



The Influence of the Flipped Classroom Learning Model with an Ethnoscience Approach on Students' Critical Thinking Ability

Oksa Afdarina^{1*}, Moralita Chatri¹, Helendra¹, Irdawati¹

¹ Master of Biology Education, Universitas Negeri Padang, Padang, Indonesia.

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Corresponding Author:

Oksa Afdarina

oksaafdarina25@gmail.com

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Abstract: The application of the flipped classroom learning model with an ethnoscience approach trains students to learn independently in developing and sharpening critical thinking skills. The aim of the research is to determine the effect of the flipped classroom learning model with an ethnoscience approach on students' critical thinking abilities. This type of research is a quasi-experiment with a non-equivalent control group design. The sample used consisted of two classes, one class was designated as the experimental class and one class as the control class. The purposive sampling method was used to collect samples. The results of hypothesis testing using the t test show that t count is greater than table at a significance level of 0.05, which indicates that the hypothesis H_0 is rejected. Thus, the flipped classroom learning model with an ethnoscience approach influences students' critical thinking abilities.

Keywords: Critical thinking skills; Ethnoscience; Flipped classroom

Introduction

Currently, the world of education is moving towards a student-centered learning process (Kavenuke & Kihwele, 2023). Education today requires students to construct their own knowledge (Prihantini et al., 2023). This is done in order to achieve educational goals according to Todres et al. (2023) namely giving students the skills necessary to live in society. The abilities in question consist of attitudinal competence which includes spirituality and high social ethics in living in society and skills competence which includes the ability to understand and apply what has been learned (Siddiq et al., 2023). Students must have modern age skills. Modern century learning requires 4C skills: communication, collaboration, critical thinking and creativity (Azmi & Festiyed, 2023). These skills are critical to successful learning in the digital era (GonzálezPérez & Ramírez-Montoya, 2022). These skills can be obtained through a learning process, experience

or practice. Active learning occurs when teachers and students continually develop their skills (Lombardi et al., 2021). The involvement of all students can create an active and democratic atmosphere (Saekhow & Cheewaviriyanon, 2021). Each student has a role in sharing their learning experiences with other students. Students first go to school to get a formal education. One of the fields of science taught in schools is Natural Sciences (IPA), namely science that studies facts, concepts, discovery processes and scientific attitudes through observation and experimentation (Sintiawati et al., 2021). Natural science is human knowledge about nature that is obtained in a controlled manner (Febri et al., 2019).

Science lessons are related to the process of finding out so that science is not just mastering concepts or principles of knowledge. In order to gain a better understanding of the natural environment, the learning process emphasizes direct experience. In addition, it emphasizes contemporary pedagogical aspects, namely

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the application of a scientific approach to learning so that students are asked to improve their own skills during their learning process (Hillmayr et al., 2020). In this field, students are faced with many abstract concepts that require good critical thinking skills. Critical thinking means thinking carefully and reasonably so that you can make decisions about something important to determine whether your ideas can be accepted or carried out based on scientific thinking.

Critical thinking skills emphasize the decisions or considerations made by individuals. Students' low critical thinking abilities are a problem faced today. Remembering, recognizing, calculating, measuring, classifying, ordering, applying, representing, modeling, analyzing, generalizing, synthesizing and solving problems are all aspects of knowledge that are measured in international studies, known as Trends in International Mathematics and Science Study (TIMSS) (Teig et al., 2022). This study involved junior high school students studying science and mathematics. TIMSS results show that Indonesia experienced another decline, being in 44th position out of 49 countries (Rahmawati, 2020). This also illustrates that students are not actively involved in learning.

At SMP Negeri 9 Batang Hari, the results of testing their critical thinking skills by giving 25 HOTS questions. The results are shown in Table 1.

Table 1. Student Critical Thinking Ability Test Results

Class	The number of students	Average	Completeness
VIII A	32	52.78	16.89%
VIII B	31	58.90	18.26%
VIII C	32	53.65	17.17%
Average completion			17.44%

In Table 1, it can be seen that the average completion rate for class VIII students is 17.44%. A low level of completion indicates that students' critical thinking skills are still lacking. Apart from that, the conventional learning model used by teachers is not effective in the learning process. As a result, students' critical thinking abilities are low. To improve students' critical thinking skills, educators must choose a more relevant learning model to apply, because the success of learning activities in the classroom depends on the educator.

The flipped classroom learning model is an effort to solve critical thinking problems in modern education (Sari et al., 2023). Basically, this model says that students at home do what they do in class, namely learning by understanding the material provided by the teacher and students in class do what students usually do at home, namely working on questions and completing

assignments (Khairunnisak et al., 2023). He further explained that the flipped classroom model is an alternative learning that teachers can use to improve students' critical thinking skills. This is in line with the opinion which states that the flipped classroom has a positive effect on the critical thinking abilities of high school (SMA) students. The flipped classroom maximizes mutual interaction between teachers, students and their environment (Harjono et al., 2022). This learning model uses learning media that students can access online and offline to support their learning. This model emphasizes how to use class time effectively to increase student knowledge, student learning activities and their critical thinking abilities.

Based on research conducted by Pratama et al. (2023) shows that ethnosience has the potential to be a source of knowledge that can be explored to improve students' critical thinking abilities. Ethnosience is the process of combining cultural science and scientific science (Siami et al., 2023). All knowledge related to society is considered genuine science of society. Local wisdom or understanding of nature and culture that develops in society is a representation of the community's original science. This is in line with opinion Mulatsih et al. (2023) states that learning whose learning resources are obtained from indigenous knowledge of the community packaged in ethnosience has the potential to improve students' critical thinking abilities. The ethnosience approach has the ability to expand students' knowledge about their surrounding environment and prevent them from being isolated (Fitri & Asrizal, 2023). Meaningful learning in an ethnosience approach can increase student competence because this approach focuses more on integrated understanding rather than just in-depth understanding (Putu Verawati et al., 2022). Developing connections between science, technology and society is an important component of science studies.

Therefore, it is necessary to conduct research on the influence of the flipped classroom learning model with an ethnosience approach on students' critical thinking abilities by considering the need for models and approaches in learning that can improve students' critical thinking abilities. Bearing in mind that the ability to think critically is one of the very important abilities possessed by every individual student to face the life of today's modern society.

Method

This type of research is a quasi-experimental (quasi-experimental) form of non-equivalent control group design. In this design, control variables cannot be implemented strictly or fully (Miller et al., 2020). This

research compares critical thinking skills between an experimental group that applies the flipped classroom learning model with an ethnoscience approach and a control group that applies conventional learning. The research design used was a posttest only control group design. The research design can be seen in the following table:

Table 2. Posttest Only Control Group Design

Class	Treatment	Posttest
Experiment	X	T
Control	O	T

Information:

X: Flipped classroom learning model with an ethnoscience approach

O: Conventional learning

T: Posttest experimental class and class control

The population of this study was all 95 students in class VIII of SMP Negeri 9 Batang Hari. The sample used was two classes with one class as the control class and one class as the experimental class. It was found that class VIII A was the experimental class which received the flipped classroom learning model with an ethnoscience approach and class VIII C was the control class which received conventional learning treatment. The sample used in this research was taken using a purposive sampling technique. The reason for using the purposive sampling technique was because the criteria used by the researcher for the research sample were classes taught by the same teacher, namely Mrs. Mailis Padus., S.Pd and both classes had almost the same average score, namely 52.78 in class VIII A and 53.65 in class VIII C. This aims to equalize students' initial experiences.

The independent variable in the research is the flipped classroom learning model with an ethnoscience approach. Meanwhile, the dependent variable in this research is the critical thinking ability of class VIII students at SMP Negeri 9 Batang Hari. The instruments used in this research were the Learning Implementation Plan (RPP) and critical thinking skills questions. Validation of the research instruments used in this research was validated by two experts in science learning. The data analysis technique in this research consists of testing the normality of data distribution, homogeneity of variance testing and hypothesis testing. The hypothesis proposed in this research is:

H₀: The flipped classroom learning model with an ethnoscience approach has no effect on critical thinking skills of class VIII students of SMP Negeri 9 Batang Hari.

H₁: The flipped classroom learning model with an ethnoscience approach influences the critical thinking

abilities of class VIII students at SMP Negeri 9 Batang Hari.

The overall research procedure can be described as follows:

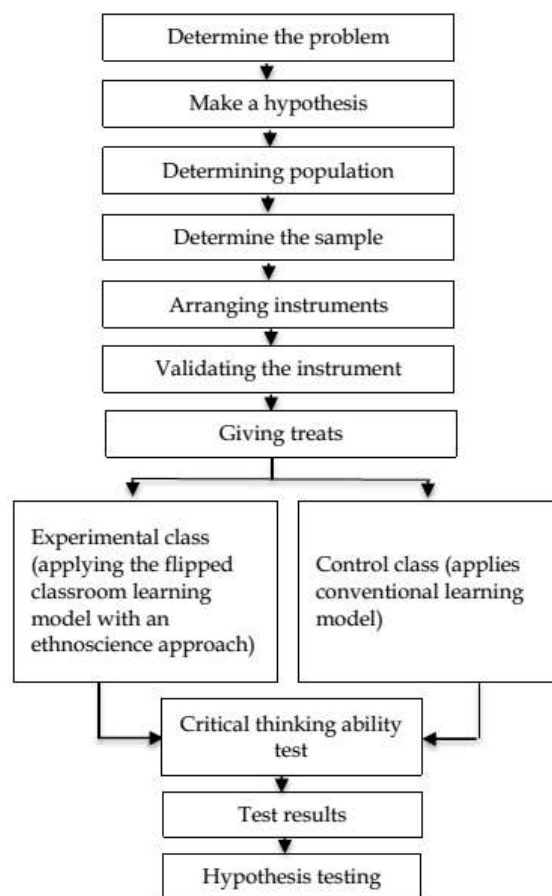


Figure 1. Research procedure

Results and Discussion

Validation Results

This research instrument was validated by two experts in science learning. The validation results are presented in the following table:

Table 3. Results of Validation of Research Instruments

Instrument	Information
lesson plan	Valid
Critical thinking ability test questions	Valid

Table 3 shows the validity of the research instrument in the valid category for RPP, LKPD, and critical thinking skills questions. This means that the research instruments are suitable for use.

Normality Test Results

The normality test is carried out to determine whether the data obtained is normally distributed (Nuryadi et al., 2017). Calculation of the normality test

in the experimental class and control class uses the Liliefors test. The results of the normality test calculations are summarized in the following table:

Table 4. Normality Test Results

Class	N	L_{count}	L_{table}	Information
Experiment	32	0.13	0.15	Normally distributed
Control	32	0.15	0.15	Normally distributed

Based on Table 4, the results in the experimental class and control class show that $L_{count} < L_{table}$. This means that the data in both classes is normally distributed.

Homogeneity Test Results

The homogeneity test aims to see whether the two subjects have homogeneous variants or not (Nuryadi et al., 2017). The results of the homogeneity test calculations are summarized in the following table:

Table 5. Homogeneity Test Results

Class	N	F_{count}	F_{table}	Information
Eksperiment	32	1.62	1.93	Homogen
Control	32			

Based on Table 5, $F_{count} < F_{table}$ is obtained, which means that the experimental class and control class data are homogeneous.

Hypothesis Test Results

Hypothesis testing aims to determine whether the flipped classroom learning model has a significant influence on students' critical thinking skills so that it can be seen whether the research hypothesis is accepted or rejected (Nuryadi et al., 2017). Hypothesis test results can be seen in the following table:

Table 6. Hypothesis Test Results

Class	N	T_{count}	T_{table}	Information
Experiment	32	8.64	1.67	H_0 Rejected
Control	32			

Based on Table 6, the results of the test carried out using the two-sample t test were obtained, namely $T_{count} = 8.64$ and $T_{table} = 1.67$ so it can be seen that the value of $T_{count} > T_{table}$ at a significance level of 0.05, this means that the hypothesis H_0 is rejected. Application of the flipped classroom learning model with an approach ethnosience is carried out by providing essential materials by including local wisdom values such as linking additive materials with various traditional food ingredients of the local community. The results of the research found that the use of an ethnosience approach in additive material was able to enable students to obtain meaningful learning, and stated that conceptual reconstruction could be realized if there was meaningful

learning (Nugraheni et al., 2022). This material is given before students carry out learning activities in the classroom so that students can study independently at home first. Apart from that, the critical thinking ability test questions are also packaged with ethnosience.



Figure 2. Concept of the flipped classroom learning model (Dong, 2019)

The flipped classroom model learning activity with an ethnosience approach begins by providing material about additives and additive substances packaged in ethnosience via a WhatsApp group.



Figure 3. Providing material via whatsapp group

The next activity is for students to note down things they don't understand to discuss together.



Figure 4. Students note things they don't understand

Then students carry out discussion activities to find answers to various things they do not understand. At this stage the teacher acts as a facilitator.



Figure 5. Students discussing

Then the teacher evaluates the learning that has taken place.



Figure 6. Evaluation by teacher

Based on the research results, it is known that the flipped classroom learning model with an ethnoscience approach has a positive effect on the critical thinking skills of class VIII students at SMP Negeri 9 Batang Hari because the posttest results for the experimental class obtained a higher average test score of 75 compared to the control class which only got a score of 67. Apart from that, from the results of the hypothesis test it was also found that the hypothesis H_0 was rejected, which means that the flipped classroom learning model with an ethnoscience approach had a positive effect on students' critical thinking abilities in class VIII of SMP Negeri 9 Batang Hari.

The flipped classroom learning model is able to make students study the material independently before class starts (Huong et al., 2018). Meanwhile, class time is used for discussion activities regarding various things that students do not yet understand (Novitri et al., 2022).

By implementing the flipped classroom learning model, students receive provisions before entering class (Alqarni, 2018). Exposure to virtual material provided before students enter the face-to-face classroom really helps students to be better prepared to face problems in class during discussions (Atwa et al., 2022). Having prior knowledge also really helps students be more critical when facing various problems (Al-Rafayah, 2023). This allows them to increase their understanding of the material and improve their critical thinking skills. This is in line with opinion Zulhamdi et al. (2022) which states that the flipped classroom learning model is influential and able to improve students' critical thinking abilities. Furthermore Nugraheni et al. (2022) revealed that many learning activities can be designed using the flipped classroom model both in environments outside the classroom and inside the classroom so as to enable students to be actively involved in learning and improve students' critical thinking skills.

On the other hand, classrooms can be integrated by utilizing various technologies that help students learn to think critically better (Fadli et al., 2022). The results of research conducted by Bosch-Farré et al. (2024) stated that the flipped classroom learning model had a positive effect on improving students' critical thinking skills. According to Etemadfar et al. (2020) said that the flipped classroom learning model is a learning model that is able to improve students' critical thinking skills and is highly recommended for application in today's modern times. It is very necessary to use local knowledge in learning (Andayani et al., 2021). Using local cultural elements in education is one way to improve the quality of learning (Rahman et al., 2023). By incorporating elements of local wisdom into lessons, education must correct the difference between mainstream knowledge and local wisdom (Idul & Fajardo, 2023). Additionally, according to Hikmawati et al. (2020) encourage students to participate actively in the learning process.

The ethnoscience approach emphasizes the use of local culture in science learning and enriching the learning context (Yasir & Dwiyantri, 2023). The application of ethnoscience in learning is very dependent on the student's environment (Haryanto & Kencanawati, 2023). Therefore, teachers who use an ethnoscience approach in the classroom must have a good understanding of each student's local culture (Atmojo et al., 2019). The ethnoscience approach can improve cognitive and critical thinking abilities because it links classroom learning to students' daily lives and encourages them to actively participate in the learning process (Putu Verawati et al., 2022). This combination can give students greater opportunities to develop critical thinking skills because they are actively involved in group discussions, analyzing concepts with cultural

contexts and solving problems that are relevant to their daily lives.

Students' mastery of the material and development of critical thinking skills can also increase. This is in line with opinion Al-Zoubi et al. (2021) which says that the flipped classroom model is a better teaching methodology than traditional teaching methodology in developing students' critical thinking skills. Additionally, according to Hanum et al. (2023) Integrating ethnoscience in learning is very important so that students' critical thinking skills are better amidst the trend of using technology.

Conclusion

Based on the results of research that has been conducted, it shows that the flipped classroom learning model with an ethnoscience approach has a positive effect on the critical thinking abilities of class VIII students at SMP Negeri 9 Batang Hari.

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Author Contributions

Conceptualization; O. A., M. C., H., I.: methodology; O. A.; validation; M. C.; formal analysis; H.: investigation; I.; resources; O. A: data curation; M. C.: writing—original; H: draft preparation; I: writing—review and editing; O. A; visualization: M. C. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

References

- Alqarni, A. (2018). Blended learning and flipped classroom approaches. *American Research Journal of Humanities and Social Sciences*, 4(1), 1–6. <https://doi.org/10.21694/2378-7031.18012>
- Al-Rafayah, A. A. (2023). The effectiveness of the flipped learning strategy in developing the critical thinking and accounting skills of commercial technical secondary school students. *Perspektivy Nauki i Obrazovania*, 66(6), 107–126. <https://doi.org/10.32744/pse.2023.6.6>
- Al-Zoubi, A. M., & Suleiman, L. M. (2021). Flipped classroom strategy based on critical thinking skills: Helping fresh female students acquiring derivative concept. *International Journal of Instruction*, 14(2), 791–810. <https://doi.org/10.29333/iji.2021.14244a>
- Andayani, Y., Anwar, Y. A. S., & Hadisaputra, S. (2021). Pendekatan etnosains dalam pelajaran kimia untuk pembentukan karakter siswa: tanggapan guru kimia di NTB. *Jurnal Pijar Mipa*, 16(1), 39–43. <https://doi.org/10.29303/jpm.v16i1.2269>
- Atmojo, S. E., Kurniawati, W., & Muhtarom, T. (2019). Science learning integrated ethnoscience to increase scientific literacy and scientific character. *Journal of Physics: Conference Series*, 1254(1). <https://doi.org/10.1088/1742-6596/1254/1/012033>
- Atwa, Z., Sulayeh, Y., Abdelhadi, A., Jazar, H. A., & Eriqat, S. (2022). Flipped classroom effects on grade 9 students' critical thinking skills, psychological stress, and academic achievement. *International Journal of Instruction*, 15(2), 737–750. <https://doi.org/10.29333/iji.2022.15240a>
- Azmi, N., & Festiyed, F. (2023). Development of physics learning assessment instrument in project-based learning model to improve 4C skills. *Jurnal Penelitian Pendidikan IPA*, 9(4), 1798–1804. <https://doi.org/10.29303/jppipa.v9i4.3174>
- Bosch-Farré, C., Cicres, J., Patiño-Masó, J., Basuldo, P. M., Toran-Monserrat, P., Martínez, A. L., & Malagón-Aguilera, M. D. C. (2024). Effectiveness of the flipped classroom methodology in higher education. A systematic review. *Educacion XX1*, 27(1), 19–56. <https://doi.org/10.5944/educxx1.35773>
- Dong, X. (2019). The Application of Flipped Classroom Teaching Model in College English Teaching. *Psychiatria Danubina*, 34(suppl 1). <https://doi.org/10.23977/icamei.2019.075>
- Etemadfar, P., Soozandehfar, S. M. A., & Namaziandost, E. (2020). An account of EFL learners' listening comprehension and critical thinking in the flipped classroom model. *Cogent Education*, 7(1). <https://doi.org/10.1080/2331186X.2020.1835150>
- Fadli, M. R., Rochmat, S., Sudrajat, A., Aman, Rohman, A., & Kuswono. (2022). Flipped classroom in history learning to improve students' critical thinking. *International Journal of Evaluation and Research in Education*, 11(3), 1416–1423. <https://doi.org/10.11591/ijere.v11i3.22785>
- Febri, A., Sajidan, & Sarwanto. (2019). Analysis of students' critical thinking skills at junior high school in science learning. *Journal of Physics: Conference Series*, 1397(1). <https://doi.org/10.1088/1742-6596/1397/1/012018>
- Fitri, A. D., & Asrizal. (2023). Development of physics e-module integrated with PBL model and ethnoscience to improve students' 21st century

- skills. *Jurnal Penelitian Pendidikan IPA*, 9(12), 10610–10618. <https://doi.org/10.29303/jppipa.v9i12.5877>
- González-pérez, L. I., & Ramírez-montoya, M. S. (2022). Components of education 4.0 in 21st century skills frameworks: systematic review. *Sustainability (Switzerland)*, 14(3), 1–31. <https://doi.org/10.3390/su14031493>
- Hanum, L., Hasan, M., Pada, A. U. T., Rahmatan, H., Rahmayani, R. F. I., Elisa, E., & Yusrizal, Y. (2023). Development of learning devices based on ethnoscience project based learning to improve students' critical thinking skills. *Jurnal Pendidikan Sains Indonesia*, 11(2), 288–305. <https://doi.org/10.24815/jpsi.v11i2.28294>
- Harjono, A., Andani, T. G., Gunada, I. W., & Susilawati, S. (2022). Implementation of blended-flipped classroom model assisted by video to improve students' creative thinking skills. *Jurnal Penelitian Pendidikan IPA*, 8(6), 3180–3186. <https://doi.org/10.29303/jppipa.v8i6.2255>
- Haryanto, T., & Kencanawati, I. (2023). Improving critical thinking skills of prospective biology teacher students through ethnoscience-based biology Learning. *Tarbawi: Jurnal Ilmu Pendidikan*, 19(1), 13–24. <https://doi.org/10.32939/tarbawi.v19i1.2601>
- 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>
- Hillmayr, D., Ziernwald, L., Reinhold, F., Hofer, S. I., & Reiss, K. M. (2020). The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis. *Computers and Education*, 153(4). <https://doi.org/10.1016/j.compedu.2020.103897>
- Huong, H. T. L., Hoang Doan Huy, N., & Ngoc Ha, N. (2018). The Flipped classroom: using thematic teaching to develop critical thinking for high school students. *American Journal of Educational Research*, 6(6), 828–835. <https://doi.org/10.12691/education-6-6-36>
- Idul, J. J. A., & Fajardo, M. T. M. (2023). Ethnoscience-based physical science learning and its effects on students' critical thinking skills: A meta-analysis study. *Journal of Mathematics and Science Teacher*, 3(2). <https://doi.org/10.29333/mathsciteacher/13700>
- Kavenuke, P. S., & Kihwele, G. E. (2023). Intercultural competence, a necessity in 21st century classrooms: are teacher educators in Tanzania interculturally competent? *Center for Educational Policy Studies Journal*, 10(10), 1–24. <https://doi.org/10.26529/cepsj.1524>
- Khairunnisak, I., Mawardi, M., Widarti, H. R., & Yamtinah, S. (2023). Effectiveness of guided inquiry based student worksheet integrated with flipped classroom system on reaction rate material on students' ability to think critically. *Jurnal Penelitian Pendidikan IPA*, 9(5), 2431–2437. <https://doi.org/10.29303/jppipa.v9i5.3271>
- Lombardi, D., Shipley, T. F., Bailey, J. M., Bretones, P. S., Prather, E. E., Ballen, C. J., Knight, J. K., Smith, M. K., Stowe, R. L., Cooper, M. M., Prince, M., Atit, K., Uttal, D. H., LaDue, N. D., McNeal, P. M., Ryker, K., St. John, K., van der Hoeven Kraft, K. J., & Docktor, J. L. (2021). The curious construct of active learning. *Psychological Science in the Public Interest*, 22(1), 8–43. <https://doi.org/10.1177/1529100620973974>
- Miller, C. J., Smith, S. N., & Pugatch, M. (2020). Experimental and quasi-experimental designs in implementation research. *Psychiatry Research*, 283(03), 112–452. <https://doi.org/10.1016/j.psychres.2019.06.027>
- Mulatsih, D., Yamtinah, S., & Matsuri, M. (2023). Use of lokal wisdom-based media to improve critical thinking. *Jurnal Penelitian Pendidikan IPA*, 9(10), 7987–7992. <https://doi.org/10.29303/jppipa.v9i10.3989>
- Novitri, A., Pada, A. U. T., Nurmaliah, C., Khairil, K., & Artika, W. (2022). Implementation of flipped classroom learning to improve critical thinking and self managements skills of vocational students. *Jurnal Penelitian Pendidikan IPA*, 8(1), 371–377. <https://doi.org/10.29303/jppipa.v8i1.1268>
- Nugraheni, B. I., Surjono, H. D., & Aji, G. P. (2022). How can flipped classroom develop critical thinking skills? A literature review. *International Journal of Information and Education Technology*, 12(1), 82–90. <https://doi.org/10.18178/ijiet.2022.12.1.1590>
- Nuryadi, Astuti, T. D., Utami, E. S., & Budiantara, M. (2017). *Buku Ajar Dasar-dasar Statistik Penelitian*. Sibuku Media.
- Pratama, D. H., & Jumadi, J. (2023). Analysis the implementation of ethnoscience approach in learning science. *Jurnal Penelitian Pendidikan IPA*, 9(4), 1615–1620. <https://doi.org/10.29303/jppipa.v9i4.2721>
- Prihantini, P., Sutarto, S., Punggeti, R. N., Rukmini, A., & Intes, A. (2023). The use of ICT as a resource and media for modern 21st century learning in primary schools. *Journal International of Lingua and Technology*, 3(1), 13–28. <https://doi.org/10.55849/jiltech.v3i1.509>

- Putu Verawati, N. N. S., Harjono, A., Wahyudi, & Gummah, S. (2022). Inquiry-creative learning integrated with ethnoscience: efforts to encourage prospective science teachers' critical thinking in Indonesia. *International Journal of Learning, Teaching and Educational Research*, 21(9), 232-248. <https://doi.org/10.26803/ijlter.21.9.13>
- Rahman, A. A., Santosa, T. A., Nurtamam, M. E., Widoyo, H., & Rahman, A. (2023). Meta-Analysis: The effect of ethnoscience-based project based learning model on students' critical thinking skills. *Jurnal Penelitian Pendidikan IPA*, 9(9), 611-620. <https://doi.org/10.29303/jppipa.v9i9.4871>
- Rahmawati, A. D. (2020). Analisis kesalahan siswa SMP dalam menyelesaikan soal TIMSS-like domain data dan peluang. *MATHEdunesa*, 9(3), 495-503. <https://doi.org/10.26740/mathedunesa.v9n3.p495-503>
- Saekhow, J., & Cheewaviriyanon, C. (2021). Effects of online-media training integrated with active learning on the development of 21st century skills for teachers in ranong province, Thailand. *IJAEDU-International E-Journal of Advances in Education*, VII(20), 117-121. <https://doi.org/10.18768/ijaedu.971283>
- Sari, F. D., Subagiyo, L., & Syam, M. (2023). Effect of guided inquiry learning model with flipped classroom method toward critical thinking. *Jurnal Penelitian Pendidikan IPA*, 9(1), 57-65. <https://doi.org/10.29303/jppipa.v9i1.1953>
- Siami, F., Sumarni, W., Sudarmin, S., & Harjono, H. (2023). Pengembangan LKPD terintegrasi etnosains batik semarang untuk meningkatkan literasi kimia siswa. *Jurnal Penelitian Pendidikan IPA*, 9(10), 7784-7792. <https://doi.org/10.29303/jppipa.v9i10.3604>
- Siddiq, F., Olofsson, A. D., Lindberg, J. O., & Tomczyk, L. (2023). Special issue: what will be the new normal? digital competence and 21st-century skills: critical and emergent issues in education. *Education and Information Technologies*. <https://doi.org/10.1007/s10639-023-12067-y>
- Teig, N., Scherer, R., & Olsen, R. V. (2022). A systematic review of studies investigating science teaching and learning: over two decades of TIMSS and PISA. *International Journal of Science Education*, 44(12), 2035-2058. <https://doi.org/10.1080/09500693.2022.2109075>
- Todres, J., & Alexander, C. (2023). Bringing the right to education into the 21st century. *SSRN Electronic Journal*, 42, 1-29. <https://doi.org/10.2139/ssrn.4391829>
- Yasir, M., & Dwiyantri, L. (2023). Analysis of critical thinking levels of prospective science teachers in ethnoscience learning based on reflective and impulsive cognitive styles. *Jurnal Pendidikan Sains Indonesia*, 11(4), 808-825. <https://doi.org/10.24815/jpsi.v11i4.31799>