BIO-INOVED
Jurnal Biologi-Inovasi Pendidikan
Volume 5, Issue 3, October 2023 page. 314-320

P-ISSN : 2684-9062 | E-ISSN : 2714-9803
https://ppjp.ulm.ac.id/journal/index.php/bino
DOI: 10.20527/bino.v5i3.16713

Improving undergraduate biology students' critical thinking skills through a case study-based free inquiry module

Qurrotul Anfa [(1)], Desi Nuzul Agnafia [(1)], Fitri Astriawati [(2)] *

[(1)] Study Program of Natural Science Education, Sekolah Tinggi Keguruan dan Ilmu Pendidikan Modern Ngawi, Ngawi, East Java, Indonesia
[(2)] Study Program of Biology Education, Faculty of Teacher Training and Education, Universitas Jambi, Muaro Jambi, Jambi, Indonesia

**Corresponding Author Email:* fitriastriawati@unja.ac.id

Article Information

Keyword:
Case study; Free inquiry module; Critical thinking skills; Classroom action research

Kata Kunci:
Studi kasus; Modul inkuiri bebas; Keterampilan berpikir kritis; Penelitian tindakan kelas

History:
Received : 02/07/2023
Accepted : 30/09/2023

Abstract

The free inquiry-based module supports independent research-based learning among undergraduate students. Adding case studies to the modules will encourage students to apply concepts to real-world situations to improve their thinking skills. Therefore, this study aims to improve the critical thinking skills of biology education students at Jambi University using case-study-based free inquiry modules. This study is Classroom Action Research (CAR) with the Kurt Lewin model, which consists of two cycles. The subjects of this study were 36 second-semester biology education students taking environmental science courses. The data collection techniques included questionnaires, critical thinking tests, and observation sheets. Data analysis techniques used quantitative descriptive analysis. Our findings indicated that critical thinking skills among undergraduate students in each cycle increased by an average of 23.01%. This means that the case-study-based free inquiry module successfully improves the critical thinking skills of biology education students.

Abstrak

Modul berbasis *free inquiry* mendukung pembelajaran berbasis penelitian secara mandiri pada mahasiswa. Sementara penambahan studi kasus pada modul akan mendorong mahasiswa untuk menerapkan konsep pada situasi nyata untuk meningkatkan keterampilan berpikir mereka. Oleh karena itu, penelitian ini bertujuan untuk melihat implikasi penggunaan modul *free inquiry* berbasis studi kasus terhadap peningkatan keterampilan berpikir kritis mahasiswa pendidikan biologi Universitas Jambi. Penelitian ini adalah Penelitian Tindakan Kelas (PTK) dengan model Kurt Lewin yang terdiri dari dua siklus. Partisipan penelitian ini adalah 36 mahasiswa pendidikan biologi semester dua yang mengambil mata kuliah ilmu lingkungan. Teknik pengumpulan data menggunakan angket, instrument test ketarmpilan berpikir kritis, dan lembar observasi. Teknik analisis data menggunakan analisis kuantitatif deskriptif. Hasil penelitian menunjukkan bahwa kemampuan berpikir kritis mahasiswa pada setiap siklus rata-rata meningkat sebesar 23,01%. Artinya penggunaan modul *free inquiry* berbasis studi kasus berhasil meningkatkan keterampilan berpikir kritis mahasiswa pendidikan biologi.

© 2023 BIO-INOVED : Jurnal Biologi-Inovasi Pendidikan

A. Introduction

Education plays an essential role in the development of human resources. Through education, quality teaching and learning activities can be organized to support improving the quality of human resources by Law No. 20 of 2003 on the National Education System. Meanwhile, qualified teaching is realized through the learning process that can train and improve students' competence as the nation's successor generation.

The higher the level of education, the higher the competence that needs to be developed, including that of biology education students at the University of Jambi. In line with the demands of the 21st century, critical thinking skills must be mastered by a prospective teacher who will subsequently teach in high school. Through mastery of critical thinking, a candidate teacher is expected to face various learning challenges with the development of the times (Nuraini, 2017). Moreover, according to a United Nations (UN) report by Chaeruman (2010), the ability to think critically is characteristic of today's global-era society (Knowledge-based Society). A high level of critical thinking requires students to be able to ask questions in detail, channel their opinions and thoughts, and solve problems independently.

Unfortunately, pre-cycle observations show that the critical thinking skills of biology education students at the University of Jambi remain low. In learning presentation activities, most students do not participate actively and only listen to the materials delivered by their peers. The questions given are also limited to questions on the level 'what' (C1), whose answers are written in textbooks or on the Internet. Meanwhile, the remaining students did not respond to the question.

The researcher assumes that using an inquiry approach in environmental science lectures on the topic of environmental impact analysis (EIA) can improve the critical thinking skills of second-semester biology education students at Jambi University in the 2022/2023 Academic Year. There are four levels of inquiry: controlled, guided, planned, and free inquiry (Anam, 2016). Compared to controlled, guided, and planned inquiry, the choice of free inquiry can give undergraduate students the freedom to analyze problems with all their efforts and then find solutions to solve them. Student classes that apply the free inquiry learning model no longer rely on lecturer instructions because they only act as facilitators (Shofiyah, 2017; Anam, 2016). Therefore, free inquiry is suitable for application at the college level, assuming that undergraduate students' cognitive abilities are very mature so that they can carry out free inquiry syntax properly. Meanwhile, controlled, guided, and planned inquiries are more suitable for elementary and middle school-level children.

This statement is in line with Hadi's (2017) study on the improving of students' critical thinking skills through the application of the modified free inquiry model on photosynthesis and cellular respiration topics, which stated that the application of modified free inquiry could enhance each indicator of students' critical thinking as they are directly involved in organizing their learning process. Furthermore, she explained that applying the free inquiry model would familiarize students with the andragogical learning style, which places them as subjects to make their learning more meaningful.

The selection of case studies as the basis of an independent inquiry approach aimed to enhance students' critical thinking skills. This is consistent with Herreid (2005), which stated that case studies have gained a strong foundation in science teaching. Furthermore, he revealed that 97% of students who learned using case study methods could find new ways to think about a problem, 95% of students participated more actively in the learning process, 92% of students were more engaged in learning activities, 59% were charged with conducting independent research outside the classroom to improve their understanding, and 68% argued that they could gain more meaningful lessons. Mahdi et al. (2020) also confirmed that the case study approach is considered more flexible because it is intended to explore a problem. Due to their flexible nature, students can conduct research or collect data according to the development of their research activities. They can seek knowledge based on their preferred and fun learning style.

Anfa (2019) also conducted environmental science learning using a case study-based free inquiry model, as outlined in the learning module. This aims to enable students to investigate issues in the environment independently. Through these learning modules, students can seek information and conduct independent investigations individually and in groups. The learning modules with a case-study-based free inquiry developed effectively can train undergraduate students' critical thinking skills.

Based on the description, the teaching team should conduct CAR to improve the critical thinking skills of biology education students using case study-based free inquiry modules in environmental science courses. CAR is a study by practitioners

(lecturers) to improve learning quality performance in their classes. CAR focuses on the teaching process that occurs in the classroom and is implemented in real situations (Indahri & Djahimo, 2018). Actions were planned for the students to achieve certain goals. The goal of CAR is to improve the quality of the learning process, such that the activities performed are thought to be better than ordinary activities. In this regard, using case study-based free inquiry modules provides a better learning experience for undergraduate students in environmental science courses than previously applied learning models or resources.

B. Material and Method

This study is a CAR with the Kurt Lewin model, carried out in two cycles. Class Action Research is conducted by practitioners (lecturers or teachers) to improve their professional practice and better understand learning problems in the classroom (Rademaker, 2013; Nicodemus & Swabey, 2017). Based on the Kurt Lewin Model, this study consists of cycles in which each cycle is designed in three stages:1) planning, 2) action and observation, and 3) reflection (Cresswell, 2012).

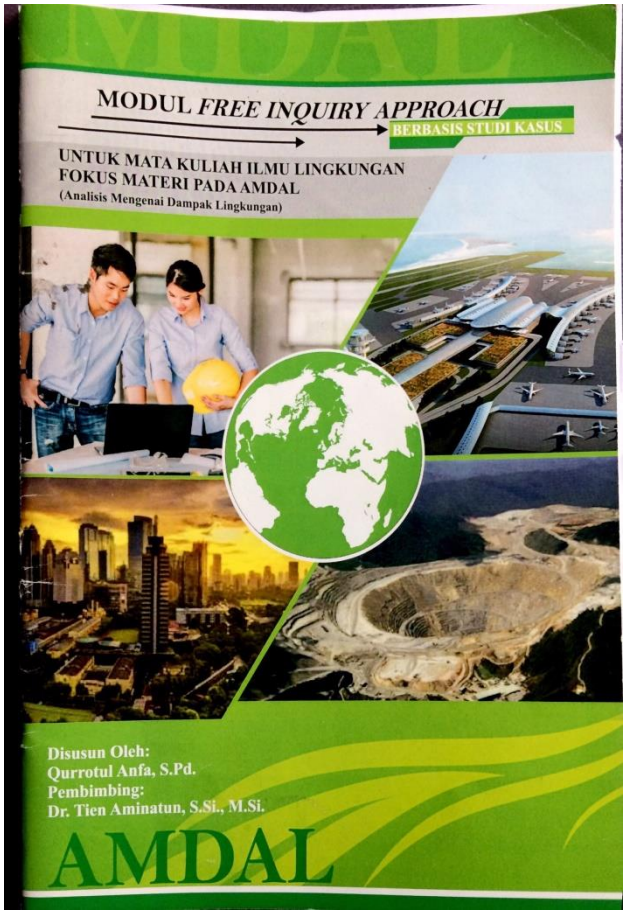

Figure 1
The front cover of free inquiry module (in Indonesian)

The planning phase is carried out by collecting information on the implementation of the lessons conducted during this period and identifying problems that arise during learning. The research team then discussed the issues and planned improvements to the teaching. The action phase implements the learning improvement plan compiled by applying the case study-based free inquiry learning module in environmental science teaching. Figure 1 is the front cover of this module. At this stage, there is also an observation of the implementation of actions and undergraduate student learning activities while using the case study-based free inquiry module. The next phase is reflection, in which the research team analyzes whether there is an improvement in the critical thinking skills of undergraduate students after using the module. In addition, the research team examined the shortcomings and problems that arise in environmental learning using modules. The analysis results are used as a benchmark and material to consider whether the cycle will continue and whether modifications will be made with other actions.

The subjects in this study were 36 undergraduate biology education students at the University of Jambi in the second semester of the 2022/2023 academic year who took environmental science courses. According to Yennita et al. (2022), the data collection procedures were performed using questionnaires, observation sheets, and tests. Questionnaires were given to undergraduate students to gather information about learning problems in the classroom (planning stage). The test instrument measured undergraduate students' critical thinking skills after using the case study-based free inquiry module in each cycle (the action stage). The observation sheet instrument was used to observe student learning activities using the case-study-based free inquiry module in environmental science teaching. Furthermore, data on undergraduate students' critical thinking skills were analyzed quantitatively using Formula 1 (Mulyasa, 2010).

$$P = \frac{N}{A} \times 100\% \text{.....Formula 1}$$

Information:
P = Classical percentage of increased critical thinking skills
N = Number of students scored ≥ 70
A = Total number of students

The data were analyzed using descriptive quantitative analysis. This study is said to be successful if: 1) the student's critical thinking skills score is ≥70; and 2) the student who gets a score ≥70 is 85% of the number of students in the class

(Mulyasa, 2010). Next, the percentage of values was interpreted based on the criteria in Table 1 to determine the improvement level in undergraduate students' critical thinking skills after using the case study-based free inquiry module.

Table 1 The Criteria of Critical Thinking Skills

Achievement Percentage	Criteria
80<P≤100	Very High
60<P≤80	High
40<P≤60	Medium
20<P≤40	Low
0<P≤20	Very Low

C. Results and Discussion

Classroom Action Research is a strategic way for lecturers to improve the learning process in class because they directly deal with problems in the classroom. Syah (2016) supports the idea that improvement is the essential basis for CAR. In addition, Subali (2019), this improvement is related to the context of the learning process.

As mentioned in the Kurt–Lewin model, this study consists of cycles, and each cycle consists of three stages. The research begins with planning; the plan is then implemented as an action in the classroom and observed. Reflection activities were performed to analyze the data obtained during the action. Classroom Action Research consists of a series of iterative steps: after the initial cycle is completed, the cycle begins again with the revision placed into the new action, and so on (Stringer, 2014). Classroom Action Research was performed in two cycles. Each cycle consisted of two meetings with a time allocation of 2 times 50 minutes. Undergraduate students' critical thinking skills data for the pre-cycle, cycle I, and cycle II are shown in Table 2.

Table 2 shows those undergraduate students' critical thinking skills in the pre-cycle are still very low because none of them are rated 70. After the implementation of action in cycle I, it is known that 25 of 36 students obtained a score of 70, so the percentage of completeness increased by 69%. This indicates that there was an improvement in the critical thinking skills of undergraduate students after the use of free inquiry-based case study modules in environmental science courses. However, the results of this first cycle do not meet the criteria of research success set by the research team: 85% of the total students must pass individually or score ≥70; thus, the CAR study continues to cycle II based on the result of reflection. The results of cycle II show that all students achieved a score ≥70, which indicates that the accuracy percentage reached 100%. Based on these results, it can be concluded that there was an increase in undergraduate students' critical thinking skills in each learning cycle.

Critical thinking skills are improved in every indicator: providing simple explanations, building basic skills, making inferences, making further explanations, and building strategies and techniques. The improvement of critical thinking skills indicators of the undergraduate students in each cycle is presented in Table 3.

Table 2 The Critical Thinking Skills of Under-graduate Students in Each Cycle

Description	Pre-Cycle	Cycle I	Cycle II
Total Number of students	36	36	36
Minimum Score	22	65	80
Maximum Score	54	80	91
Class Average	38.75	71.14	84.94
Number of students scored ≥70	0	25	36
Percentage of completeness	0%	69%	100%

Table 3 The Improvement of Critical Thinking Skills of Undergraduate Students in Each Cycle

Criteria of Critical Thinking Skills	Pre-Cycle (%)	Cycle I (%)	Cycle II (%)
Providing simple explanation	34.72	73.06	84.17
Building basic skills	42.64	67.50	83.06
Making inferences	43.89	68.33	87.36
Making further explanation	34.72	73.89	87.08
Building strategies and techniques	37.78	72.92	83.06
Average	**38.75**	**71.14**	**84.94**

In the precycle, the average of each indicator of critical thinking skills in biology education students remained low (38.75%). This indicates that the environmental science courses' models and learning resources did not train undergraduate students' critical thinking skills. The results of the precycle test were then used as the basis for planning learning improvement. Referring to the

precycle results, the research team used a case study-based free inquiry module to train undergraduate students' critical thinking skills.

In cycle I, undergraduate students work on modules in the first part, which include EIA's position in preserving the living environment, understanding EIA, and documenting the results of EIA studies. The results in the cycle I column show that the critical thinking skills of undergraduate students on each indicator improved with high criteria (71.14%). However, the percentage of completeness did not meet the CAR criteria (still 69%); thus, the learning continued to cycle II.

In cycle II, students work on modules in the second part, which is related to a) the procedure for implementing the EIA and b) violations related to the EIA. The cycle II column results show that undergraduate students' critical thinking skills on each indicator experienced an average increase of 84.94% (very high criteria), with the percentage of completeness reaching 100%. Therefore, using case study-based free inquiry modules in environmental science teaching can improve the critical thinking skills of biology education students at the University of Jambi. The improvements in undergraduate students' critical thinking skills are presented in detail in Figure 2.

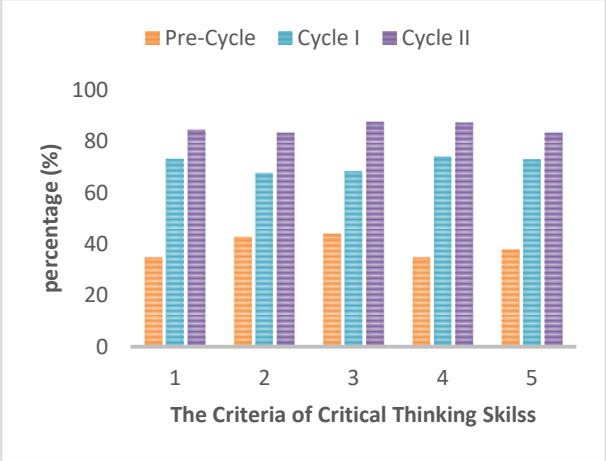

Figure 2
The improvement of critical thinking skills of undergraduate students in each criterium: 1) Providing simple explanation; 2) Building basic skills; 3) Making inferences; 4) Making further explanation; and 5) Building strategies and techniques.

Applying case study-based free inquiry leads undergraduate students to be directly involved in researching various environmental cases. Such involvement helps undergraduate students achieve meaningful learning. They became enthusiastic and participated in a series of learning activities, such as making hypotheses, conducting investigations, presenting data, drawing conclusions, and communicating the findings. Investigation activities will train undergraduate students in critical thinking skills; activities of presenting data and drawing conclusions after conducting an investigation can improve students' problem-solving skills, whereas activities of communicating data through group discussions will encourage students to understand the concept well. This is in line with a previous study stating that inquiry-based learning, both guided and free, can improve students' concept understanding (Sarwi et al., 2018), learning achievements (Yennita et al., 2022), science process skills and scientific attitude (Kholilurrohman & Suryadarma, 2019), problem-solving and critical thinking skills (Pujiani, 2022), scientific literacy (Oktaviana et al., 2023), and higher-order thinking skills (Haryono et al., 2023).

Inserting case studies into the free inquiry module trains students to analyze a problem and find the correct information to find a solution to improve their critical thinking skills. Case studies conducted in groups taught students to cooperate in solving everyday problems. This aligns with the research by Unsar & Engin (2012), who stated that applying the case study method can enhance students' critical thinking skills. In contrast, Alfiandra et al. (2022) state that case studies conducted in groups can train students to cooperate.

The relationship between the case study-based free inquiry module and students' critical thinking skills is explained in Figure 3.

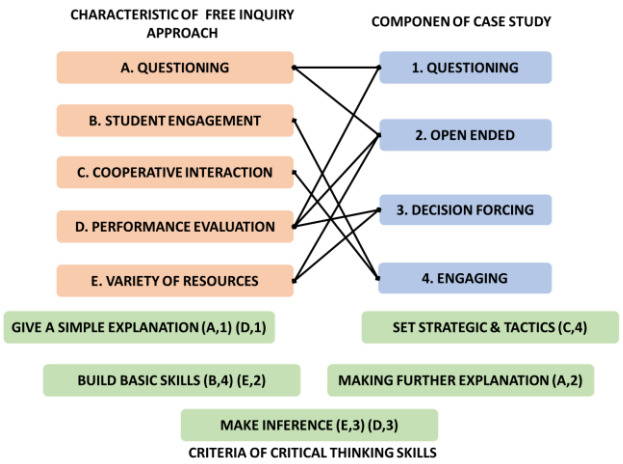

Figure 3
The relationship between free inquiry syntax and critical thinking skills criteria

Figure 3 shows that the learning steps using an inquiry approach can train each indicator of critical thinking skills. The inquiry-based learning syntax trains students to determine common goals and objectives (orientating the focus of discipline), share questions and problems (generating

solutions), share information and data (using an empirical basis), share ways of interpreting or evaluating information and share specific concepts and ideas (analyzing data), sharing keywords to make assumptions (providing bright spots), and sharing points of view or opinions (which allows them to pursue common goals in their group).

Based on this description, it can be concluded that CAR conducted by the research team was successful. The problem of low critical thinking skills of biology education students in environmental science courses can be solved by implementing a case study-based free inquiry module. This is supported by several previous studies that also state that the application of case studies in learning can improve critical thinking skills (Widiandari & Redhana, 2021; Porzecanski et al., 2021) as well as the application of free inquiry learning (Suparmin, 2019; Suryanti et al., 2018).

D. Conclusion

Based on the results of CAR, it can be concluded that 1) the case study-based free inquiry module can improve the critical thinking skills of undergraduate students in environmental science courses; 2) the improvement of critical thinking skills of undergraduate students was found in each cycle; 3) in cycle I, the critical thinking score was 71.14, with 69% completeness, while in cycle II, the critical thinking score was 84.94 and there was an improvement in completeness to 100%. The case study-based free inquiry module directs students to be directly involved in researching various environmental problems. This makes them participate more in learning activities, such as creating hypotheses, conducting investigations, presenting data, drawing conclusions, and communicating findings, all of which improve their critical thinking skills.

E. References

Alfiandra, A., Yusuf, S., Barlian, I., & Safitri, S. (2022). Improving students' critical thinking skills through case based learning oriented textboox. *Jurnal Penelitian dan Pengembangan Pendidikan*, *6*(3), 440-449. DOI: https://dx.doi.org/10.23887/jppp.v6i1

Anam, K. (2016). *Pembelajaran berbasis inkuiri (Metode dan aplikasi).* Yogyakarta: Pustaka Belajar.

Anfa, Q. (2019, July). Effectiveness of free inquiry approach module-based case study in the environmental impact analysis material to practice critical thinking skill of undergraduate biology education student. In *Proceeding The 6th International Conference on Research, Implementation and Education of Mathematics and Sciences (ICRIEMS),* (pp. 17-24). The Eastparc Hotel, Yogyakarta, Indonesia. Retrieved from http://seminar.uny.ac.id/icriems/sites/seminar.uny.ac.id.icriems/files/Proceeding2019/QURROTUL%20ANFA.pdf

Chaeruman, U. (2010). *E-Learning dalam pendidikan jarak jauh*. Jakarta: Kemendiknas.

Cresswell, J. W. (2012). *Educational research (Planning, conducting, and evaluating quantitative and qualitative research).* Fourth Edition. Boston: Pearson Education.

Haryono, D., Fajrie, N., & Sri, S. W. (2023). Inquiry learning untuk peningkatan HOTS dan hasil belajar IPA pada siswa kelas V SDN Doropayung 01 Kecamatan Juwana. *Journal on Education*, *5*(2), 5535-5541. DOI: https://doi.org/10.31004/joe.v5i3.1334

Herreid, C. F. (2005). Using case studies to teach science. *ERIC ED485982, Action Bioscience*, 1-10. Retrieved from https://eric.ed.gov/?id=ED485982

Indahri, Y., & Djahimo, S. E. P. (2018). Teaching and Researching: identifying problems and finding solutions through classroom action research. *Aspirasi: Jurnal Masalah-Masalah Sosial*, *9*(1), 141–147. DOI: https://doi.org/10.46807/aspirasi.v9i1.993

Kholilurrohman, K., & Suryadarma, I. G. P. (2019). The effect ff modified free inquiry approach on student's process skill and science attitudes. *Journal of Science Education Research*, *3*(1), 67-80. DOI: http://dx.doi.org/10.21831/jser.v3i1.27630

Mahdi, O. R., Nassar, I. A., & Almuslamani, H. A. I. (2020). The role of using case studies method in improving students' critical thinking skills in higher education. *International Journal of Higher Education, 9*(2), 297-308. DOI: https://doi.org/10.5430/ijhe.v9n2p297

Mulyasa, E. (2010). *Penelitian tindakan sekolah*. Bandung: PT Remaja Rosda Karya.

Nicodemus, B., & Swabey, L. (2017). Action research "A method for developing teachers" research competencies: "An analytical study". *Researching Translation and Interpreting*, *36*(174), 525–565. DOI: https://doi.org/10.21608/jsrep.2017.6983

Nuraini, N. (2017). Critical thinking profile of students of biological teacher candidate as efforts to prepare 21st century generation. *Didaktika Biologi*, *1*(2), 89–96. DOI: https://doi.org/10.32502/dikbio.v1i2.676

Oktaviana, R., Nuraeni, E., & Amprasto, A. (2023). The effectiveness of inquiry lesson-based digestive system materials for training students'

science literacy ability. *BIO-INOVED*, *5*(2), 187-194. DOI: http://dx.doi.org/10.20527/bino.v5i2.15911

Porzecanski, A. L., Bravo, A., Groom, M. J., Da´Valos, L. M., Bynum, N., Abraham, B. J., Cigliano, J. A., Griffiths, C., Stokes, D. L., Cawthorn, M., Fernandez, D. S., Freeman, L., Leslie, T., Theodose, T., Vogler, D., & Sterling, E. J. (2021). Using case studies to improve the critical thinking skills of undergraduate conservation biology students. *Case Studies in the Environment, 5*(1), 1–16. DOI: https://doi.org/10.1525/cse.2021.1536396

Pujiani, N. M. (2022). The effectiveness of the inquiry learning model on basic science learning materials on problem solving and critical thinking skills. *Jurnal Pendidikan dan Pengajaran*, *55*(1), 173-181. DOI: https://doi.org/10.23887/jpp.v55i1.44722

Rademaker, L. (2013). Action research in education: A practical guide-a book review. *IE: Inquiry in Education*, *4*(2), 1-10. Retrieved from https://digitalcommons.nl.edu/ie/vol4/iss2/6

Sarwi, S., Hidayah, N., & Yulianto, A. (2019, March). Guided inquiry learning model to improve the conceptual understanding and scientific work skills of high school students in Central Java. In *Journal of Physics: Conference Series,* (Vol. 1170, No. 1, pp. 1-5). IOP Publishing. DOI: http://dx.doi.org/10.1088/1742-6596/1170/1/012083

Shofiyah, N. (2017). Penerapan model pembelajaran modified free inquiry untuk mereduksi miskonsepsi mahasiswa pada materi Fluida. *Science Education Journal, 1*(1), 19-28. DOI: http://dx.doi.org/10.21070/sej.v1i1.836

Stringer, E. (2014). *Action research in education*. New Jersey: Pearson Education Limited.

Subali, B. (2019). *Metode penelitian biologi dan terapan.* Yogyakarta: UNY Press.

Suparmin, S. (2019). Enhancing students' critical thinking skills through inquiry learning model at SMA Negeri 9 Makassar. *Jurnal Pendidikan Fisika, 7*(1), 102-116. DOI: https://doi.org/10.26618/jpf.v7i1.1738

Suryanti, S., Arifin, I. S. Z. & Baginda, U. (2018, November). The application of inquiry learning to train critical thinking skills on light material of primary school students. In *Journal of physics: Conference series*, (Vol. 1108, No. 1, pp. 1-7). IOP Publishing. DOI: http://dx.doi.org/10.1088/1742-6596/1108/1/012128

Syah, M. N. S. (2016). Classroom action research as professional development of teachers in Indonesia. *Jurnal Tarbawi, 13*(1), 1–16. DOI: https://doi.org/10.34001/tarbawi.v13i1.526

Hadi, S. A., Susantini, E., & Agustini, R. (2018, January). Training of students' critical thinking skills through the implementation of a modified free inquiry model. In *Journal of Physics: Conference Series*, (Vol. 947, pp. 1-6). IOP Publishing. DOI: http://dx.doi.org/10.1088/1742-6596/947/1/012063

Unsar, A. S. & Engin, E. (2013). A case study to determine critical thinking skills of university. *Procedia-Social and Behavioral Sciences*, *75*(1), 563–569. DOI: http://dx.doi.org/10.1016/j.sbspro.2013.04.061

Widiandari, L. A., & Redhana, I. W. (2021, March). Students' critical thinking skills in case study-based learning. In *AIP Conference Proceedings,* (Vol. 2330, No. 1). AIP Publishing. DOI: https://doi.org/10.1063/5.0043204

Yennita, Y., Putri, R. Z. E., Astriawati, F., & Abas, A. (2022). Penerapan model iquiry learning untuk meningkakan hasil belajar kognitif mahasiswa pada mata kuliah anatomi tumbuhan. *Diklabio*, *6*(2), 189-196. DOI: https://doi.org/10.33369/diklabio.6.2.189-196