



Application of the asicc learning model in human physiological system to improve students' critical thinking and creative thinking skills

Dila Elpin Setiani¹, Budi Purwoko², Tutut Indah Sulistiyowati^{1,3}, Poppy Rahmatika Primandiri^{1,3}, Agus Muji Santoso^{1,3*}

¹ Biology Education, Faculty of Health and Science, Universitas Nusantara PGRI Kediri, Indonesia

² Junior High School 5 Kertosono, Nganjuk, East Java, Indonesia

³ Research Centre of Biodiversitas & Conservation, Universitas Nusantara PGRI Kediri, Indonesia

*Corresponding author: agusmujisantoso@unpkediri.ac.id

ARTICLE INFO

Article history

Received: 07 April 2024

Revised: 10 October 2024

Accepted: 20 October 2024

Keywords:

ASICC learning model

Creative thinking skills

Critical thinking skills

ABSTRACT

Critical thinking and creative thinking skills are needed to improve the quality and competitive human resources. Therefore, the application of appropriate learning models is expected to stimulate students' critical thinking and creative thinking skills. This research aims to improve critical thinking and creative thinking skill scores using the ASICC learning model. This type of research is classroom action research which is carried out in 2 cycles, with 3 meetings in each cycle. Data on students' critical thinking and creative thinking skills were collected using essay tests on science learning materials. Data analysis was carried out by comparing the N-gain scores in cycle 1 and cycle 2 for students' critical thinking and creative thinking skills. The results of the research revealed that there was an increase that occurred in cycle 2, namely 5.6% in the aspects of moderate critical thinking skills and high creative thinking, as well as in the aspects of critical thinking skills and high creative thinking by 5.6%. Meanwhile, in the previous cycle, these two aspects did not have a high category. Another result found from this research is that students who have low critical thinking skills do not necessarily have low creative thinking skills. This is because students who have low critical thinking skills may have moderate creative thinking skills or vice versa. Thus, the application of the ASICC learning model is effective in improving the scores of critical thinking skills and creative thinking skills of students at Junior High School 5 Kertosono.

© 2024 Universitas Negeri Jakarta. This is an open-access article under the CC-BY license (<https://creativecommons.org/licenses/by/4.0>)

INTRODUCTION

In the era of globalization, 21st century education is developing rapidly so that it does not only rely on knowledge but also skills. The 21st century has very high demands for creating quality human resources, so that people in this century are required to have innovative and characteristic skills. Therefore, the learning system in the 21st century is actually no longer centered on educators, but rather on participants (Mardhiyah et al., 2021).

It is hoped that 21st century education can make students more active in finding effective ways of learning, so that they can develop and improve their quality (Fikri *et al.*, 2021). According to Septikasari & Frasandy (2018), the personal qualities that are required to be developed include creative thinking skills, critical thinking and problem solving, communicating, and collaborating. Critical thinking and creative thinking skills are the foundation for facing the challenges that have developed. Critical thinking skills are often used to produce rational, systematic, organized, and logical thinking in dealing with various problems in certain conditions (Siswati & Suratno, 2023). Students who have critical thinking skills will be able to conclude what they know and analyze the information received to solve problems (Setiawan et al., 2022). Critical thinking skills require a process that must be carried out actively when analyzing information to find ideas (Leasa et al., 2023). Critical thinking does not mean someone who likes to argue against wrong ideas or notions, but by thinking critically someone can provide solutions to problems, so that the ideas conveyed have an appropriate, rational, and careful basis (Agustina, 2019). Meanwhile, according to Hagi & Mawardi (2021), creative thinking skills will be useful in improving learning processes and outcomes during the learning process. Creative thinking skills are also very important for students to have because with creative thinking, skills and knowledge to find new ideas for solving problems can develop (Lestari & Ilhami, 2022). Therefore, if creative thinking skills are involved in the learning process, student creativity can also be raised (Usman et al., 2020).

Critical thinking and creative thinking skills in science subjects are interrelated. This connection is proven by the critical and creative thinking skills they possess, which can train students to reason logically through arguments, interpretation, evaluation, and being able to draw conclusions, so that students are motivated to put forward new, unique ideas in solving a problem (Mayarni & Yulianti, 2020). Critical thinking involves interpreting activities, conducting analysis, evaluating, making inferences, communicating, and self-regulating. Meanwhile, creative thinking involves mental activities including curiosity, generating a number of ideas, generating new ideas, and elaborating on new, more varied ideas (Santoso et al., 2021b). However, this is still rarely implemented in the learning process, so students' critical thinking and creative thinking skills are low. According to Anisa et al., (2021), the influence of students' low critical thinking skills is caused by the fact that during the daily learning process, it is considered less effective in developing the potential within students. Meanwhile, Sudiantini & Shinta (2018) stated that the lack of opportunities for students to show their ideas or representations in solving problems and not being taught varied strategies that encourage finding answers to problems are also the causes of students' low creative thinking skills. The statement about the low level of critical thinking and creative thinking skills is in line with observations that have been carried out in partner schools.

Based on the results of the observations that have been made, it is known that students' critical thinking and creative thinking skills are still low. According to Setiani et al., (2023), before using the ASICC learning model, students' critical thinking skills were still not developed, because the implementation of learning only took place in one direction, students were rarely given the opportunity to express their ideas, and the use of a learning model that was not appropriate to the students' learning conditions. Apart from that, students' creative thinking skills are also still lacking. This can be seen from the fact that many students still have difficulty finding solutions to problems, so they prefer to give answers as they are without looking at the suitability of the context of the material being asked (Faelasofi, 2017).

One way that can be used to improve students' critical thinking and creative thinking skills is to optimize effectiveness in the learning process. The effectiveness of learning can be achieved by implementing a learning model that has been adapted to the learning conditions experienced by students. This can be realized by applying the ASICC learning model, which consists of the Adapting, Searching, Interpreting, Creating and Communicating stages. This learning model allows students to gather important/keys information, solve contextual problems, share ideas, produce products, and

solve problems in groups (Santoso et al., 2021a). The ASICC learning model has been proven to be able to improve students' metacognition in learning about the immune system in high school students (Ernawati et al., 2024). Apart from that, the ASICC learning model is also able to improve students' collaboration skills (Santoso et al., 2021a), argumentation skills for students with low academic abilities (Santoso et al., 2022), and can improve thinking skills in physics subjects (Sari et al., 2023). This research aimed to implement the ASICC learning model to improve student's critical and creative thinking skills.

METHODS

Research Design

The research design used is a Classroom Action Research (CAR) design based on Kemmis & McTaggart (1988). This research was conducted for two cycles and there were three meetings on each cycles. This research has four stages, namely planning, implementation, observation, and reflection. The CAR was carry out by using lesson study. This is because the number of science teachers in schools is very limited, namely only one person. Therefore, a science teacher experiences obstacles when implementing innovative learning models alone. Researchers together with science teachers design learning designs, implement learning, and reflect on learning together.

Details of the stages of classroom action research carried out through lesson study are as follows. In one cycle, there are three stages. The first stage is planning. The teacher and research team analyze student characteristics and analyze initial score data on students' critical and creative thinking skills. Then, develop learning tools in the form of student worksheets, learning materials, teaching media, and test instruments (pre and post-tests). In the second stage, the teacher and research team implemented open classes. Science teachers teach according to the learning plans developed. Then, the research team together with other subject teachers became observers. In the third stage, the teacher and research team reflected on the learning by observing photos and videos of students' learning activities. The science teacher and research team wrote notes on learning improvements for the second cycle. The second cycle was carried out in three stages, like the first cycle.

Population and Samples

This research was conducted on eight-grade students in one of junior high school in East Java. There are five eighth grade classrooms at the school. The number of classes selected is one, namely the class that has a low critical and creative thinking skills score. Critical and creative thinking skills scores were obtained during the preliminary study (data not shown). The class that was the subject of this research consisted of 18 students, consisting of 11 male students and 7 female students whose ages ranged from 12 to 13 years.

Instrument

There are two instruments were used in this research. First, instruments in the form of learning tools, namely teaching modules, student worksheets, and teaching media. The material in the pre-cycle is the digestive system, the first cycle is the human respiratory system, and the second cycle is the human excretory system. Second, test question instruments reveal students' critical and creative thinking skills, which are integrated with concept understanding tests. Zubaidah et al. (2015) revealed that students' critical and creative thinking skills can be measured simultaneously with student's conceptual understanding. Criteria for critical thinking skills consist of: (1) correctness, clarity, and specificity of concepts; (2) answers accompanied by reasons and arguments; (3) concepts are interconnected and integrated. (4) correct grammar. Meanwhile, the creative thinking skills score based on Mola (2015), namely (1) originality; (2) fluency; (3) flexibility; and (4) elaboration. Both types of instruments were validated by three experts in biology, science learning, and assessment. The validation results revealed that the average validation score reached 88.12, meaning that all devices were declared valid and usable.

Procedure

The research procedure was carried out in two cycles with three face-to-face meetings with a time allocation of 8 x 30 minutes in each cycle. This stage includes planning (Plan), namely the researcher together with the subject teacher carrying out plans related to learning strategies, teaching

materials, and learning activities that will take place, as well as preparing learning models, student worksheets, and post-tests that will be used. Then, it continues with the implementation stage (Do), namely the implementation of learning activities in accordance with the previously agreed learning plan. Next, the reflection stage (See), namely carrying out reflection with the subject teacher to review the learning activities that have been implemented for improvement in the next cycle.

Details of the learning stages of the ASICC model are presented in Table 1. Based on Table 1, student learning activities are divided into four main stages, namely adapting, searching, interpreting, creating, and communicating (Santoso et al., 2024).

Table 1.
Stages of Student Learning Activities in ASICC Learning Model

Steps	Student Activity
Adapting	Students examine problems or cases from videos that contain cases, news, or other text forms. Students understand the learning objectives and reflect on themselves regarding learning readiness.
Searching	Students form heterogeneous groups based on directions from the teacher. Students seek key information from various sources, including through observation in the laboratory or in the field.
Interpreting	Students analyse, answer, and discuss problems based on key information obtained in groups.
Creating and Communicating	Students formulate ideas in various strategies, communicate these ideas to the others, and do self-reflection.

Data Analysis Techniques

The main data in this research are students' critical and creative thinking skills scores. The score data is obtained from the initial test and final test in each cycle. Data were analysed descriptively. Initial and final test scores were analyzed by the Gain score (N-Gain) based on Hake (1999) and then the scores are compared from the first to the second cycle and so on.

RESULTS AND DISCUSSION

Based on research that has been carried out in two cycles, it can be seen that lesson study-based classroom action research by applying the ASICC learning model to science subjects has an influence on the critical thinking skills and creative thinking skills of the eighth grade students of the Junior High School 5 Kertosono. The results of the analysis of students' critical thinking and creative thinking skills in cycle 1 can be seen in Figure 1.

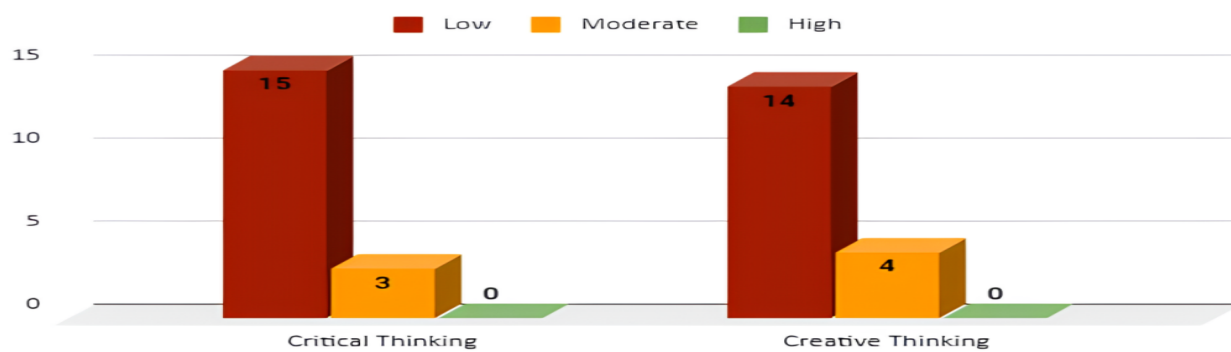


Figure 1 Comparison of Critical Thinking Skills and Creative Thinking Students of Cycle 1

Figure 1, shows a comparison of the critical thinking skills and creative thinking skills of students in cycle 1 after the application of the ASICC learning model. If compared with pre-cycle phases, then in cycles 1 students' critical and creative thought skills improved. Based on the figure, the following findings were obtained that: (1) there were 13 students who having the N-Gain category increased with aspects of low critical thinking skills and moderate creative thinking; (2) two student

who having the N-Gain category increased with aspects of low critical thinking skills and moderate creative thinking; (3) two students who having the N-Gain category increased with aspects of critical thinking skills and creative thinking being moderate; and (4) just one student who having the N-Gain category increased with aspects of moderate critical thinking skills and low creative thinking.

The following is the result of N-Gain's analysis of the critical thinking and creative thinking skills aspects of students at cycle 2, as follows:

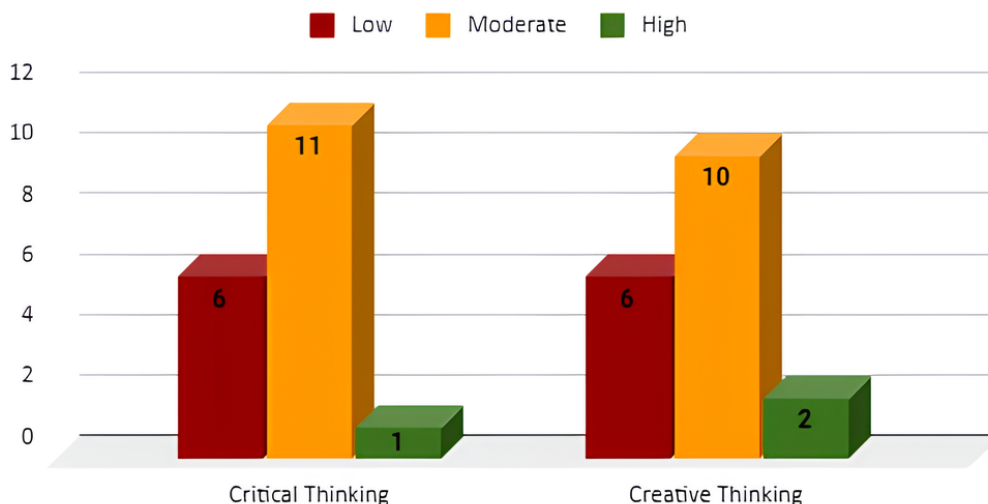


Figure 2 Comparison of Critical Thinking Skills and Creative Thinking Students of Cycle 2

Figure 2 shows a comparison of critical thinking and creative thinking skills in cycle 2 using the ASICC learning model. In cycle 2, the following findings were obtained: two students had low critical thinking and creative thinking skills aspects (11.1%) as well as two students who had low critical thinking skills and moderate creative thinking (11.1%). Besides that, eight students had moderate aspects of critical thinking and creative thinking skills (44.4%) and four students had moderate critical thinking skills and low creative thinking (22.2%) a student who had a medium critical thinking skill aspect, and a high creative thinking aspect (5.6%) and a student has a high critical thinking and creative thinking skills aspect (5.6%).

The results of a class action study that has been conducted revealed an increase in the N-Gain category in cycle 2, with one student having a medium critical thinking skill and a high creative thinking skill, or 5.6%. As well as, the N-Gain category also increased the aspect of high critical and creative thinking skills acquired by one student, or 5.6%. Furthermore, it was also found that students with low critical thinking skills do not necessarily have low creative thinking abilities. This is because students who have low critical thinking skills may have moderate creative thinking skills, or vice versa.

Based on the observations also shown that critical thinking and creative thinking skills are improved when using the ASICC learning model. This is demonstrated by student activity in the learning process, especially at the interpreting, creating, and communicating stages. At this stage, students exchange ideas and can discuss and solve problems in groups through workshops and presentations. That activity can stimulate the complex cognitive process and start higher-order thinking skills (Armandita, 2017; Jumhur et al., 2024; Irwan et al., 2024). In the searching step, the students have the chance to choose from a wealth of information during the search process and the essential elements of important information into knowledge that is relevant. The ability to choose important information is linked to critical thinking skills (Berdahl et al., 2021; Jamaludin et al., 2022). These steps are important to support the students in making the decision (Syafuruddin et al., 2023; Khoiri et al., 2023) and formulating the action plan for the project (Utomo et al., 2023)

Pupils with strong beginning motivation and learning objectives are those who can key or important knowledge. At this point, the teacher also provides learning scaffolding support to the students so that the data collected may be applied to the following step (Jamil et al., 2024), which is issue interpretation. Besides that, in interpreting steps, the students are given difficult tasks or questions to complete when understanding stages. Open ended question can be used for verification of

the student's mastery of concepts and their critical thinking skills (Sholikah et al., 2024). For instance, open-ended essay questions based on case studies about the respiratory and excretory systems of humans are assigned to students. Students work together to develop responses or solutions based on case studies or difficult topics. The activity shown by the student during this learning process proves that the ongoing learning is in line with the planned learning model. Based on this, the application of the ASICC learning model is effective in improving the skills of critical thinking and creative thinking of students in the eighth grade at junior high school.

CONCLUSION

Based on the results of classroom action research carried out over two cycles, it is known that the application of the ASICC learning model can improve the critical thinking and creative thinking skills scores of eight-grade students at junior high school. The research results revealed an increase in cycle 2 of 5.6% in the aspects of moderate critical thinking skills and high creative thinking, as well as in the aspects of critical thinking skills and high creative thinking of 5.6%. Apart from that, the results also found that students who have low critical thinking skills do not necessarily have low creative thinking skills. This is because students who have low critical thinking skills may have moderate creative thinking skills, or vice versa. Through the application of the ASICC learning model, students can play an active role during the learning process, share ideas in solving problems, analyse existing problems. Therefore, the ASICC learning model is the right solution for use in schools.

ACKNOWLEDGEMENT

This research is one part of ASICC's learning innovation research. Therefore, the researcher would like to thank the Directorate of Research, Technology, and Community Service, Ministry of Education and Culture, Research, and Technology of the Republic of Indonesia, for funding this research through the Higher Education Leading Applied Research Grant (077/E5/PG.02.00.PL/2023).

REFERENCES

- Agustina, I. (2019). Pentingnya berpikir kritis dalam pembelajaran matematika di era revolusi industri 4.0. *Jurnal Pendidikan Indonesia*, 8(1), 1–9. <https://doi.org/10.17977/um0330v4i1p1-8>
- Anisa, A. R., Ipungkartti, A. A., & Saffanah, K. N. (2021). Pengaruh kurangnya literasi serta kemampuan dalam berpikir kritis yang masih rendah dalam pendidikan di Indonesia. *Current Research in Education: Conference Series Journal*, 1(1), 1–12. <https://ejournal.upi.edu/index.php/crecs/article/view/32685/pdf>
- Armandita, P. (2017). Analisis kemampuan berfikir kreatif pembelajaran fisika di kelas XI MIA 3 SMA Negeri 11 Kota Jambi. *Jurnal Penelitian Ilmu Pendidikan*, 10(2), 129–135. <https://doi.org/10.21831/jpipfip.v10i2.17906>
- Berdahl, L., Hoessler, C., Mulhall, S., & Matheson, K. (2021). Teaching critical thinking in political science: A case study. *Journal of Political Science Education*, 17(sup1), 910–925. <https://doi.org/10.1080/15512169.2020.1744158>.
- Ernawati, T., Agustin, D., Agustini, N., Darmawan, E., Utami, B., Primandiri, P. R., & Santoso, A. M. (2024). *Improving Metacognition Skills through Implementing ASICC-Based Student Worksheets on the Body's Defense System*. In Proceedings of the 9th Mathematics, Science, and Computer Science Education International Seminar (MSCEIS 2023) (p. 384).
- Faelasofi, R. (2017). Identifikasi kemampuan berpikir kreatif matematika pokok bahasan peluang. *JURNAL E-DuMath*, 3(2). <https://doi.org/10.26638/je.460.2064>
- Fikri, A. A., Nurona, A., Saadah, L., Nailufa, L. E., & Ismah, V. (2021). Keterampilan guru dalam membimbing diskusi pada pembelajaran abad 21. *Journal of Education and Teaching*, 2(1), 1–7. <https://doi.org/10.35961/tanjak.v2i1.119>
- Hagi, N. A., & Mawardi, M. (2021). Model Problem Based Learning untuk meningkatkan keterampilan berpikir kreatif siswa Sekolah Dasar. *Edukatif: Jurnal Ilmu Pendidikan*, 3(2), 463–471. <https://doi.org/10.31004/edukatif.v3i2.325>
- Hake, Richard R. (1999). Analyzing Change/Gain Score. Woodlands Hills, CA American Educational Research Association's Division D, Measurement and Research Methodology
- Hikmawati, V. Y., & Ningsih, Y. S. (2020). Blended-problem based learning: critical thinking skills and information literacy in cell learning. *Jurnal Bioedukatika*, 8(2), 122.

<https://doi.org/10.26555/bioedukatika.v8i2.14315>.

- Irwan Irwan, Arnadi Arnadi, & Aslan, A. (2024). Developing critical thinking skills of primary school students through independent curriculum learning. *Indonesian Journal of Education (INJOE)*, 4(3), 788-803. <https://injoe.org/index.php/INJOE/article/view/138>.
- Jamaludin, J., Kakaly, S., & Batlolona, J. R. (2022). Critical thinking skills and concepts mastery on the topic of temperature and heat. *Journal of Education and Learning (EduLearn)*, 16(1), 51-57. <https://doi.org/10.11591/edulearn.v16i1.20344>.
- Jamil, M. ., Hafeez, F. A., & Muhammad, N. (2024). Critical thinking development for 21st Century: Analysis of physics curriculum. *Journal of Social & Organizational Matters*, 3(1), 01-10. <https://doi.org/10.56976/jsom.v3i1.45>.
- Jumhur, A. A., Avianti, R. A., Nurfitri, P. E., & Mahir, I. (2024). Implementation of problem-based learning to improve critical thinking ability of vocational students in Jakarta. *European Journal of Education and Pedagogy*, 5(5), 16-24. <https://doi.org/10.24018/ejedu.2024.5.5.860>.
- Kemmis, S., & Mc Taggart, R. (1988). Unidad 2 lecturas the action research planner. Capitulo 1 Del Libro Del Mismo Nombre, Editando Por La Deakin University, 1-16.
- Khoiri, N., Ristanto, S., & Kurniawan, A. F. (2023). Project-based learning via traditional game in physics learning: Its impact on critical thinking, creative thinking, and collaborative skills. *Jurnal Pendidikan IPA Indonesia*, 12(2), 286-292. <https://doi.org/10.15294/jpii.v12i2.43198>
- Leasa, M., Fenanlampir, A., Pelamonia, J., Talakua, M., & Likumahwa, H. (2023). Contribution of metacognition awareness to critical thinking skills with pbl model and hpc strategy: A food digestion system study. *Biosfer: Jurnal Pendidikan Biologi*, 16(2), 467-480. <https://doi.org/10.21009/biosferjpb.29921>
- Lestari, I., & Ilhami, A. (2022). Penerapan model project based learning untuk meningkatkan keterampilan berpikir kreatif siswa SMP: Systematic review. *LENSA (Lentera Sains): Jurnal Pendidikan IPA*, 12(2), 135-144. <https://doi.org/10.24929/lensa.v12i2.238>
- Mardhiyah, R. H., Aldriani, S. N. F., Chitta, F., & Zulfikar, M. R. (2021). Pentingnya keterampilan belajar di abad 21 sebagai tuntutan dalam pengembangan sumber daya manusia. *Lectura: Jurnal Pendidikan*, 12(1), 29-40. <https://doi.org/10.31849/lectura.v12i1.5813>
- Mayarni, M., & Yulianti, Y. (2020). Hubungan antara kemampuan berpikir kritis dengan kemampuan berpikir kreatif siswa pada materi ekologi. *PENDIPA Journal of Science Education*, 4(3), 39-45. <https://doi.org/10.33369/pendipa.4.3.39-45>
- Moma, L. (2015). Pengembangan instrumen kemampuan berpikir kreatif matematis untuk siswa SMP. *Delta-Pi: Jurnal Matematika Dan Pendidikan Matematika*, 4(1). <https://doi.org/10.33387/dpi.v4i1.142>
- Santoso, A. M., Primandiri, P. R., Zubaidah, S., & Amin, M. (2021a). Improving student collaboration and critical thinking skills through ASICC model learning. *Journal of Physics: Conference Series*, 1806(1), 12174. <https://doi.org/10.1088/1742-6596/1806/1/012174>
- Santoso, A. M., Primandiri, P. R., Zubaidah, S., & Amin, M. (2021b). The development of students' worksheets using project based learning (PjBL) in improving higher order thinking skills (HOTs) and time management skills of students. *Journal of Physics: Conference Series*, 1806(1), 12173. <https://doi.org/10.1088/1742-6596/1806/1/012173>
- Santoso, A. M., Primandiri, P. R., Susantini, E., Zubaidah, S., & Amin, M. (2022, December). Revealing the effect of ASICC learning model on scientific argumentation skills of low academic students. In *AIP Conference Proceedings* (Vol. 2468, No. 1). AIP Publishing.
- Santoso, A. M., Primandiri, P. R., & Zubaidah, S. (2024, September). Development of Student Whorksheets Containing Green/Blue Economy for Prospective Teacher Students. In *9th Mathematics, Science, and Computer Science Education International Seminar (MSCEIS 2023)* (pp. 371-383). Atlantis Press. https://doi.org/10.2991/978-2-38476-283-5_37
- Sari, R. A. ., Zulirfan, Z., & Rahmad, M. . (2023). Application of the ASICC learning model (Adapting, Searching, Interpreting, Creating, and Communicating) to increase physics creativity. *Jurnal Penelitian Pendidikan IPA*, 9(11), 10191-10196. <https://doi.org/10.29303/jppipa.v9i11.4316>
- Syafruddin, S., Agustina, I. ., Jemmy, J., Komari, K., & Santosa, T. A. . (2023). The effectiveness of IoT-based flipped classroom model on students' critical thinking skills: A meta-analysis. *Jurnal Penelitian Pendidikan IPA*, 9(10), 883-891. <https://doi.org/10.29303/jppipa.v9i10.5265>.
- Septikasari, R., & Frasandy, R. N. (2018). Keterampilan 4C abad 21 dalam pembelajaran pendidikan

- dasar. *Tarbiyah Al-Awlad: Jurnal Kependidikan Islam Tingkat Dasar*, 8(2), 107–117. <https://doi.org/10.15548/alawlad.v8i2.1597>
- Setiani, D. E., Purwoko, B., Sulistiyowati, T. I., & Santoso, A. M. (2023). Keterampilan berpikir kritis siswa SMP Negeri 5 Kertosono dan implikasi rencana desain pembelajaran IPA. *Prosiding Seminar Nasional Pendidikan Biologi*, 9(1), 37–43. <https://doi.org/10.29303/jppipa.v9i3.1723>
- Setiawan, T. Y., Destrinelli, D., & Wulandari, B. A. (2022). Keterampilan berfikir kritis pada pembelajaran IPA menggunakan model pembelajaran radec di sekolah dasar: Systematic literature review. *Justek: Jurnal Sains Dan Teknologi*, 5(2), 133–141. <https://doi.org/10.31764/justek.v5i2.11421>
- Siswati, B. H., & Suratno, S. (2023). The contribution of cognitive ability and critical thinking skills on the problem solving skills of biology education profession students using case method learning. *Biosfer: Jurnal Pendidikan Biologi*, 16(2), 419–426. <https://doi.org/10.21009/biosferjpb.34633>
- Solikhah, A. A., Saputro, S., Yamtinah, S., & Masykuri, M. (2024). Research trends in group investigation learning model for critical thinking skills in science learning. *Jurnal Inovasi Pendidikan IPA*, 10(1), 62-75. <https://10.21831/jipi.v10i1.70942>.
- Sudiantini, D., & Shinta, N. D. (2018). Pengaruh media pembelajaran terhadap kemampuan berpikir kreatif dan penalaran matematis siswa. *JPPM (Jurnal Penelitian Dan Pembelajaran Matematika)*, 11(1). <https://doi.org/10.30870/jppm.v11i1.2996>
- Usman, U., Utari, E., & Yulita, N. (2020). Hubungan berpikir kritis dengan kreativitas siswa melalui mind map pada pembelajaran biologi. *Bio-Lectura: Jurnal Pendidikan Biologi*, 7(2), 143–152. <https://doi.org/10.31849/bl.v7i2.5299>
- Utomo, W., Suryono, W., Jimmi, J., Santosa, T. A. ., & Agustina, I. . (2023). The Effect of STEAM-based hybrid based learning model on students' critical thinking skills. *Jurnal Penelitian Pendidikan IPA*, 9(9), 742–750. <https://doi.org/10.29303/jppipa.v9i9.5147>.
- Zubaidah, S., & Corebima, A. D. (2015). Mistianah.(2015). Asesmen berpikir kritis terintegrasi tes essay. *Symbion: Symposium on Biology Education*, 200–213.