis penerapan model Pembelajaran berbasis etnosains dalam pembelajaran tematik SD. *MIMBAR PGSD Undiksha*, *4*(1), 1–8. Retrieved from https://ejournal.undiksha.ac.id/index.php/JJPGSD/article/view/22972

Brown, T. (2020). A learning toolkit to promote creative and critical thinking in product design and development through Design Thinking. *IEEE Software*, *37*(2), 21–24. https://doi.org/10.1109/CISPEE.2016.7777732

Damayanti, C., Rusilowati, A., & Linuwih, S. (2017). Pengembangan Model Pembelajaran IPA Terintegrasi Etnosains. *Journal of Innovative Science Education*, *6*(1), 116–128. https://doi.org/10.15294/jise.v6i1.17071

Dewi, C. A., Erna, M., Martini, Haris, I., & Kundera, I. N. (2021). Effect of Contextual Collaborative Learning Based Ethnoscience to Increase Student's Scientific Literacy Ability. *Journal of Turkish Science Education*, *18*(3), 525–541. https://doi.org/10.36681/tused.2021.88

Djamas, D., & Padang, U. N. (2018). Development of Interactive Multimedia Learning Materials for Improving Critical Thinking Skills. *International Journal of Information and Communication Technology Education*, *14*(4), 66–84. https://doi.org/10.4018/IJICTE.2018100105

Elfira, I., & Santosa, T. A. (2023). Literature Study : Utilization of the PjBL Model in Science Education to Improve Creativity and Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 133–143. https://doi.org/10.29303/jppipa.v9i1.2555

Ennis, R. H. (1984). A Logical Basis for Measuring Critical Thinking Skills. *Educational Leadership*, *43*(2), 44–48. Retrieved from https://jgregorymcverry.com/readings/ennis1985assessingcriticalthinking.pdf

Fasasi, R. A. (2017). Effects of ethnoscience instruction , school location , and parental educational status on learners ' attitude towards science. *International Journal of Science Education*, *0693*, 1–18. https://doi.org/10.1080/09500693.2017.1296599

Festiyed, F. N. Y. A. (2022). Networked-based Inquiry : An Effective Physics Learning in the New Normal COVID-19 Era in Indonesia. *International Journal of Instruction*, *15*(2), 997–1016. https://doi.org/10.29333/iji.2022.15255a

Fitriani, A. (2020). PBLPOE : A Learning Model to Enhance Students ' Critical Thinking Skills and Scientific Attitudes. *International Journal of Instruction*, *13*(2), 89–106. https://doi.org/10.29333/iji.2020.1327a

Hamdani, S. A., Prima, E. C., Agustin, R. R., Feranie, S., & Sugiana, A. (2022). Development of Android-based Interactive Multimedia to Enhance Critical Thinking Skills in Learning Matters. *Journal of Science Learning*, *5*(1), 103–114. https://doi.org/10.17509/jsl.v5i1.33998

Herzon, H. H., Budijanto, & Utomo, H. D. (2018). Pengaruh Problem-Based Learning (PBL) terhadap Keterampilan Berpikir Kritis. *Jurnal Pendidikan*, *3*(1), 42–46. Retrieved from https://journal.um.ac.id/index.php/jptpp/article/view/10446

Hidaayatullaah, H. N., Suprapto, N., Hariyono, E., Prahani, B. K., & Wulandari, D. (2021, November). Research trends on ethnoscience based learning through bibliometric analysis: Contributed to physics learning. In *Journal of Physics: Conference Series* (Vol. 2110, No. 1, p. 012026). IOP Publishing. https://doi.org/10.1088/1742-6596/2110/1/012026

Hikmawati, H., Suastra, I. W., & Pujani, N. M. (2020). Ethnoscience-Based Science Learning Model to Develop Critical Thinking Ability and Local Cultural Concern for Junior High School Students in Lombok. *Jurnal Penelitian Pendidikan IPA*, *7*(1), 60. https://doi.org/10.29303/jppipa.v7i1.530

IAzalia, I., & Wisnuadi, A. (2020). International Journal of Active Learning The Effects of Ethnoscience Integrated STEM E-Book Application on Student ' s Science Generic Skills in Chemical Equilibrium Topic. *International Journal of Active Learning*, *5*(1), 19–25. Retrieved from https://www.learntechlib.org/p/216680/

Ibe, E. &, & Nwosu, A. A. (2017). Effects Of Ethnoscience And Traditional Laboratory Practical On Science Process Skills Acquisition Of Secondary School Biology Students In Nigeria. *British Journal of Multidisciplinary and Advanced Studies*, *1*(1), 10–21. Retrieved from https://bjmas.org/index.php/bjmas/article/view/4

Kanmaz, A. (2022). Middle School Teachers' Critical Thinking Skills and Awareness Towards Teaching Critical Thinking Skills. *International Online Journal of Education and Teaching (IOJET)*, *9*(4), 1648–1671. Retrieved from https://files.eric.ed.gov/fulltext/EJ1353469.pdf

Kik, A., Adamec, M., Aikhenvald, A. Y., Bajzekova, J., & Baro, N. (2021). Language and ethnobiological skills

decline precipitously in Papua New Guinea, the world ' s most linguistically diverse nation. *PNAS 2021*, *118*(2), 1–8. https://doi.org/10.1073/pnas.2100096118

Ludwig, A., & Charbel, N. (2023). Philosophy of Ethnobiology : Understanding Knowledge Integration and Its Limitations Philosophy of Ethnobiology : Understanding Knowledge Integration. *Journal of Ethnobiology*, *40*(1), 3–20.

Ma, X., Zhang, Y., & Luo, X. (2021). Students ' and teachers ' critical thinking in science education : are they related to each other and with physics achievement ? *Research in Science & Technological Education*, *00*(00), 1–25. https://doi.org/10.1080/02635143.2021.1944078

Masani Romauli Helena Marudut, Ishak. G. Bachtiar, Kadir, V. I. (2020). Peningkatan Kemampuan Berpikir Kritis dalam Pembelajaran IPA Melalui Pendekatan Keterampilan Proses. *Jurnal Basicedu*, *4*(3), 577–585. Retrieved from https://jbasic.org/index.php/basicedu/article/view/401

Moath Khalaf Alomery, &, W. A. H. (2021). The Effectiveness of Visual Mind Mapping Strategy for Improving English Language Learners' Critical Thinking Skills and Reading Ability. *European Journal of Educational Research*, *11*(1), 69–81. Retrieved from https://digitallibrary.aau.ac.ae/handle/123456789/642

Muhamad, C., Falah, N., & Windyariani, S. (2018). Peningkatan Kemampuan Berpikir Kritis Peserta Didik Melalui Model Pembelajaran Search, Solve, Create, and Share (Sscs) Berbasis Etnosains. *Didaktika Biologi: Jurnal Penelitian Pendidikan Biologi*, *2*(1), 25–32. https://doi.org/10.32502/dikbio.v2i1.1035

Munirotus, S. adah;, Suryaningsih, S., & Muslim, B. (2020). Pemanfaatan multimedia interaktif pada materi hidrokarbon untuk menumbuhkan keterampilan berpikir kritis siswa The use interactive multimedia on hydrocarbon chapter to grow student ' s critical thinking skill. *Jurnal Inovasi Pendidikan IPA, 6*(2), 184–194. http://dx.doi.org/10.21831/jipi.v6i2.29680

Nuroso, H., & Sudarmin, S. (2018, March). Identification of indigenous science in the brick-making process through ethnoscience study. In *Journal of Physics: Conference Series* (Vol. 983, No. 1, p. 012172). IOP Publishing. https://doi.org/10.1088/1742-6596/983/1/012172

Oktarina, K., Suhaimi, S., Santosa, T. A., Razak, A., Irdawati, I., Ahda, Y., ... & Putri, D. H. (2021). Meta-Analysis: The Effectiveness of Using Blended Learning on Multiple Intelligences and Student Character Education during the Covid-19 Period. *IJECA (International Journal of Education and Curriculum Application), 4*(3), 184-192. https://doi.org/10.31764/ijeca.v4i3.5505

Padhy, S., Dash, S. K., & Mohapatra, R. (2015). Ethno-biology: The Science of a Common Man to Explore the Traditional Ecology, Biodiversity and Philosophy of Conservation: A Review. *Journal of Biodiversity*, *6*(1–2), 9–21. https://doi.org/10.1080/09766901.2015.11884751

Padhy, S., Dash, S. K., Mohapatra, R., Padhy, S., Dash, S. K., & Mohapatra, R. (2017). Ethno-biology : The Science of a Common Man to Explore the Traditional Ecology , Biodiversity and Philosophy of Conservation : A Review Ethno-biology : The Science of a Common Man to Explore the Traditional Ecology , Biodiversity and Philosophy of Conserv. *Journal of Biodiversity*, *6*(1), 1–14. https://doi.org/10.1080/09766901.2015.11884751

Pande, M., & Bharathi, S. V. (2020). Theoretical foundations of design thinking – A constructivism learning approach to design thinking. *Thinking Skills and Creativity*, *36*(October 2019), 100637. https://doi.org/10.1016/j.tsc.2020.100637

Parmin, Sajidan2, Ashadi3, Sutikno4Sutikno4, F. F. (2017). Jurnal Pendidikan IPA Indonesia the Scientific Work Independence of Student Teacher. *Jurnal Pendidikan IPA Indonesia*, *6*(2), 365–372. https://doi.org/10.15294/jpii.v6i2.11276

Rahmawati, S., & Subali, B. (2019). The Effect o f Ethnoscience Based Contextual Learning Toward Students ' Learning Activity. *Journal of Primary Education*, *8*(2), 152–160. Retrieved from https://journal.unnes.ac.id/sju/index.php/jpe/article/view/25688

Ramli, R., Sari, Y. S., Selisne, M., Fisika, J., Padang, U. N., & Hamka, J. P. (2020). Pengembangan Lembar Kerja Peserta Didik Fisika Berbasis Pendekatan Science , Technology , Engineering , and Mathematics untuk Meningkatkan Berpikir Kritis Peserta Didik. *JEP (Jurnal Eksakta Pendidikan)*, *4*, 10–17. Retrieved from https://repository.unp.ac.id/37432/

Razak, Abdul, Santosa, Tomi Apra, Lufri., et al. (2021). Meta-Analisis: Pengaruh Soal HOTS (Higher Order Thinking Skill) Terhadap Kemampuan Literasi Sains dan Lesson Study Siswa Pada Materi Ekologi dan Lingkungan Pada Masa Pandemi Covid-19. *Bioedusiana*, *6*(1), 79–87. Retrieved from https://103.123.236.7/index.php/bioed/article/view/2930

Redhana, I. W. (2013). Model Pembelajaran Berbasis Masalah Dan Pertanyaan Socratik Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa. *Jurnal Cakrawala Pendidikan*, *3*, 351–365. https://doi.org/10.21831/cp.v0i3.1136

Rijal, M., Mastuti, A. G., Safitri, D., Bachtiar, S., & Samputri, S. (2021). Differences in learners ' critical thinking by ability level in conventional , NHT , PBL , and integrated NHT-PBL classrooms. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(4), 1133–1139. https://doi.org/10.11591/ijere.v10i4.21408

Risdianto, E., Dinissjah, M. J., & Kristiawan, M. (2020). The Effect of Ethno Science-Based Direct Instruction Learning Model in Physics Learning on Students ' Critical Thinking Skill. *Universal Journal of Educational Research*, *8*(2), 611–615. https://doi.org/10.13189/ujer.2020.080233

Riti, Y. U. R., Degeng, I. N. S., & Sulton, S. (2021). Pengembangan Model Pembelajaran Berbasis Proyek dengan Menerapkan Metode Design Thinking untuk Meningkatkan Keterampilan Berpikir Kritis Siswa Dalam Mata Pelajaran Kimia. J*urnal Pendidikan: Teori, Penelitian, dan Pengembangan, 6*(10), 1581-1587. Retrieved from https://journal.um.ac.id/index.php/jptpp/article/view/15056

Samaras, S. A., Adkins, C. L., & White, C. D. (2022). Developing critical thinking skills: Simulations vs. cases. *Journal of Education for Business*, *97*(4), 270–276. https://doi.org/10.1080/08832323.2021.1932703

Santoro, F. R., Luiz, A., Nascimento, B., Soldati, G. T., Soares, W., Júnior, F., & Albuquerque, U. P. (2018). Evolutionary ethnobiology and cultural evolution : opportunities for research and dialog. *Journal of Ethnobiology and Ethnomedicine*, *14*(1), 1–14. https://doi.org/10.1186/s13002-017-0199-y

Santosa, T. A., Razak, A., Arsih, F., & Sepriyani, E. M. (2021). Meta-Analysis : Science Learning Based on Local Wisdom Against Preserving School Environments During the Covid-19 Pandemic. *Journal of Biology Education*, *10*(2), 244–251. https://doi.org/10.15294/jbe.v10i2.48533

Sari, F. P., & Wilujeng, I. (2023). Ethnoscience Studies Analysis and Their Integration in Science Learning : Literature Review. *Jurnal Penelitian Pendidikan IPA*, *9*(3), 1135–1142. https://doi.org/10.29303/jppipa.v9i3.2044

Setiawan, B., Innatesari, D. K., & Sabtiawan, W. B. (2017). The Development Of Local Wisdom-Based Natural Science Module To Improve Science Literation Of Students. *Jurnal Pendidikan IPA Indonesia*, *6*(1), 49–54. https://doi.org/10.15294/jpii.v6i1.9595

Shaw, A., Liu, O. L., Gu, L., Kardonova, E., Chirikov, I., Li, G., Hu, S., Yu, N., Ma, L., Guo, F., Su, Q., Shi, J., Loyalka, P., Shaw, A., Liu, O. L., Gu, L., Kardonova, E., & Chirikov, I. (2019). Studies in Higher Education Thinking critically about critical thinking : validating the Russian HEIghten ® critical thinking assessment Thinking critically about critical thinking : validating the Russian. *Studies in Higher Education*, *50*(9), 1–17. https://doi.org/10.1080/03075079.2019.1672640

Siti Arfianawati, Sudarmin, dan W. S. (2016). Model Pembelajaran Kimia Berbasis Etnosains Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *Jurnal Pengajaran MIPA, 21*(1), 46–51.

Suastra, I. W., & Pujani, N. M. (2021). Ethnoscience-Based Science Learning Model to Develop Critical Thinking Ability and Local Cultural Concern for Junior High School Students in Lombok. *Jurnal Penelitian Pendidikan IPA*, *7*(20). https://doi.org/10.29303/jppipa.v7i1.530

Sudarmin, S., Zahro, L., Pujiastuti, S. E., Asyhar, R., Zaenuri, Z., & Rosita, A. (2019). The development of PBL-based worksheets integrated with green chemistry and ethnoscience to improve studentsâ€™ thinking skills. *Jurnal Pendidikan IPA Indonesia, 8*(4), 492-499. https://doi.org/10.15294/jpii.v8i4.17546

Sudarmin, S., Selia, E., & Taufiq, M. (2018). The influence of inquiry learning model on additives theme with ethnoscience content to cultural awareness of students. *Journal of Physics: Conference Series*, *983*(1). https://doi.org/10.1088/1742-6596/983/1/012170

Sudarmin, S., Mursiti, S., & Asih, A. G. (2018, April). The use of scientific direct instruction model with video learning of ethnoscience to improve students' critical thinking skills. In *Journal of Physics: Conference Series* (Vol. 1006, No. 1, p. 012011). IOP Publishing. https://doi.org/10.1088/1742-6596/1006/1/012011

Suharyat, Y., Santosa, T. A., & Satria, E. (2023). The Effectiveness of STEM-Based Learning in Teaching 21 st Century Skills in Generation Z Student in Science Learning : A. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 160–166. https://doi.org/10.29303/jppipa.v9i1.2517

Sumarni, W., Sudarmin, S., Sumarti, S. S., & Kadarwati, S. (2022). Indigenous knowledge of Indonesian traditional medicines in science teaching and learning using a science – technology – engineering – mathematics (STEM) approach Indigenous knowledge of Indonesian traditional medicines in science teaching and learning using. In *Cultural Studies of Science Education* (Issue June). Springer Netherlands. https://doi.org/10.1007/s11422-021-10067-3

Sutiani, A., Situmorang, M., & Silalahi, A. (2021). Implementation of an Inquiry Learning Model with Science Literacy to Improve Student Critical Thinking Skills. *International Journal of Instruction*, *14*(2), 117–138. https://doi.org/10.29333/iji.2021.1428a

Syawaludin, A., Gunarhadi, & Rintayati, P. (2019). Development of augmented reality-based interactive multimedia to improve critical thinking skills in science learning. *International Journal of Instruction*, *12*(4), 331–344. https://doi.org/10.29333/iji.2019.12421a

Temuningsih, Peniati, E., & Marianti, A. (2017). Pengaruh Penerapan Model Problem Based Learning Berpendekatan Etnosains Pada Materi Sistem Reproduksi Terhadap Kemampuan Berpikir Kritis Siswa. *Journal of Biology Education*, *6*(1), 70–79. https://doi.org/10.15294/jbe.v6i1.14060

Tresnawati, N., Saleh, I., & Trie, D. (2020). Learning Science Through STEAM Approach (Science Technology , Engineering , Arts , and Mathematics) Integrated Ethnoscience in the Context of Batik Culture for Pre Service Teachers of Primary Education. *International Conference on Agriculture, Social Sciences, Education, Technology and Health (ICASSETH 2019*, *429*, 243–246. https://doi.org/10.2991/assehr.k.200402.056

Untari, R., Indrayani, L., & Triwiswara, M. (2020). Scientific reconstruction of indigenous knowledge of batik natural dyes using ethno-STEM approach Scientific reconstruction of indigenous knowledge of batik natural dyes using ethno-STEM approach. *Journal of Physics: Conference Series PAPER*, 0–6. https://doi.org/10.1088/1742-6596/1567/4/042046

Van der Zanden, P. J. A. C., Denessen, E., Cillessen, A. H. N., & Meijer, P. C. (2020). Fostering critical thinking skills in secondary education to prepare students for university: teacher perceptions and practices. *Research in Post-Compulsory Education*, *25*(4), 394–419. https://doi.org/10.1080/13596748.2020.1846313

Vandebroek, I., Pieroni, A., Stepp, J. R., Hanazaki, N., Ladio, A., Romeu, R., Alves, N., Picking, D., Delgoda, R., Maroyi, A., Andel, T. Van, Quave, C. L., Paniagua-zambrana, N. Y., Bussmann, R. W., Odonne, G., Abbasi, A. M., Albuquerque, U. P., Baker, J., Kutz, S., … Olango, T. M. (2020). Reshaping the future of ethnobiology research after the COVID-19 pandemic. *Nature Plants*, *6*(July). https://doi.org/10.1038/s41477-020-0691-6

Welsh, A. A., & Dehler, G. E. (2019). Combining Critical Reflection and Design Thinking to Develop Integrative Learners. *Journal of Management Education*, *37*(6), 771–802. https://doi.org/10.1177/1052562912470107

Yaki, A. A. (2022). Fostering Critical Thinking Skills Using Integrated STEM Approach among Secondary School Biology Students. *European Journal of STEM Education*, *7*(1), 06. https://doi.org/10.20897/ejsteme/12481

Yulkifli, Y., Yohandri, Y., & Azis, H. (2022). Development of physics e-module based on integrated project-based learning model with Ethno-STEM approach on smartphones for senior high school students. *Momentum: Physics Education Journal*, *6*(1), 93-103. https://doi.org/10.21067/mpej.v6i1.6316

Yustina, Mahadi, I., Ariska, D., Arnentis, & Darmadi. (2022). The Effect of E-Learning Based on the Problem-Based Learning Model on Students ' Creative Thinking Skills During the Covid-19 Pandemic. *International Journal of Instruction*, *15*(2), 329–348. https://doi.org/10.29333/iji.2022.15219a

Zaenuri, Z., Sudarmin, S., Utomo, Y., & Juul, E. (2017). Habituation model of implementing environmental education in elementary school. *Jurnal Pendidikan IPA Indonesia*, *6*(2), 206-212. https://doi.org/10.15294/jpii.v6i2.10200

Zidny, R., & Eilks, I. (2022). Learning about Pesticide Use Adapted from Ethnoscience as a Contribution to Green and Sustainable Chemistry Education. *Education Sciences*, *12*(4), 100–110. https://doi.org/10.3390/educsci12040227