Indonesian Journal of Sustainability
Vol. 5 No. 1, January : 9-21
P-ISSN 2827-8526
E-ISSN 2827-8917

INDONESIAN JOURNAL of SUSTAINABILITY

INQUIRY EXPLORATION IN SCIENCE LITERACY: LEARNING INNOVATION IN SCHOOL OF LIFE LEBAH PUTIH

Setyo Wuri Kartika Nugraheni, Adek Candra Nur Wijayanti, Sabar Kuswanto, Jupriyanto

Faculty of Teacher Training and Education, Sultan Agung Islamic University, Semarang, Indonesia

setyowuri0902@std.unissula.ac.id

ABSTRACT

Scientific literacy is an essential competency for students; however, science learning in primary schools is often dominated by teacher-centered methods that limit student engagement and conceptual understanding. This study aims to describe the implementation of an inquiry-based approach in strengthening Disciplinary Core Ideas, mapping Science and Engineering Practices skills, and analyzing the relationship between scientific concepts and Crosscutting Concepts at School of Life Lebah Putih. This research employed a qualitative case study design involving semi-structured interviews with the principal, teachers, and students. The findings indicate that the inquiry-based approach enhances students' active participation, conceptual understanding, and the relevance of science learning to everyday life, although its implementation is constrained by teachers' reliance on lecture-based instruction. It can be concluded that inquiry-based learning has strong potential to improve scientific literacy in primary education; therefore, the development of locally contextualized learning modules is recommended to support more effective and sustainable implementation aligned with NGSS standards.

Keywords: *Science Literacy; Inquiry Approach; Basic Education*

INTRODUCTION

Classroom observations and prior studies indicate that students often struggle to apply scientific knowledge when they are asked to analyze real-world phenomena or make evidence-based decisions. These challenges suggest that scientific literacy is closely linked to students' engagement in inquiry-oriented learning experiences that involve experimentation, reasoning, and scientific argumentation ((Eymur & Seda, 2024).

In the context of education, the Next Generation Science Standards (NGSS) framework emphasizes three main dimensions of science literacy: (1) understanding of science content (Disciplinary Core Ideas), (2) scientific practices (Science and Engineering Practices), and (3) crosscutting concepts. The integration

of these three dimensions is believed to create holistic learning, but its implementation in schools is often constrained by conventional teaching methods, such as the dominance of lectures and the lack of student involvement in the exploration process. In the context of education, the Next Generation Science Standards (NGSS) framework emphasizes three main dimensions of science literacy: (1) understanding of science content (Disciplinary Core Ideas), (2) scientific practices (Science and Engineering Practices), and (3) crosscutting concepts. The integration of these three dimensions is believed to create holistic learning, but its implementation in schools is often constrained by conventional teaching methods, such as the dominance of lectures and the lack of student involvement in the exploration process (Efendi & Barkara, 2021).

Field observations at the School of Life Lebah Putih show that science learning activities are characterized by students' active involvement in asking questions, planning simple investigations, and exploring natural phenomena in their surrounding environment. During classroom activities, students are encouraged to design experiments, test their ideas, and discuss their findings collaboratively rather than relying solely on teacher explanations. This learning context illustrates how local phenomenon-based inquiry practices are embedded in daily instruction, supporting the relevance of science learning to students' real-life experiences (Ummah, 2019).

Initial observations of the exploration of inquiry in science literacy at Sekolah Alam Lebah Putih showed the application of a contextual approach that actively involves students in learning experiences in nature. Students are invited to observe, experiment and solve scientific problems, which not only improves their understanding of science concepts, but also develops critical and collaborative thinking skills. The rich natural environment becomes a learning resource that supports the inquiry process, allows students to link theory with real practice, and encourages deep curiosity about the scientific phenomena around them.

This finding is in line with Sapitri and Ferianto's research which states that inquiry learning requires systematic support (scaffolding) so that all students, regardless of ability background, can be optimally involved (Sapitri & Ferianto, 2018). In addition, research by Sarifah and Nurita showed that inquiry-based learning can improve students' conceptual understanding and their ability to apply knowledge in new situations (Sarifah & Nurita, 2023). Another study by (Dyan Wulan Sari Hs & Agus Kistian, 2020) also emphasized the importance of the inquiry approach in science education, stating

that inquiry learning not only improves students' science knowledge, but also critical thinking skills and the ability to work in teams.

This research focuses on the description of the application of the inquiry approach in the three aspects of NGSS science literacy at School of Life Lebah Putih. The main objectives of this research are to describe the form of inquiry application in strengthening Disciplinary Core Ideas (science content) through exploration of local phenomena. Map the Science and Engineering Practices skills that students develop during the inquiry process. Analyzing how students connect science concepts with crosscutting issues. By exploring these three aspects, this research is expected to be a concrete example of how the inquiry approach can be adapted to meet the NGSS science literacy standards, while at the same time addressing learning needs that are relevant to the local context.

RESEARCH METHOD

This study used a qualitative approach with a case study model (Assyakurrohim et al., 2022) to explore the application of the inquiry method in science literacy at Lebah Putih School of Life. The research subjects consisted of the principal, three teachers who teach in grades 3 and 6, and five students (representatives of each grade). Data were collected through semi-structured interviews designed to explore the principal's views on policies and support for the inquiry method, teachers' strategies in designing and implementing lessons, and students' experiences during the learning process.

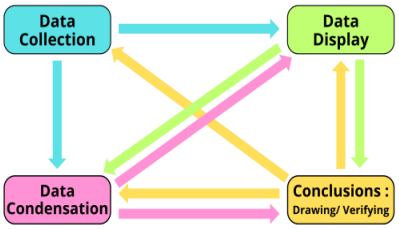

Figure 1 Data Analysis Technique
Source: (Milles, Huberman, 2014)

Data were analyzed using an interactive qualitative analysis approach adapted from Miles and Huberman (2014)). Interview transcripts and field notes were systematically coded and condensed to identify recurring patterns related to the implementation of inquiry-based learning at the School of Life Lebah Putih. NVivo software was used to support the data condensation and categorization process, enabling the organization of themes associated with instructional practices, student engagement, and implementation challenges. These analytical procedures allowed for an in-depth examination of both the challenges and successful aspects of inquiry-based learning in the research context.

RESULT AND DISCUSSION

Based on the results of the research conducted, the researcher presents the results of interviews at

the School of Life Lebah Putih related to the exploration of inquiry in science literacy as a learning innovation. This research involved interviews with the principal, teachers and students to explore their understanding and experiences regarding the application of inquiry methods in science learning. The inquiry approach at School of Life Lebah Putih focuses on students' direct experience with the surrounding environment, which contributes to the improvement of science literacy. Interviews with respondents showed that the school instills a sense of curiosity and "wondering" about science. The principal stated, "The school is committed to driving students' curiosity through science, which we call 'wondering science.'"

Students are allowed to bring various learning resources, such as encyclopedias and educational games, to encourage exploration. The Grade VI teacher explained, "Students reveal what items they have at home to be used as teaching materials, for example, one student has an encyclopedia, another has a science-based game board. Later, these learning resources will be collected in the classroom together." Students are also encouraged to observe and think critically, such as when experimenting with aquariums in the classroom. The Grade VI homeroom teacher added, "Even in the classroom there is an aquarium, it turns out that the radiator vibrates. Well, they experimented, crumpled the paper into a small sphere and put it on top." Some of the activities that support students' science literacy include:

1. Observation Habit
   Students observe the growth of eggplant and kale plants in Q Hall, analyze the failure, and record the observation results. One student explained, "After 2.5 months of planting, it turned out that the kale could not withstand the water falling from the roof. My friends analyzed it, found that there were traces of water falling from the roof, and the kale died."
2. Data Collection Through Interviews
   In Grade 6, students interviewed stall owners to understand capital, selling prices, and challenges in entrepreneurship. One student stated, "At the beginning of the class, we did Market Day, where grade 6 took students to the stalls to conduct interviews."
3. Communicating Findings Through Presentation
   Students make observations in the neighborhood, such as observing butterflies, and present their findings. One student explained, "We were taken outside so we wouldn't get bored, and asked to make observations around the neighborhood."

In addition, research data also obtained from interviews, analysis of

science literacy aspects at the School of Life Lebah Putih showed that the inquiry approach applied contributed significantly to the development of students' science literacy. The results of interviews with principals, teachers and students revealed several aspects of science literacy relevant to the inquiry approach, which can be linked to the NGSS framework. The following are the results of open coding from NVivo showing each aspect of science literacy identified:

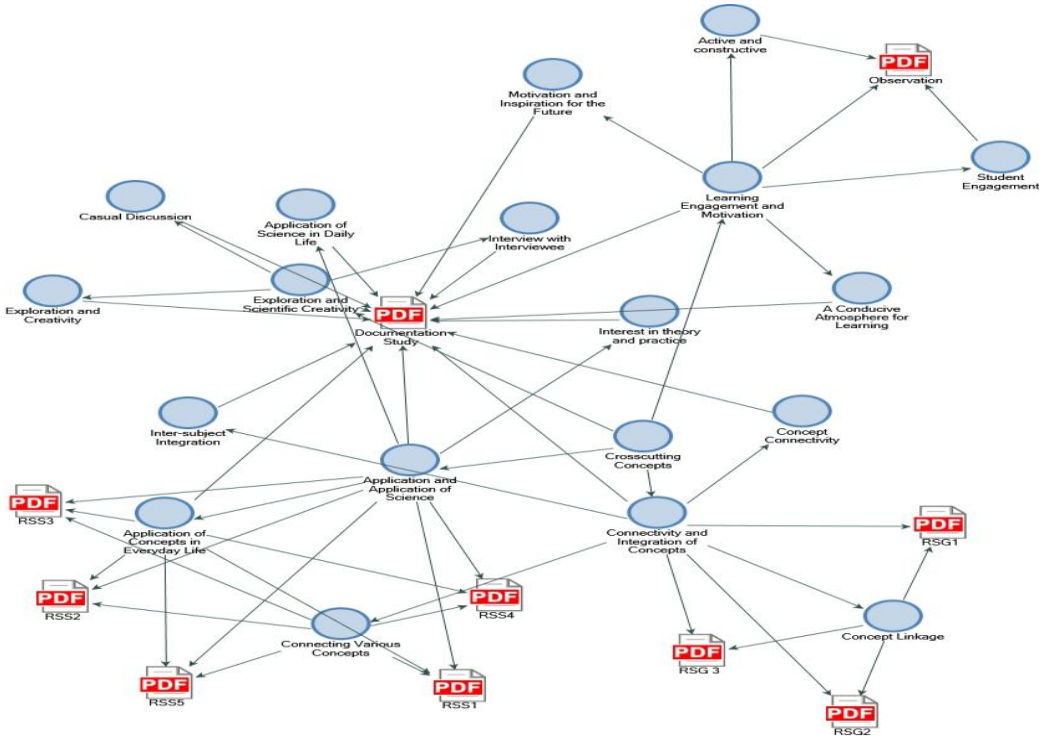

Figure 2 Crosscutting Concepts Project Maps Results
Source: Analysis using NVivo

1. Crosscutting Concepts

In this study, the emphasis on inquiry aspects, such as the promotion of Crosscutting Concepts and scientific exploration, is expected to enrich students' learning experience. Through activities involving interviews with resource persons and casual discussions, students not only learn theory, but also relate scientific concepts to phenomena they observe in everyday life. This makes learning more contextual and relevant, and encourages students to be actively involved in their learning process (Utaminingsih & Shufa, 2019).

In the context of conducive learning, engagement between students is the key to creating an atmosphere that supports motivation and triggers inspiration in the learning process. In constructivism learning theory, as expressed by Piaget, where learning occurs through social

interaction, student engagement is instrumental in facilitating a deeper understanding of learning concepts (Alhabib, 2021).

Some aspects that support the inquiry process include the promotion of Crosscutting Concepts for the integration of various concepts, which helps students understand the relationship between topics. In addition, supporting aspects such as scientific exploration and creativity, including interviews with resource persons and casual discussions, enrich the applicable learning experience (Sugrah, 2020). The application of concepts in daily life shows the connection between theory and practice, making learning more contextual and relevant for students. Thus, the inquiry process becomes an effective tool in encouraging students to be actively involved in their learning.

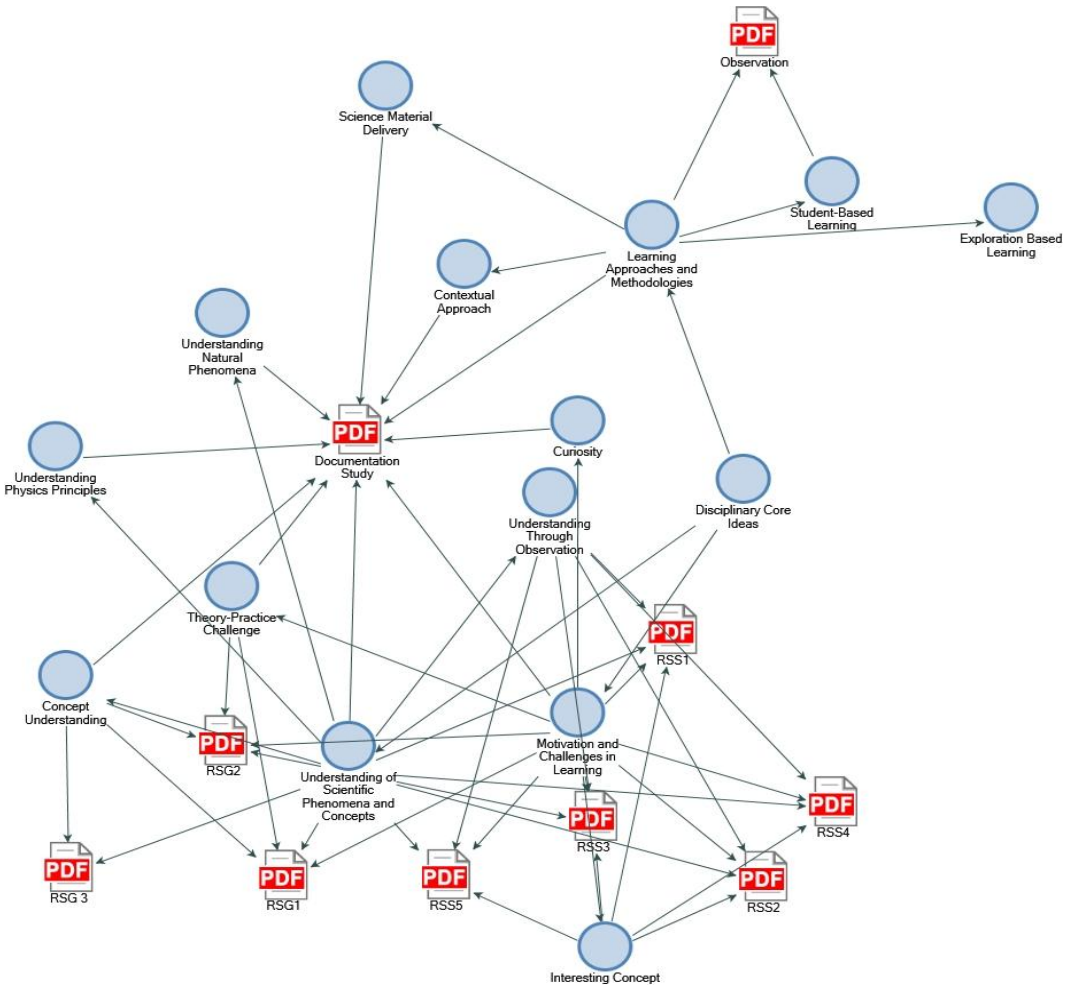

Figure 3 Disciplinary Core Ideas Project Maps Results
Source: Analysis using Nvivo

2. Disciplinary Core Ideas

Effective science learning should integrate an active approach that emphasizes Exploration-Based Learning and Student-Based Learning methods. This is important for material contextualization, where students are expected to relate scientific concepts to natural phenomena, thus increasing their curiosity and engagement. As stated by (Hawa, 2014), "Meaningful learning occurs when students are actively involved in the learning process."

In addition, it is important to pay attention to the motivation and challenges that students face, especially in the concept understanding gap. Through observation and understanding, students can learn to understand phenomena and apply scientific principles. Inquiry diagrams that focus on questions and curiosity encourage students to ask questions and find out more, followed by observation and data collection to systematically document findings (Ernst et al., 2017). The process of analysis and problem solving equips students to analyze data and find solutions, while communication of findings teaches students how to share their research results (Sapitri & Ferianto, 2018). By linking science concepts to the real world, students are encouraged to see relevant connections, which in turn improves their understanding of science as a whole.

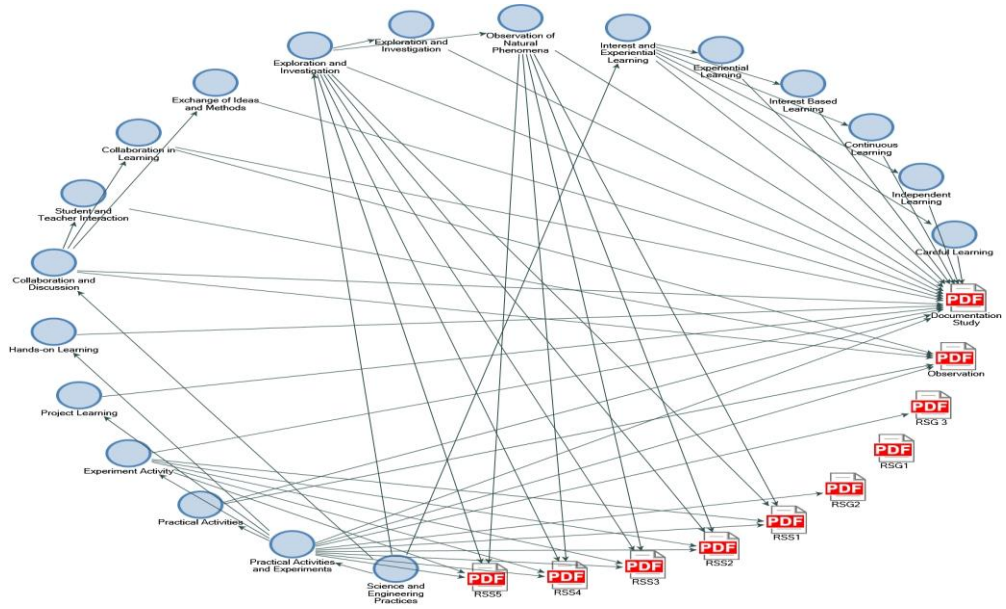

Figure 4 Science and Engineering Practices Project Maps Results
Source: Analysis using NVivo

3. Science and Engineering Practices

Science and engineering learning through active and engaged practice is an approach that supports the development of critical thinking skills among students. In the words of (Nurdiniah, 2024), "Active learning requires students to be directly involved in the learning process, exploring their own knowledge through experience." Elements of this practice include exploration and investigation, where students make observations of natural phenomena and engage in practical activities and experiments that reinforce their understanding.

In addition, collaborative experiments and projects are essential, as these activities not only aid concept understanding, but also encourage constructive interaction between students and teachers. The exchange of ideas and discussions builds a collaborative learning environment, providing space for students for interest-based exploration (Kasi, 2022).Continuous and self-directed learning emphasizes the need to develop relevant skills and knowledge, as well as ensuring students can learn independently over time (Vioreza et al., 2023). The concept of inquiry includes questioning and curiosity, observation and data collection, analysis and problem solving, and communication of findings, all of these elements are interconnected to create a holistic and deep learning process.

The findings from this study provide new insights in the context of constructivism learning theory, which emphasizes that knowledge is constructed through experience and social interaction. By applying the inquiry approach, this study shows that students' active engagement not only deepens their understanding of scientific concepts, but also develops essential critical thinking skills. This is in line with Piaget's view that emphasizes the importance of direct experience in the learning process (Alhabib, 2021). In addition, this study corroborates the argument (Fitri Lastini, Sri Haryanti, Bambang Sumardjoko, 2024) that effective learning occurs when students are actively involved, thus confirming the relevance of exploration and inquiry-based learning methods in modern education.

From a practical perspective, the results of this study show that educational institutions can implement the inquiry approach to increase students' participation in science learning. By providing opportunities for students to explore and use various learning resources, such as encyclopedias and educational games, schools can create a more interesting and interactive learning atmosphere.

After analyzing the data related to science literacy. Then, the researcher looked for the nodes of the

inquiry approach, the researcher conducted open coding using NVivo software. This process aims to identify and categorize key aspects that emerge from the data.

Activities such as interviews with resource persons and group discussions not only enrich the learning experience, but also help students connect scientific concepts with real situations they face. This application of concepts in everyday contexts makes learning more relevant and contextualized, and encourages students to be actively involved in their learning process. After analyzing the data related to science literacy. Then, the researcher looked for the nodes of the inquiry approach, the researcher conducted open coding using NVivo software. This process aims to identify and categorize key aspects that emerge from the data. The following are the results of open coding:

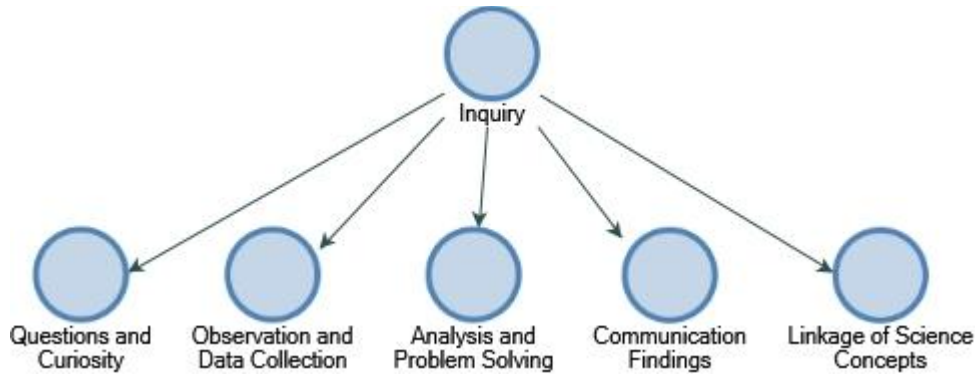

Figure 1 Crosscutting Concepts Project Maps Results
Source: Analysis using NVivo

From a practical perspective, the results of this study show that educational institutions can implement the inquiry approach to increase students' participation in science learning. By providing opportunities for students to explore and use various learning resources, such as encyclopedias and educational games, schools can create a more interesting and interactive learning atmosphere. Activities such as interviews with resource persons and group discussions not only enrich the learning experience, but also help students connect scientific concepts with real situations they face. This application of concepts in everyday contexts makes learning more relevant and contextualized, and encourages students to be actively involved in their learning process.

Scientific inquiry is a process that involves several important steps to explore a topic. The first step is questioning and curiosity, where individuals ask questions that prompt further research. Then, observations

and data collection are made to obtain relevant and supporting information. Once the data is collected, the next stage is analysis and problem solving, which aims to make sense of the data and find patterns or solutions. Furthermore, research results need to be conveyed through communication of findings so that they can be understood by others. Finally, it is important to understand the interconnectedness of science concepts which aims to integrate the knowledge gained with existing theories and concepts, creating a more complete understanding in the field of science. This inquiry approach encourages students to be active and critical in understanding science concepts. The interview results show that students are very interested in science, as expressed by one respondent: "They ask a lot of questions about energy sources and scientific processes that they observe."

The results of this study are in line with a number of previous studies that show that the inquiry approach can improve students' understanding of science. For example, research by (Johnstone et al., 2022) revealed that inquiry-based learning in a formal school environment successfully improved students' ability to formulate hypotheses and analyze data. In addition, research by (Remmen & Iversen, 2023) in Finland showed that nature exploration in inquiry-based learning can improve students' understanding of ecosystems. However, this study also highlights the uniqueness of the alternative education context, where students at the Lebah Putih School of Life are given the freedom to bring learning resources from home and engage in projects that suit their interests.

Overall, this study not only strengthens existing theories, but also provides a new perspective on the application of inquiry methods in a broader educational context. The findings confirm that students' engagement in the science learning process is key to creating meaningful and relevant learning experiences, as well as preparing them to face challenges in the real world.

CONCLUSION

This research shows that the application of inquiry approach in science learning at School of Life Lebah Putih contributes significantly to the increase of students' active engagement. By involving students in the learning process through exploration, observation and social interaction, students are able to relate scientific concepts to their real-life experiences. This supports the hypothesis that the inquiry approach not only improves understanding of science concepts, but also develops critical thinking skills needed to face challenges in the real world.

Suggestions for future research include the development of training

programs for teachers to implement the inquiry method more effectively, as well as further exploration of the long-term impact of this approach on students' science literacy. In addition, it is important to conduct research in various educational contexts to understand how the inquiry approach can be adapted and applied widely. With these steps, it is hoped that the quality of science education can be continuously improved and the relevance of learning can be maintained.

REFERENCES

Alhabib, L. (2021). Jean-Piaget's Constructivist Theory of Learning and Its Application in Teaching. *Doran-International Early Childhood Education*.

Allsop, D. B., Chelladurai, J. M., Kimball, E. R., Marks, L. D., & Hendricks, J. J. (2022). Qualitative Methods with Nvivo Software: A Practical Guide for Analyzing Qualitative Data. *Psych*, *4*(2), 142–159. https://doi.org/10.3390/psych4020013

Assyakurrohim, D., Ikhram, D., Sirodj, R. A., & Afgani, M. W. (2022). Metode Studi Kasus dalam Penelitian Kualitatif. *Jurnal Pendidikan Sains Dan Komputer*, *3*(01), 1–9. https://doi.org/10.47709/jpsk.v3i01.1951

Dyan Wulan Sari Hs, & Agus Kistian. (2020). Perbedaan Sikap Ilmiah Siswa Menggunakan Model Pembelajaran Inquiry Training Dengan Model Pembelajaran Direct Instruction. *Jurnal Tunas Bangsa*, *7*(2), 174–188. https://doi.org/10.46244/tunasbangsa.v7i2.1160

Efendi, N., & Barkara, R. S. (2021). Studi literatur literasi sains di sekolah dasar. *Jurnal Dharma PGSD*, *1*(2), 57–64.

Ernst, D. C., Hodge, A., & Yoshinobu, S. (2017). What Is Inquiry-Based Learning? *Notices of the American Mathematical Society*, *64*(06), 570–574. https://doi.org/10.1090/noti1536

Eymur, G., & Seda, P. (2024). *Investigating the role of an inquiry-based science lab on students ' scientific literacy*. 743–760.

Fitri Lastini, Sri Haryanti, Bambang Sumardjoko, E. F. (2024). Implementasi Teori Perkembangan Kognitif Bruner Pada Pembelajaran Matematika Tentang Perkalian Di Kelas Ii Sekolah Dasar. *Αγαη*, *15*(1), 37–48.

Hawa, S. (2014). Teori Belajar Bruner. *Pembelajaran Matematika Sekolah Dasar*, 1–5.

Johnstone, A., Martin, A., Cordovil, R., Fjortoft, I., Iivonen, S., Jidovtseff, B., Lopes, F., Reilly, J. J., Thomson, H., Wells, V., & McCrorie, P. (2022). Nature-Based Early Childhood Education and Children's Social, Emotional and Cognitive Development: A Mixed-Methods Systematic Review. *International Journal of Environmental Research and Public Health*, *19*(10), 1–30. https://doi.org/10.3390/ijerph19105967

Kasi, R. (2022). Pembelajaran Aktif : Mendorong Partisipasi Siswa. *Jurnal Pembelajaran*, *1*(1), 1–12.

Milles, Huberman, S. (2014). qualitative data analysis. In *Sustainability (Switzerland)* (Vol. 11, Issue 1).

NGSS. (2013). *Next Generation Science Standards: For States, By States*. *1–2*(November), 1–504. https://doi.org/10.17226/18290

Nurdiniah, S. (2024). Langkah-langkah Partisipasi Guru dalam Pendekatan Pembelajaran Aktif di Muslimeen Suksa School, Thailand. *Karimah Tauhid*, *3*, 8581–8598.

Remmen, K. B., & Iversen, E. (2023). A scoping review of research on school-based outdoor education in the Nordic countries. *Journal of Adventure Education and Outdoor Learning*, *23*(4), 433–451. https://doi.org/10.1080/14729679.2022.2027796

Sapitri, A. J., & Ferianto. (2018). Efektivitas Model Pembelajaran Inkuiri Ilmiah Berbasis Kearifan Lokal Budaya Dayak Ketapang Terhadap Minat Belajar Mahasiswa: Studi Literatur Mahasiswa Politeknik Negeri Ketapang. *Academia.Edu*, 34–50.

Sarifah, F., & Nurita, T. (2023). Implementasi model pembelajaran inkuiri terbimbing untuk meningkatkan keterampilan berpikir kritis dan kolaborasi. *Pendidikan Sains*, *11*(1), 22–31.

Sugrah, N. U. (2020). Implementasi teori belajar konstruktivisme dalam pembelajaran sains. *Humanika*, *19*(2), 121–138. https://doi.org/10.21831/hum.v19i2.29274

Ummah, M. S. (2019). Pendekatan Kontekstual Di Sekolah Alam Lukulo Kebumen. *Jurnal Ilmiah KONTEKSTUAL*, *11*(1), 1–14.

Utaminingsih, S., & Shufa, N. K. F. (2019). Model Contextual Teaching and Learning. *UPT PERPUSTAKAAN. Universitas Muria Kudus*, *1*, 105–112.

Vioreza, N., Hilyati, W., & Lasminingsih, M. (2023). Education for Sustainable Development: Bagaimana Urgensi Dan Peluang Penerapannya Pada Kurikulum Merdeka? *EUREKA: Journal of Educational Research and Practice*, *1*(1), 34–47.