INTERNATIONAL JOURNAL OF ADVANCES IN EDUCATIONAL RESEARCH
2024, VOL. 1, NO. 2, 71–78
https://doi.org/10.62941/ijaer.v1i2.83

The application of inquiry-based student worksheets to enhance critical thinking skills on buffer solutions

Khairul Rizal[1] and Meriza Faradilla[2]

[1]Department of Physical Education, Faculty of Teacher Training and Education, Universitas Islam Kebangsaan Indonesia, Bireuen, Indonesia
[2]Department of Science Education, Faculty of Teacher Training and Education, Universitas Bina Bangsa Getsempena, Banda Aceh, Indonesia

ABSTRACT
This study aims to determine the effectiveness of inquiry-based learning student worksheets (LKS) in improving students' critical thinking skills on buffer solutions. One student from a class of 27 in grade XI at SMAN 1 Bireuen, Aceh, Indonesia, was selected as the sample for this research, which employed a qualitative descriptive approach. Data were collected through validated multiple-choice tests. The results indicate that inquiry-based LKS enhances students' critical thinking skills in four key aspects: questioning and answering, observing and evaluating observation reports, making decisions and considering outcomes, and drawing inductions and evaluating inductive conclusions. However, students exhibited relatively weak skills in formulating questions. Inquiry-based learning enables students to actively participate in the learning process, conduct experiments, and solve problems independently. Previous research has shown that inquiry-based learning is effective in developing critical thinking skills.

KEYWORDS
Inquiry-based learning, critical thinking skills, student worksheets, buffer solutions, science education

HOW TO CITE
Rizal, K. & Faradilla, M. (2024). The application of inquiry-based student worksheets to enhance critical thinking skills on buffer solutions. *International Journal of Advances in Educational Research*, *1*(2), 71-78. https://doi.org/10.62941/ijaer.v1i2.83

1. Introduction

Thinking is a critical activity in the learning process. Students are expected not only to achieve learning objectives but also to apply the knowledge and skills they acquire in their daily lives. This will help them face challenges and solve problems both inside and outside the school environment (Magdalena et al., 2024). Critical thinking is a complex and multidimensional process that involves accepting,

CORRESPONDING AUTHOR Khairul Rizal ✉ krizal.uniki@gmail.com Department of Physical Education, Faculty of Teacher Training and Education, Universitas Islam Kebangsaan Indonesia, Bireuen, Indonesia

understanding, mastering, analyzing, and evaluating data while considering both qualitative and quantitative aspects. This process does not end with analysis but also includes selecting information and making decisions based on evaluation results. Critical thinking is essential for learning as it helps students become resilient problem-solvers, wise decision-makers, and lifelong learners who are eager to grow and develop (Lestari et al., 2019).

Critical thinking is an excellent way of thinking that can be applied in various contexts, such as language use, problem-solving, drawing conclusions, and making decisions. It involves analyzing information objectively and thoroughly, enabling individuals to evaluate evidence, consider multiple perspectives, and make logical and rational decisions (Shanti et al., 2017). These activities demonstrate mental processes that involve critical thinking to analyze data or information obtained through observation and communication. This means that individuals must understand, evaluate, and interpret data they observe themselves or gather through interaction with others and then use that data to draw conclusions or develop a better understanding. This process is crucial in helping individuals learn and make fact-based decisions.

As a science subject, chemistry is expected to help students learn critical thinking. Students are encouraged to independently discover and understand chemical concepts through laboratory activities, which are an effective way to achieve this goal. This method aligns with the nature of chemistry as a subject that heavily involves experiments and practical activities. Interviews with chemistry teachers revealed that an analysis of teaching material needs highlights the importance of student worksheets in the learning process. Additionally, findings indicate that lecture, discussion, and Q&A remain the most commonly used teaching approaches in the two schools studied. Educators rarely use more creative and interactive teaching methods. In the absence of teaching materials, teachers and students generally rely on textbooks or resources available in libraries as the primary reference. During laboratory activities, teachers often use worksheets from textbooks, additional resources, or commercially available worksheets. This has led to suboptimal student comprehension.

The lack of student understanding is caused by several factors, including a low understanding of subject matter concepts, failure to retain learned concepts, difficulty interpreting practice questions before solving them (which makes the questions seem challenging), and a lack of awareness of the benefits of learning (Hulu et al., 2023).

The concept of inquiry-based learning is believed to enhance students' thinking abilities. Inquiry-based learning involves a series of activities designed to improve critical and analytical thinking skills. In this process, students are encouraged not to passively receive information but to actively seek and discover solutions independently. Consequently, this technique fosters active participation and helps students develop deeper thinking skills (Noviana, 2021).

This research focuses on the implementation of student worksheets as teaching materials. In addition to practice questions, these materials include summaries to help students understand the subject matter. Student worksheets also serve as evaluation tools for teachers and educational resources. Student worksheets are paper sheets containing tasks based on the basic competencies students need to master (Aminullah et al., 2022). Teaching materials used by teachers and students to support the learning process can include books, worksheets (student worksheets), and visual aids. Teaching materials can also take the form of digital content, food packages, photos, direct discussions with resource persons, teacher instructions, written assignments, and peer discussions. Thus, teaching materials encompass a variety of resources considered capable of enhancing knowledge (Kosasih, 2021).

Based on the context outlined above, there is a growing interest in conducting research on the implementation of inquiry-based student worksheets. This study aims to evaluate students' critical thinking skills, particularly in the topic of Buffer Solutions, conducted at SMAN 1 Jeumpa. In other words, the objective of this research is to determine the effectiveness of inquiry techniques in enhancing students' critical thinking abilities in chemistry, with a specific focus on the topic of buffer solutions.

2. Method

The qualitative approach focuses on understanding the processes that occur, rather than merely examining results or end products. The objective of this approach is to explore and comprehend how a phenomenon or event unfolds in depth. The type of research utilized in this approach is descriptive research, which aims to provide a detailed depiction of a specific phenomenon or event. This research focuses on how a phenomenon can be influenced or controlled.

The study was conducted at SMAN 1 Jeumpa in Bireuen from January to May 2024. The research sample consisted of 27 randomly selected eleventh-grade students from the 2023/2024 academic year. Student learning outcomes were measured using a valid and reliable multiple-choice test administered after the

lessons. According to Sudijono (2008), the formula used to calculate the percentage of learning mastery achieved is shown in Equation (1).

$$P = \frac{f}{N} x100\% \quad (1)$$

Where P represents the percentage, f is the frequency for which the percentage is being calculated, and N is the total frequency or the number of individuals. Equation (1) illustrates the formula used to calculate the results of the students' critical thinking skills test. The test is based on concepts related to buffer solutions and critical thinking indicators.

3. Results and discussion

3.1. Results and discussion

The four critical thinking metrics that students can develop through inquiry-based experimental learning are as follows: 1) observing and considering observational reports; 2) asking and answering questions; 3) making decisions and considering the outcomes; and 4) making inductions and considering the results of the inductions. Figure 1 illustrates the students' critical thinking abilities in the topic of buffer solutions for each indicator.

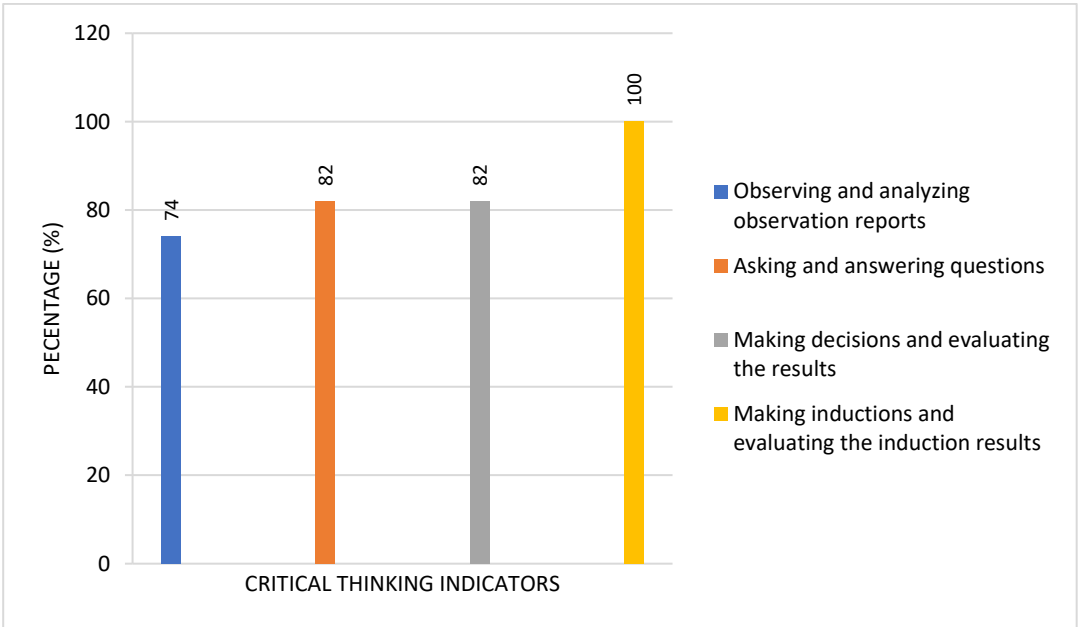

Figure 1. Average scores for critical thinking skills indicators

The student worksheets (LKS) applied in the research schools were developed and tailored to the inquiry approach and the aspects being assessed in critical thinking skills.

The analysis of questions 7, 8, and 10 revealed the results of students' critical thinking skills in the category of observing and considering observational reports. Of the 27 students, 19 (74%) demonstrated the ability to observe and correctly evaluate observational reports, as shown in Figure 1.

3.2. Discussion

Most students mastered this skill during the practical sessions, enabling them to observe and evaluate what they witnessed. One highly essential skill is observing and evaluating observation results, as it goes beyond conducting experiments or collecting data; students must also report their observations in a readable and comprehensible manner (Bahtiar & Maimun, 2022). The ability to evaluate observational reports involves the students' ability to present accurate evidence based on what they observed in tables or observational data. This stage encourages students to critically develop their understanding of the practical material being taught, followed by discussions. Through observation, they can validate the theories they have learned, thereby enhancing their knowledge of relevant concepts (Fernanda et al., 2019).

The critical thinking skill category of asking and answering questions was reflected in questions 1 and 5. The ability to ask and answer questions was demonstrated by 22 students (82%); however, this skill has not been fully utilized, as shown in Figure 1. Students are often trained to answer questions rather than to ask them. As a result, their inherent abilities remain underexplored and underdeveloped. Marudut et al. (2020) found that students' critical thinking abilities in understanding science learning have met expectations, as indicated by test results given to students for solving written questions. However, some students were misled by initial assumptions, resulting in inaccurate answers. Furthermore, while many students were skilled at answering, they often relied on intuition rather than sound conceptual reasoning, leading to quick but conceptually unfounded responses (Susilawati et al., 2020).

The critical thinking skill category of making decisions and considering outcomes was reflected in questions 2, 3, 4, and 6. Figure 1 shows that 22 students (82%) possessed this skill. While the LKS did not include many questions to teach this skill,

some students understood the applications discussed in class. Decision-making involves determining outcomes based on existing facts. To test this ability, students were tasked with determining final solutions to problem-solving scenarios (Fernanda et al., 2019).

All students mastered the critical thinking skill of making inductions and considering results, as shown in question 9. Figure 1 clearly indicates that all students achieved a 100% success rate in this skill. This was due to their ability to draw conclusions from specific understandings about buffer solutions to general concepts. The induction and deduction category was observed when students were organized to learn. It involves applying previously learned theories to interpret information (Widyaningrum et al., 2023). This skill is also evident during the analysis and evaluation stages of problem-solving in the learning process. It reflects students' ability to draw general conclusions based on specific circumstances. At the end of the lesson, teachers asked students to write conclusions about what they had learned on their worksheets. This was done to assess the depth of their understanding of the material. During practical sessions, students in each group recorded their conclusions and evaluations in their lab reports. Students identified patterns, trends, similarities, or differences through learning (Agustin et al., 2016). Moreover, laboratory practicals helped students conclude material about buffer solutions. Salbiah's (2017) study showed that students more easily drew conclusions from experiments on purifying dirty water and distinguishing solutions, colloids, and suspensions.

This research aligns with studies by Shafira and Nurita (2024) at SMAN 4 Samarinda, which explored the effectiveness of the Guided Inquiry model in enhancing students' critical thinking skills. Their findings showed a significant improvement, with the model's impact considered highly effective. Parwati et al. (2020) also conducted research emphasizing collaboration and critical thinking. They reported that the guided inquiry model effectively enhances students' critical thinking skills and scientific attitudes.

The inquiry-based LKS developed has motivated students to learn. According to the study, students should not be treated merely as learning objects; rather, they should be regarded as learning subjects capable of acting as peer tutors. The inquiry-based LKS allowed students to independently learn and understand essential knowledge while sharing it with their peers, making learning more meaningful for both themselves and their classmates.

4. Conclusion

The application of inquiry-based LKS has proven effective in improving students' critical thinking skills on the topic of buffer solutions. Inquiry-based learning enables students to actively participate in the learning process through experimentation and independent problem-solving. The study results indicate that the four main indicators—observing, asking and answering questions, making decisions, and making inductions—show significant improvement in students' critical thinking abilities. Although the inquiry method has successfully enhanced students' overall critical and analytical thinking skills, some students still lack sufficient practice in asking questions.

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgment

We extend our gratitude to the principal of SMAN 1 Jeumpa for granting permission and providing the necessary time to conduct this research, ensuring its smooth implementation.

ORCID

Khairul Rizal https://orcid.org/0009-0008-3201-5641

Meriza Faradilla https://orcid.org/0009-0009-0284-629X

References

Agustin, Y., Fadiawati, N., & Tania, L. (2016). Peningkatan keterampilan berpikir kritis siswa pada materi laju reaksi melalui pendekatan saintifik. *Jurnal Pendidikan dan Pembelajaran Kimia*, *5*(3), 98-112. https://core.ac.uk/reader/294900970

Aminullah, Witilar. H., Misna, dan Elihami. 2022. Pengembangan Lembar Kerja Siswa Berbasis Kearifan Lokal Budaya Masserempulu Tema Keragaman Negeriku di Sekolah Dasar. *Jurnal Pendidikan Guru Sekolah Dasar*. 3(1) : 25 – 30.

Bahtiar, B., & Maimun, M. (2022). Pengaruh model Discovery Learning melalui kegiatan praktikum IPA Terpadu terhadap kemampuan berpikir kritis siswa. *Jurnal Pendidikan MIPA*, *12*(2), 134-142. https://doi.org/10.37630/jpm.v12i2.564

Fernanda, A., Haryani, S., Prasetya, A. T., & Hilmi, M. (2019) Analisis kemampuan berpikir kritis siswa kelas xi pada materi larutan penyangga dengan model pembelajaran predict observe explain. *Jurnal Inovasi Pendidikan Kimia*, *13*(1). https://doi.org/10.15294/jipk.v13i1.16183

Hulu, P., Harefa, A. O., & Mendrofa, R. N. (2023). Studi Model Pembelajaran Inkuiri terhadap Pemahaman Konsep Matematika Siswa. *Educativo: Jurnal Pendidikan*, *2*(1), 152-159. https://doi.org/10.56248/educativo.v2i1.97

Kosasih. E. 2021. *Pengembangan Bahan Ajar*. Jakarta Timur: PT. Bumi Aksara.

Lestari, F., Putri, A. D., & Wardani, A. K. (2019). Identifikasi kemampuan berpikir kritis siswa kelas VIII menggunakan soal pemecahan masalah. *Jurnal Riset Pendidikan dan Inovasi Pembelajaran Matematika (JRPIPM)*, *2*(2), 62-69. https://doi.org/10.26740/jrpipm.v2n2.p62-69

Magdalena, I., Agustin, E. R., & Fitria, S. M. (2024). Konsep Model Pembelajaran. *Sindoro: Cendikia Pendidikan*, *3*(1), 1-10. https://doi.org/10.9644/sindoro.v3i1.2027

Marudut, M. R. H., Bachtiar, I. G., Kadir, K., & Iasha, V. (2020). Peningkatan Kemampuan Berpikir Kritis dalam Pembelajaran IPA melalui Pendekatan Keterampilan Proses. *Jurnal Basicedu*, *4*(3), 577–585. https://doi.org/10.31004/basicedu.v4i3.401

Noviana, W. (2021). *Analisis Penggunaan Model Pembelajaran Inkuiri Terbimbing Untuk Meningkatkan Hasil Belajar Siswa Sekolah Dasar (Analisis Deskriptif Kualitatif dengan Teknik Studi Pustaka)* (Doctoral dissertation, FKIP UNPAS). http://repository.unpas.ac.id/52507/

Parwati, G. A. P. U., Rapi, N. K., & Rachmawati, D. O. (2020). Penerapan model pembelajaran inkuiri terbimbing untuk meningkatkan kemampuan berpikir kritis dan sikap ilmiah siswa SMA. *Jurnal Pendidikan Fisika Undiksha*, *10*(1), 49-60. https://doi.org/10.23887/jjpf.v10i1.26724

Salbiah, S. (2017). Profil keterampilan berpikir kritis siswa menggunakan pembelajaran discovery inquiry pada konsep koloid. *JTK (Jurnal Tadris Kimiya)*, *2*(1), 109-115. https://doi.org/10.15575/jta.v2i1.1367

Sarifah, F., & Nurita, T. (2023). Implementasi model pembelajaran inkuiri terbimbing untuk meningkatkan keterampilan berpikir kritis dan kolaborasi siswa. *PENSA: E-Jurnal Pendidikan Sains*, *11*(1), 22-31. Retrieved from https://ejournal.unesa.ac.id/index.php/pensa/article/view/46474

Shanti, W. N., Sholihah, D. A., & Martyanti, A. (2017). Meningkatkan kemampuan berpikir kritis melalui problem posing. *Literasi: Jurnal Ilmu Pendidikan*, *8*(1), 48-58. http://dx.doi.org/10.21927/literasi.2017.8(1).48-58

Sudijono, A. 2008. *Pengantar Statistik Pendidikan.* Jakarta: PT. Raja Grafindo Persada

Susilawati, E., Agustinasari, A., Samsudin, A., & Siahaan, P. (2020). Analisis tingkat keterampilan berpikir kritis siswa SMA. *Jurnal Pendidikan Fisika Dan Teknologi*, *6*(1), 11-16. https://doi.org/10.29303/jpft.v6i1.1453

Widyaningrum, W., Nurhayati, S., Mursiti, S., & Susatyo, E. B. (2023). Pengaruh Penerapan Model Blended Problem-Based Learning terhadap Kemampuan Berpikir Kritis Siswa pada Materi Larutan Penyangga. *Chemistry in Education*, *12*(1), 89-97. https://doi.org/10.15294/chemined.v12i1.65145