ISSN: 3026-0442

Proceedings of the 2nd International Conference on Education, Science Technology and Health 2nd ICONESTH 2024 Universitas Bina Bangsa Getsempena, Dec 10-12, 2024, Banda Aceh, Indonesia

ENHANCING GENERIC SCIENCE SKILLS THROUGH INQUIRY-BASED LEARNING: A FOCUS ON ELECTROLYTE SOLUTIONS IN CHEMISTRY EDUCATION

Meriza Faradilla[1*], Miswatul Hasanah[2], Dzikrul Rizki[3]

[1,2,3] Universitas Bina Bangsa Getsempena, Banda Aceh, Indonesia

***** Corresponding email: *meriza@bbg.ac.id*

ABSTRACT

The inquiry-based learning model has been widely recognized for its effectiveness in enhancing students' science generic skills, particularly in the context of chemistry education. This study explores the impact of applying the inquiry learning model on the development of students' generic science skills, specifically in the topic of electrolyte solutions. The research aims to assess how inquiry-based teaching methods can improve students' abilities in problem-solving, critical thinking, and practical application of scientific concepts. The study involved a quasi-experimental design with pre-test and post-test assessments to measure the students' progress. The results indicate a significant improvement in the students' generic science skills, suggesting that the inquiry model fosters active engagement, deeper understanding, and enhanced scientific inquiry abilities. These findings highlight the potential of inquiry-based learning as a strategy for improving chemistry education, particularly in topics that require conceptual and practical mastery such as electrolyte solutions.

Keywords: *Inquiry Learning, generic science skills, electrolyte solutions***.**

INTRODUCTION

The development of science and technology has led to a growing need for education systems to focus on fostering skills that are essential for students to succeed in an increasingly complex world. One of the most critical aspects of science education is the development of generic science skills, which include critical thinking, problem-solving, observation, and the ability to apply scientific concepts in various contexts (Doyan et al. 2022. Utami & Rohaeti, 2019). In chemistry education, these skills are especially important, as students need to understand and apply abstract concepts while engaging in practical experiments and real-world applications (Campbell et al. 2022).

In recent years, educational approaches that emphasize active learning have gained significant attention. Among these approaches, the inquiry-based learning model has been recognized for its potential to enhance students' engagement and understanding of scientific concepts (Almuntasheri, 2023). Inquiry-based learning encourages students to actively explore scientific phenomena, pose questions, and seek answers through investigation and experimentation. This model contrasts with traditional teaching methods, which are often more focused on teacher-centered instruction and rote memorization.

The topic of electrolyte solutions in chemistry education offers a relevant context for applying the inquiry-based learning model. Electrolyte solutions are central to various chemical processes and have practical applications in fields ranging from medicine to environmental science (Fadlilah & Nasrudin, 2020). However, the abstract nature of the topic can make it challenging for students to grasp without an engaging and interactive learning approach. By using the inquiry model, educators can guide students to explore the properties of electrolyte solutions, conduct experiments, and develop a deeper understanding of the subject matter.

The traditional approach to teaching chemistry often relies on direct instruction, where students are presented with theoretical knowledge and basic facts through lectures and textbook readings (Da Silva Lima & Da Silva Lima Viana, 2022). While this approach can be effective in delivering foundational information, it may not be sufficient in fostering the critical thinking and problem-solving skills that students need to succeed in the scientific field. As the educational landscape evolves, there is a growing emphasis on instructional methods that promote student engagement and active participation in the learning process (Deslauriers et al., 2019). One such method is the inquiry-based learning model, which prioritizes student-led exploration, question formulation, and evidence-based reasoning.

Research has shown that inquiry-based learning not only enhances students' understanding of scientific concepts but also helps them develop a range of transferable skills. These generic science skills, such as analytical thinking, creativity, and effective communication, are essential for students as they progress in their academic careers and enter the workforce (Sarkar et al., 2020). In the context of chemistry education, these skills are particularly important as students are required to apply their knowledge to solve real-world problems, conduct experiments, and make evidence-based conclusions. The inquiry model, therefore, provides an opportunity to bridge the gap between theoretical learning and practical application, ensuring that students are well-prepared for future scientific endeavors (Abulibdeh, Zaidan & Abulibdeh, 2024).

Electrolyte solutions, a key topic in the chemistry curriculum, presents an excellent opportunity to apply the inquiry-based learning model (Orozco et al, 2023). The behavior of electrolytes in solutions, including their ability to conduct electricity and dissociate into ions, can be complex for students to understand, particularly without hands-on experience or interactive learning strategies (Tarng, 2012). Traditional teaching methods may not fully address the challenges students face when learning about these phenomena. By integrating inquiry-based learning, educators can encourage students to explore the properties of electrolytes, conduct experiments to observe real-world applications, and critically analyze their findings. This hands-on, student-centered approach can significantly enhance students' conceptual understanding and scientific reasoning, making it an effective strategy for improving both their content knowledge and generic science skills.

This study aims to investigate the effectiveness of the inquiry-based learning model in improving students' generic science skills, specifically in the context of electrolyte solutions. By exploring how this model impacts students' ability to engage with scientific concepts and apply them in practice, this research seeks to contribute valuable insights into the integration of inquiry-based learning in chemistry education.

METHODS

This study employed a quasi-experimental design to assess the effectiveness of the inquiry-based learning model in improving students' generic science skills within the context of electrolyte solutions in chemistry education. The study was conducted in a high school setting, with a sample of students from two classes enrolled in the chemistry course. One class was designated as the experimental group, where the inquiry-based learning model was applied, while the other class served as the control group, where traditional teaching methods were used.

The participants in this study consisted of 60 high school students aged 16-17, enrolled in the second year of their chemistry curriculum. These students were selected from two different classes that were similar in terms of prior academic performance in chemistry. The experimental group (n = 30) was taught using the inquiry-based learning model, while the control group (n = 30) received conventional instruction. Both groups were taught the same topic, electrolyte solutions, but the teaching approach differed significantly.

The study followed a pre-test and post-test design to measure the changes in students' generic science skills before and after the intervention. The pre-test was administered at the beginning of the study to assess the students' baseline knowledge and skills regarding the concept of electrolyte solutions. The post-test was conducted after the instructional period to evaluate the improvements in students' understanding and their generic science skills.

Data was collected using two primary instruments: a pre-test and post-test assessing students' knowledge of electrolyte solutions and a rubric to evaluate their generic science skills. The tests focused on key concepts such as the dissociation of electrolytes, conductivity, and the real-world applications of electrolyte solutions. The rubric for evaluating generic science skills included criteria such as problem-solving abilities, critical thinking, communication, and the ability to apply scientific concepts in practical situations. Both tests were developed by the research team and reviewed by experts to ensure validity and reliability.

The data collected from the pre-test and post-test were analyzed using statistical methods. The paired t-test was used to compare the mean scores of the pre-test and post-test for each group. Additionally, the independent t-test was applied to compare the post-test scores between the experimental and control groups. The analysis aimed to determine if there was a statistically significant improvement in the generic science skills of students in the experimental group compared to those in the control group.

RESULTS AND DISCUSSION

Results

The data collected from the pre-test and post-test were analyzed to determine the impact of the inquiry-based learning model on students' generic science skills in the context of electrolyte solutions. The mean scores of the pre-test and post-test for both the experimental and control groups were calculated, and statistical tests were performed to compare the results.

Both the experimental and control groups had similar mean scores on the pre-test, indicating that the students in both groups had a comparable baseline understanding of the topic of electrolyte solutions before the intervention. The average score for the experimental group was 58% (SD = 7.4), and for the control group, it was 57% (SD = 6.9).

After the intervention, the experimental group showed a significant increase in their post-test scores. The average score for the experimental group was 85% (SD = 5.3), representing a substantial improvement in students' understanding of electrolyte solutions and their generic science skills. In contrast, the control group showed a smaller improvement, with an average post-test score of 68% (SD = 7.1).

The paired t-test revealed a significant difference in the mean pre-test and post-test scores for both groups. The experimental group demonstrated a significant increase in their scores ($t = 15.2$, $p < 0.05$), whereas the control group also showed an improvement, but to a lesser extent ($t = 6.4$, $p < 0.05$). The independent t-test comparing the post-test scores between the experimental and control groups indicated that the experimental group outperformed the control group ($t = 9.2$, $p < 0.05$).

Discussion

The results of this study indicate that the inquiry-based learning model significantly enhances students' generic science skills in the context of electrolyte solutions. The experimental group, which was taught using the inquiry approach, demonstrated a marked improvement in their understanding of the topic, as well as in their problem-solving, critical thinking, and application of scientific concepts. This finding is consistent with previous research that highlights the benefits of inquiry-based learning in fostering active engagement and deeper learning in science education (Gillies, 2023).

The substantial improvement in the experimental group's scores can be attributed to the hands-on, student-centered nature of the inquiry-based approach. By actively engaging in experiments and exploring the properties of electrolyte solutions, students were able to develop a more thorough understanding of the topic. The inquiry model also encouraged students to ask questions, formulate hypotheses, and analyze data, all of which are essential components of generic science skills (Gunawan et al., 2019). This approach allowed students to connect theoretical knowledge with practical experience, thereby reinforcing their conceptual understanding and enhancing their scientific reasoning abilities.

On the other hand, while the control group also showed some improvement in their post-test scores, the increase was not as significant as that seen in the experimental group. This suggests that traditional teaching methods, while effective in conveying basic knowledge, may not be as effective in promoting the development of generic science skills. The more passive nature of lecture-based instruction may limit students' opportunities for active engagement and critical thinking, which are essential for developing skills such as problem-solving and scientific inquiry (Khasawneh et al, 2023).

Furthermore, the success of the inquiry-based model in this study suggests that its application can be beneficial in teaching other complex topics in chemistry. The inquiry model not only supports content mastery but also cultivates important skills that students can apply in various contexts, both in and outside the classroom (Joyce & Calhoun, 2024). These findings underscore the importance of adopting active learning strategies, such as inquiry-based learning, to foster a more holistic approach to science education.

While the results of this study provide valuable insights into the effectiveness of inquiry-based learning, there are several limitations to consider. First, the study was conducted in a single educational setting with a limited sample size, which may affect the generalizability of the findings. Additionally, the study focused solely on the topic of electrolyte solutions, and it is unclear whether the results would be replicated with other chemistry topics. Further research is needed to explore the long-term effects of inquiry-based learning and its impact on students' science skills across different subject areas and educational contexts.

CONCLUSION

This study demonstrated that the application of the inquiry-based learning model significantly enhances students' generic science skills, specifically in the context of electrolyte solutions in chemistry education. The results showed that students in the experimental group, who were taught using the inquiry-based approach, exhibited a considerable improvement in both their understanding of the topic and their ability to apply scientific concepts. In contrast, students in the control group, who were taught using traditional methods, showed a more modest improvement.

The inquiry-based learning model proved effective in fostering critical thinking, problem-solving, and hands-on engagement, all of which are essential components of generic science skills. By actively exploring scientific phenomena and conducting experiments, students developed a deeper understanding of electrolyte solutions and strengthened their ability to engage in scientific inquiry. These findings support the idea that inquiry-based learning not only improves content knowledge but also promotes the development of transferable skills that are valuable both in academic and real-world contexts.

REFERENCES

Abulibdeh, A., Zaidan, E., & Abulibdeh, R. (2024). Navigating the confluence of artificial intelligence and education for sustainable development in the era of industry 4.0: Challenges, opportunities, and ethical dimensions. *Journal of Cleaner Production*, 140527.

Almuntasheri, S. (2023). The Impact of a Formative Assessment-Based Inquiry Model on Science Student Understanding and Explanations of Chemical and Physical Changes. *Problems of Education in the 21st Century*.

Campbell, C., Midson, M., Mann, P., Cahill, S., Green, N., Harris, M., Hibble, S., O'Sullivan, S., To, T., Rowlands, L., Smallwood, Z., Vallance, C., Worrall, A., & Stewart, M. (2022). Developing a skills-based practical chemistry programme: an integrated, spiral curriculum approach. *Chemistry Teacher International*, 4, 243 - 257.

Da Silva Lima, R., & Da Silva Lima Viana, K. (2022). Teaching Strategies for High School Chemistry Teachers. *International Journal Education and Teaching (PDVL) ISSN 2595-2498*.

Deslauriers, L., McCarty, L., Miller, K., Callaghan, K., & Kestin, G. (2019). Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. *Proceedings of the National Academy of Sciences of the United States of America*, 116, 19251 - 19257.

Doyan, A., Susilawati, S., Hakim, S., Mahdini, M., & Hamidi, H. (2022). Impact of Physics Learning to Improving Learners' Generic Science Skills: A Review. *Jurnal Penelitian Pendidikan IPA*.

Fadlilah, A., & Nasrudin, H. (2020). Implementation Of Inquiry Learning Models Integrated with Nested to Increase Student's Critical Thinking Skills on Electrolyte and Non-Electrolyte Solution Materials. *JCER (Journal of Chemistry Education Research)*.

Gillies, R. M. (2023). Using Cooperative Learning to Enhance Students' Learning and Engagement during Inquiry-Based Science. *Education Sciences*, *13*(12), 1242.

Gunawan, G., Harjono, A., Hermansyah, H., & Herayanti, L. (2019). Guided Inquiry Model Through Virtual Laboratory to Enhance Students'science Process Skills on Heat Concept. *Jurnal Cakrawala Pendidikan*, *38*(2), 259-268.

Joyce, B., & Calhoun, E. (2024). *Models of teaching*. Taylor & Francis.

Khasawneh, E., Hodge-Zickerman, A., York, C. S., Smith, T. J., & Mayall, H. (2023). Examining the effect of inquiry-based learning versus traditional lecture-based learning on students' achievement in college algebra. *International Electronic Journal of Mathematics Education*, *18*(1), em0724.

Orozco, M., Boon, M., & Susarrey Arce, A. (2023). Learning electrochemistry through scientific inquiry. Conceptual modelling as learning objective and as scaffold. *European journal of engineering education*, *48*(1), 180-196.

Sarkar, M., Overton, T., Thompson, C. D., & Rayner, G. (2020). Academics' perspectives of the teaching and development of generic employability skills in science curricula. *Higher Education Research & Development*, *39*(2), 346-361.

Tarng, W., Lin, Y. J., & Ou, K. L. (2021). A virtual experiment for learning the principle of Daniell cell based on augmented reality. *Applied Sciences*, *11*(2), 762.

Utami, R., & Rohaeti, E. (2019). Students' Generic Science Skills in Chemistry Learning Using Inquiry-Based Learning. *Proceedings of the First International Conference on Progressive Civil Society (ICONPROCS 2019)*.