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Guided Inquiry-Based LKPD on Swamp Vegetation Biodiversity: Development and Effectiveness in Enhancing Science Process Skills

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Abstract: Contextual and environment-based science learning remains a challenge, especially in enhancing students' science process skills (SPS). At MTs Nurul Ula Desa Burai, the lack of learning materials based on environmental exploration and the minimal use of active learning models pose obstacles. However, the swamp ecosystem in Desa Burai is rich in biodiversity and can be utilized as a learning resource. This study aims to develop a guided inquiry-based LKPD incorporating swamp vegetation biodiversity to improve SPS. Using the R&D method with the 4D model (Define, Design, Develop, Disseminate), the study involved seventh-grade students at MTs Nurul Ula Desa Burai. The results show that the LKPD is highly valid (94.74%), practical for students (75%) and teachers (95%), and effective in enhancing SPS based on observation, pretest and posttest results. In conclusion, this LKPD is valid, practical, and effective while also promoting and preserving the local wisdom of Desa Burai.

Keywords: Science process skills; Local wisdom; Inquiry learning; LKPD development

Introduction

Contextual and environmental-based science learning has become a major challenge in today's education system. Science Process Skills (SPS) are essential elements that students must master to understand scientific concepts more deeply and develop critical thinking, analytical, and problem-solving skills (Samputri & Arif, 2023). According to Matsna et al. (2023) SPS encompasses various aspects, including observation, classification, measurement, inference, hypothesis formulation, and experiment design.

Unfortunately, the mastery of SPS among students in Indonesia remains relatively low due to the dominance of teaching methods that emphasize rote memorization rather than scientific exploration (Azizah et al., 2023). This issue is exacerbated by the lack of laboratory practices and environmental exploration in science learning (Perdana et al., 2023). According to Deky & Akhdinirwanto (2023), the low level of SPS is also closely related to the minimal use of teaching materials that incorporate local environmental exploration. Traditional teaching methods that prioritize memorization over scientific inquiry are a major contributing factor to this deficiency (Kurniawan et al., 2023). Moreover, the limited availability of teaching materials integrating local environmental contexts further hampers SPS development (Tyas et al., 2021). This gap is also linked to inadequate teacher training, which restricts the effectiveness of inquiry-based learning (Mandasari et al, 2021). Addressing these challenges requires curriculum reforms, pedagogical improvements, and enhanced teacher training to promote practice-based and exploratory science education.

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An environment-based approach is considered effective for providing a more contextual and meaningful learning experience. Burai Village, with its rich wetland ecosystem and biodiversity, offers an excellent resource for local wisdom-based learning. Research highlights the crucial role of wetland ecosystems in supporting biodiversity and local communities (Hardiansyah et al., 2018). Integrating environmental-based learning in Burai Village offers students contextual and in-depth experiences that enhance engagement and understanding. This approach supports environmental case studies and promotes knowledge retention through context-based and student-centered strategies (Şanal, 2023). Effective implementation, however, requires flexible teaching strategies to meet diverse student needs and alignment with local ecological wisdom to foster community engagement, sustainable learning, and environmental awareness (Peng et al., 2022;]Huang et al., 2024).

However, in practice, science learning at MTs Nurul Ula in Burai Village is still dominated by lecture-based methods, which do not promote scientific exploration. Teachers primarily rely on textbooks without using local resources, and the lack of Student Worksheets (LKPD) tailored to explore wetland vegetation biodiversity limits students' Science Process Skills (SPS). LKPD is an effective tool to engage students and enhance understanding (Boimau et al., 2022), yet many existing worksheets do not emphasize environmental exploration or integrate effective learning models (Astuti, 2021). The guided inquiry model offers a solution by providing systematic guidance for scientific investigation. This model encourages active exploration, problem-solving, and critical thinking, which improves students' understanding of ecology and biodiversity (Maryani et al., 2023; Larassati & Rachmadıartı, 2021; Yulianti et al., 2021). It allows students to independently formulate hypotheses, conduct experiments, and analyze data, positively influencing their scientific skills and interest (Bruckermann et al., 2022; Fating et al., 2024).

LKPD can also foster teamwork and communication through collaborative learning, increasing motivation by connecting ecological concepts to real-world issues (Jones et al., 2022; Qamariyah et al, 2021; Wu et al., 2021). The guided inquiry approach enriches learning by helping students understand concepts more deeply (Ou et al., 2021; Ruhter, 2022; Suyatmo et al, 2023). To be effective, this model requires a balance of teacher facilitation and student independence, as well as reflection and assessment to enhance understanding and self-regulation (Rahmawati et al., 2021; Syahgiah et al., 2023). Implementing guided inquiry not only improves academic performance but also fosters environmental literacy, conservation awareness, and preparation for future scientific challenges (Grindle et al., 2023; Mutammimah et al., 2019; Zachariah et al., 2022).

According to Douglas & Llewellyn (2013), the guided inquiry model includes key steps such as problem formulation, hypothesis development, experiment planning, data collection, result analysis, and conclusion drawing. This approach has been widely applied in various studies and has been proven effective in enhancing students' conceptual understanding and critical thinking skills (Hasan & Sukariasih, 2019).

Integrating local wisdom into LKPD for Burai Village adds significant value. The local community uses wetland vegetation for daily needs, such as gelam wood for stilt houses and purun plants for handicrafts. This highlights the importance of local wisdom in raising environmental conservation awareness (Apriana et al, 2020). Research suggests that culturally-based teaching materials engage students more effectively (Khadijah et al., 2022). The development of guided inquiry-based LKPD on wetland vegetation biodiversity is an innovative solution that enhances SPS and promotes ecological awareness. Studies show that guided inquiry strengthens scientific skills through hands-on experiments and data analysis (Masruhah et al., 2022), while fostering student independence and concept discovery (Jaya et al., 2022). Integrating this approach into LKPD development will positively impact students' learning outcomes.

The successful implementation of wetland vegetation biodiversity LKPD also depends on its validity and practicality. The validity of LKPD can be assessed through expert evaluations, while its practicality is determined based on feedback from teachers and students (Nisa & Utaminingsih, 2020). he effectiveness of LKPD is analyzed through pretest and posttest results measuring the improvement of students' SPS (Rahayu et al., 2021). Previous studies, such as those conducted by Safitri et al. (2018) have found that guided inquiry-based learning can enhance students' critical thinking skills and scientific attitudes. Applying this strategy in LKPD development is expected to produce more innovative teaching materials that are responsive to students' needs.

Integrating LKPD with an ecosystem-based approach also supports the creation of more holistic learning. According to Widyanti et al. (2020) utilizing the surrounding environment as a natural laboratory can enhance students' understanding of ecological concepts. Thus, this research not only contributes to innovation in guided inquiry-based teaching material development but also strengthens the integration of science and local culture in science learning. The findings of this study are

expected to be applied more broadly and serve as inspiration for the development of other ecosystem-based LKPDs across various regions in Indonesia. Ultimately, the development of guided inquiry-based LKPD on wetland vegetation biodiversity has great potential to enhance students' SPS while fostering awareness of the importance of environmental conservation. With the right strategy and research-based approach, this LKPD can become an effective and contextual learning innovation for students in areas with unique ecosystems such as Burai Village.

Method

This study applies a Research and Development (R&D) approach based on the 4D model (Define, Design, Develop, and Disseminate) as introduced by Thiagarajan et al (1976) to develop and assess the effectiveness of guided inquiry-based student worksheets (LKPD) integrated with the biodiversity of swamp vegetation in Burai Village. The research follows a quantitative approach with an experimental design, involving an experimental group that uses the developed LKPD and a control group that follows conventional learning methods.

Conducted from January to April 2024 at MTs Nurul Ula in Burai Village, the study targeted seventh-grade students during the 2024/2025 academic year. A purposive sampling technique selected one class for the experimental group, which used a time series design over four learning sessions. The research procedure began with the define phase, involving interviews and literature reviews to identify LKPD needs. The design phase followed, using guided inquiry syntax and incorporating swamp vegetation biodiversity aligned with science process skill (SPS) indicators (Lati et al., 2012). The research stages can be seen in the following figure 1.

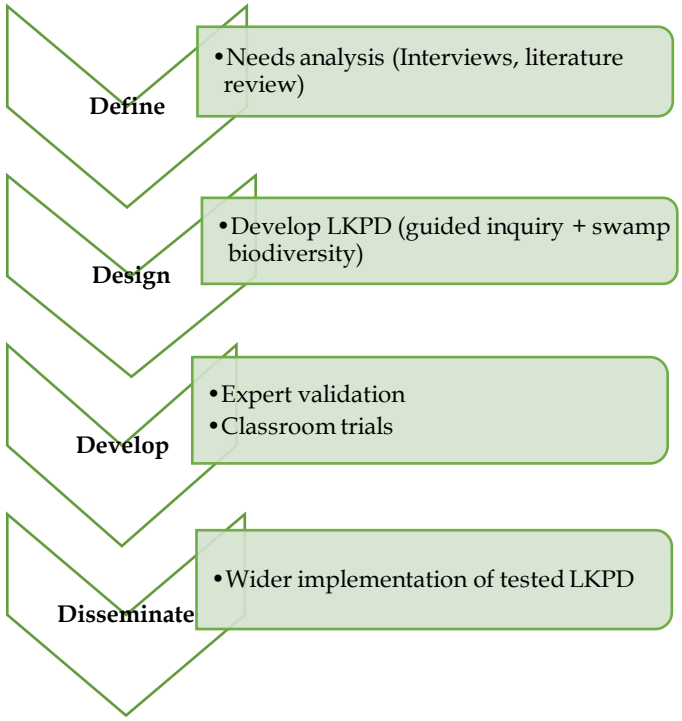

Figure 1. Research flow diagram

In this study, data were collected using several instruments. The instruments used in this study can be seen in Table 1.

Tabel 1. Summary of Research Instruments

Instrument type	Validator/ Source	Purpose	Scale used	Analysis Tech.
Validation Question-naire	Subject matter, media, and language experts	To assess LKPD validity from expert perspective	Likert scale (1–4)	Descrip-tive (percen-tage)
Practicality Question-naire	Teachers and students	To determine the usability and clarity of LKPD	Likert scale (1–4)	Descrip-tive (percen-tage)
Pretest–Posttest	Students (experimental 4 meeting)	To measure improvement in science process skills	Test scores (0–100)	Mann-Whitney test
Observation Sheet	Observers during implementa-tion	To evaluate student ngagement and activity	Check-list + notes	Descrip-tive (percen-tage)

To assess the effectiveness of LKPD in improving students' science process skills, a pretest–posttest was administered to both control and experimental groups. The difference in KPS outcomes was then analyzed using inferential statistics. Specifically, the Mann-Whitney test was used to determine whether there was a statistically significant difference between groups. Data were processed using IBM SPSS 16.0 to ensure accuracy.

Result and Discussion

The results and discussion section presents the findings from the analysis of the developed guided inquiry-based LKPD, which is integrated with swamp vegetation biodiversity, and its impact on students' SPS. The data obtained from validation sheets, practicality questionnaires, pretest and posttest scores, and observation sheets were analyzed to determine the effectiveness of the learning materials.

Validity of LKPD

The validation of the LKPD in this development research consists of content validation, construct/design validation, learning device validation, evaluation validation, and language validation. The LKPD validation was carried out by experts who completed the product assessment sheet by checking the provided statements and offering suggestions for improvement, ensuring expert or professional evaluation. The validation process involved 10 expert validators (lecturers). The validation results indicate that the LKPD achieved an average score of 94.74%, categorizing it as highly valid as shown in Table 2.

Table 2. Recapitulation of LKPD Swamp Vegetation Biodiversity Validation Results

Aspect	Percentage (%)
Content	97.9
Learning Device	95.6
Evaluation	95.7
Media	92.2
Language	92.3
Average Percentage	94.74
Category	Very High

These validation results indicate that the guided inquiry-based LKPD on swamp vegetation biodiversity is suitable for use in learning. These findings align with the research of Boimau et al. (2022) which states that guided inquiry-based teaching materials have high effectiveness in enhancing students' conceptual understanding of science. The validity of an LKPD is crucial as it determines the extent to which the teaching materials align with educational standards and achieve the intended learning objectives. According to the theory proposed by Anggraini & Novita (2023) LKPD validity can be measured through various aspects, including content suitability, presentation, design, and language. This is consistent with the study by Listiono & Winarni (2019), which states that LKPD validity must meet technical, didactic, and construction requirements to be effectively used in learning.

Practicality of LKPD

The practicality of LKPD was tested through teacher and student response questionnaires. The analysis results show that LKPD achieved an average practicality score of 85% based on teacher responses and 75% from students.

Table 3. Recapitulation of LKPD Practicality Data Analysis Results

Aspect	Percentage (%)
Student Response	75
Teacher Response	95
Average Percentage	85
Category	Very high

Based on these results, the developed LKPD is considered easy to use, engaging, and capable of helping students understand the concept of wetland vegetation biodiversity. This is supported by research by Nisa & Utaminingsih (2020) which states that interactive teaching materials can increase student engagement in learning. According to research by Wahyudi & Hisbullah (2024), a practical LKPD must meet several aspects, including language suitability for students' comprehension levels, systematic presentation structure, and ease of application in the classroom. In other words, the practicality of LKPD depends not only on the validity of the material but also on its ease of use in daily learning activities.

Table 4. Average Percentage of Students' SPS Observations

Meeting	% Achievement in SPS Indicator						
	1	2	3	4	5	6	7
Meeting 1	53	65	56	82	55	56	67
Meeting 2	63	78	57	87	62	67	77
Meeting 3	85	88	76	91	82	82	82
Meeting 4	87	97	83	98	90	95	92
Average	77	72	82	68	89	72	75
Total average	76.78%						

Effectiveness of LKPD on SPS

To measure the effectiveness of LKPD, pretest and posttest assessments were conducted in the experimental class, along with SPS observation assessments for students over four meetings. The analysis results show a significant improvement in students' science process skills after using LKPD.

Student Science Process Skills Observation

The average percentage of students' SPS observations, as shown in Table 4, is 76.78%, categorized as high. This indicates that almost all indicators of students' science process skills were achieved successfully. The improvement in science process skills was evident in each session. To further validate these findings, a one-way ANOVA non-parametric statistical test was conducted. Before performing the ANOVA test,

prerequisite tests for normality and homogeneity were conducted, with results as follows.

Table 5. Normality Test Results for SPS Observation

	Meeting	Shapiro-Wilk		
		Statistic	df	Sig.
Value	1	.830	7	.080
	2	.940	7	.637
	3	.949	7	.725
	4	.954	7	.765

The normality test results indicate that the significance values for each meeting (0.80, 0.637, 0.725, and 0.765) are greater than the α value of 0.05, meaning the average observation data for LKPD is normally distributed. A homogeneity test using Levene's test was then performed to ensure variance homogeneity among groups, with results as follows

Table 6. Homogeneity Test Results for SPS Observation Assessment

Levene Statistic	df1	df2	Sig.
2.902	3	24	.056

The homogeneity test results show a significance value of 0.056, which is greater than the α value of 0.05. This indicates that the average observation data for LKPD meets the homogeneity assumption, allowing for further one-way ANOVA testing. The results of the one-way ANOVA analysis are as follows on Tabel 7.

Table 7. One-Way ANOVA Test Results for SPS Observation Assessment

Value					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3734.964	3	1244.988	18.112	.000
Within Groups	1649.714	24	68.738		
Total	5384.679	27			

Based on Table 6, the one-way ANOVA test, it was found that the F value = 18.112 with a significance level (Sig.) = 0.000. Since the significance value is less than 0.05, it can be concluded that there is a statistically significant difference in students' SPS across the groups. H_0 is rejected, and Ha is accepted. This indicates a significant difference in the average score of each science process skill indicator across different meetings. These results show that guided inquiry-based LKPD effectively improves students' science process skills better than conventional teaching methods. This finding is consistent with the research of Maryani et al. (2023) which states that the guided inquiry model can enhance students' skills.

The integration of local wisdom with guided inquiry-based educational models, particularly in studying swamp vegetation, has shown promise in enhancing students' SPS. This approach actively engages students in formulating questions, conducting investigations, and drawing conclusions based on empirical evidence. By incorporating environmental knowledge inherent in swamp ecosystems, guided inquiry fosters scientific literacy while improving engagement and understanding of scientific concepts (Faizin et al., 2024). Research indicates that this method strengthens essential science process skills, including observation, hypothesis formulation, experimentation, and analysis (Mazidah, 2023; Yunianti et al., 2019).

Additionally, guided inquiry enhances student motivation and interest in science subjects (Basyir et al., 2018; Sari et al., 2023). Investigating local swamp ecosystems helps students relate scientific concepts to their environment, creating a personalized learning experience and improving learning outcomes (França et al., 2024). The use of educational resources such as e-modules based on local ecology further deepens students' understanding of swamp biodiversity and conservation strategies (Mr et al., 2024). Swamp ecosystems are vital for biodiversity, nutrient cycling, and carbon storage (Afentina et al., 2023), making their study crucial for both education and environmental stewardship. Evidence suggests that integrating local wisdom with guided inquiry positively influences students' skills (Chandra et al., 2020; Senisum et al., 2022) preparing them for scientific and ecological challenges.

Analysis of Science Process Skills for Each Indicator in Pretest and Posttest Results

To further examine the impact of the LKPP on SPS, an analysis was conducted based on each SPS indicator. The results indicate that the most significant improvement occurred in the skills of interpreting data and communicating experimental findings.

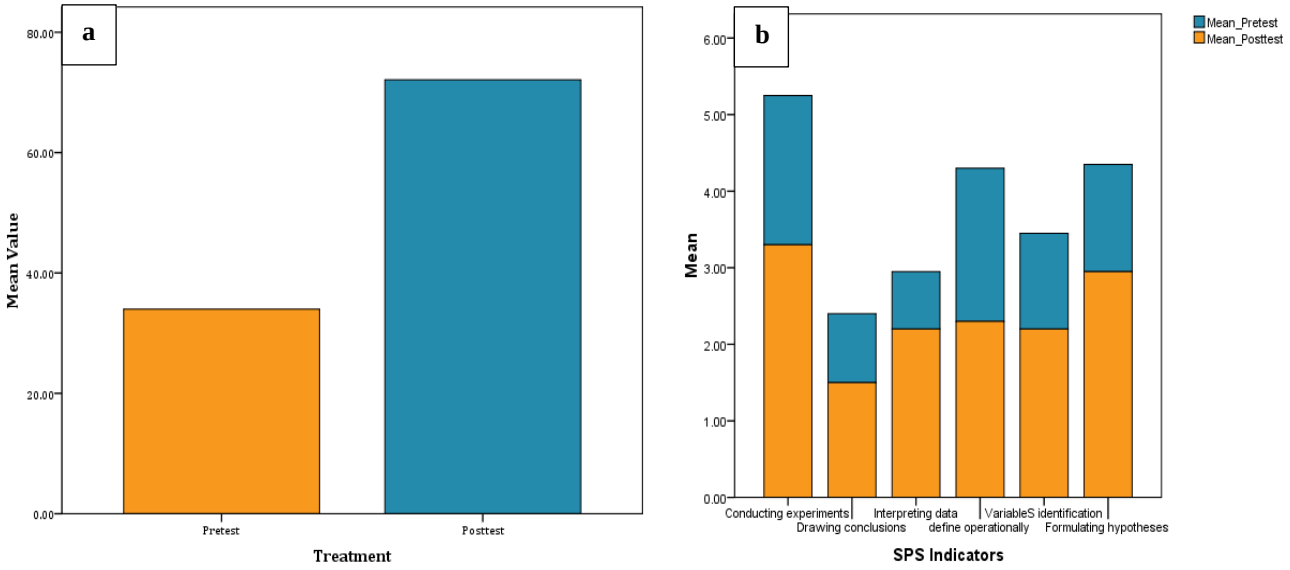

Figure 1. (a) Graph of Overall Pretest and Posttest Average Scores; (b) Differences in Average Pretest and Posttest Scores for Each SPS Indicator. (Different letters (a, b) above the bars indicate significant differences based on post-hoc analysis (Tukey HSD), where bars labeled with different letters are significantly different at $p < 0.05$).

The significant increase in data interpretation skills suggests that students using the LKPD were better able to understand relationships between variables in experiments. Additionally, improved communication skills indicate that students became more confident in presenting their findings. These results align with the study by Safitri (2023), which stated that guided inquiry-based learning models enhance students' science process skills.

The analysis also shows that students felt more supported when learning in an engaging manner rather than solely relying on textbooks. Therefore, the LKPD should be designed with attractive features such as illustrations, case studies, and experiment-based activities. One of the challenges in learning about swamp ecosystems is the limited availability of learning resources relevant to the local environment. Thus, the development of this LKPD will adapt the material to the environmental conditions of Burai Village to ensure contextual relevance and ease of understanding for students.

With this LKPD, students are expected not only to understand swamp vegetation biodiversity theoretically but also to apply their knowledge in daily life. They can learn how to protect the environment and recognize the importance of swamp ecosystems in human life. The LKPD will also include inquiry-based assignments that allow students to apply learned concepts in real-world situations. This approach provides them with a more meaningful and immersive learning experience in understanding swamp vegetation biodiversity. By developing this LKPD, students are expected to appreciate and understand their local environment better. This not only enhances their knowledge but also fosters environmental awareness. In the long term, implementing this LKPD is anticipated to improve the overall quality of science education. With a more interactive and exploratory approach, students will be more motivated to learn and gain a deeper understanding of swamp ecosystems. Thus, this research contributes significantly to the development of environmentally based teaching materials that can be widely implemented in science education.

Conclusion

The results of this study indicate that the guided inquiry-based LKPD on swamp vegetation biodiversity is effective in enhancing students' science process skills. This success is attributed to the LKPD's design, which accommodates real-world ecosystem exploration, thereby increasing student engagement in environmental learning. The implications of this study suggest that teachers can utilize the LKPD as an innovative alternative teaching resource to improve students' science skills. For schools, integrating local ecosystem-based learning can serve as a strategy for developing an environmentally oriented curriculum. This model can be replicated in other regions with unique ecosystems to contextualize science learning across Indonesia.

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Author Contributions

YH: research conceptualization, data validation, writing and editing the manuscript, and funding acquisition, BA: charge of LKPD product development, data management, investigation, initial draft writing, and data visualization, and AS; research reviewer and developer, as well as in manuscript editing and review.

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Conflicts of Interest

The authors declare no conflict of interest.

References

Afentina, A., Baddak, Y., Indrayanti, L., & Pidjath, C. (2023). Contribution of Hampangen Education Forest in Central Kalimantan to Climate Change Mitigation – An Above Ground Biomass Assessment. *Journal of Ecological Engineering*, *24*(1), 97–106. https://doi.org/10.12911/22998993/156056

Anggraini, D., & Novita, D. (2023). Feasibility Multiple Representation Based LKPD to Improve Critical Thinking Skill in Reaction Rate. *Chemistry Education Practice*. https://doi.org/10.29303/cep.v6i2.5202

Apriana, E., Munandar, A., Rustaman, N., dan Surtikanti, H. (2020). Pengembangan Program Perkuliahan Biologi Konservasi dengan Pendekatan Kontekstual Berbasis Kearifan Lokal Aceh. *Jurnal Visipena*, *11*(1), 1–15.

Arikunto, S. (2019). *Prosedur Penelitian Suatu Pendekatan Praktik*. Jakarta: Rineka Cipta.

Astuti, Zulfah, D. R. (2021). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Etnomatematika pada Materi Bangun Ruang Sisi Datar Kelas VIII SMP Negeri 11 Tapung, *5*, 9222–9231.

Azizah, H., Sukarno, S., & Hartoyo, Z. (2023). Korelasi Antara Keterampilan Proses Sains Dengan Literasi Sains Siswa Madrasah Tsanawiyah Negeri Kota Jambi. *Physics and Science Education Journal (PSEJ)*, *3*(April), 1–9. https://doi.org/10.30631/psej.v3i1.1705

Basyir, R. N., Rahayu, W., & Yatima, D. (2018). Influence of Learning Model Based on Project and Inquiry Is Leading to Skin Literature Ability Based on Learning Learning in Basic School (Experimental Study by Applying STEM-based Learning). *American Journal of Educational Research*, *6*(7), 1029–1032. https://doi.org/10.12691/education-6-7-21

Boimau, S. K., Tukan, M. B., Lawung, Y. D., & Boelan, E. G. (2022). Pengembangan LKPD Dengan Memanfaatkan Indikator Alami Berbasis Inkuiri Terbimbing Pada Materi Titrasi Asam Basa. *Educativo: Jurnal Pendidikan*, *1*(2), 374–380.

Bruckermann, T., Greving, H., Schumann, A., Stillfried, M., Börner, K., Kimmig, S., … Harms, U. (2022). Scientific Reasoning Skills Predict Topic-specific Knowledge After Participation in a Citizen Science Project on Urban Wildlife Ecology. *Journal of Research in Science Teaching*, *60*(9), 1915–1941. https://doi.org/10.1002/tea.21835

Chandra, K. R., Degeng, I. N. S., Kuswandi, D., & Setyosari, P. (2020). Effect of Guided Inquiry Learning Model and Social Skills to the Improving of Students' Analysis Skills in Social Studies Learning. *Journal for the Education of Gifted Young Scientists*, *8*(1), 603–622. https://doi.org/10.17478/jegys.654975

Douglas, & Llewellyn. (2013). *Teaching High School Science Through Inquiry and Argumentation*. *Sustainability (Switzerland)* (2th ed., Vol. 11). New Delhi: SAGE Publcations. Retrieved from http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI

Faizin, A., Susantini, E., & Raharjo, R. (2024). Application of a Guided Inquiry Learning Model to Improve Students' Scientific Literacy Skills. *Ijorer International Journal of Recent Educational Research*, *5*(2), 490–503. https://doi.org/10.46245/ijorer.v5i2.573

Fating, A., Deshmukh, J. M., Gode, Y., Dhawade, M. R., Jadhav, D., & Wankhade, Y. (2024). Assess the Effectiveness of an Inquiry Based Learning Method in Microbiology for Undergraduate Medical Students. *E3s Web of Conferences*, *491*, 4009. https://doi.org/10.1051/e3sconf/202449104009

França, F. C. O. de, Zandonadi, R. P., Moreira, I. M. de A., Silva, I. C. R. da, & Akutsu, R. de C. C. de A. (2024). Deserts, Swamps and Food Oases: Mapping Around the Schools in Bahia, Brazil and Implications for Ensuring Food and Nutritional Security. *Nutrients*, *16*(1), 156. https://doi.org/10.3390/nu16010156

Grindle, E. D., Bergan-Roller, H. E., Johnson, A., Lunaburg, G., & Koop, J. A. H. (2023). Snail Races: An Inquiry-Based Approach to Learn Invasive Species Ecology. *Coursesource*, *10*. https://doi.org/10.24918/cs.2023.47

Hamid, N., Roehrig, G. H., Liesnoor, D., Rachmah, H.,

Royyanı, M. A., & Mahat, H. (2021). Development Model for Environment-Based Learning to Improve Junior High School Students' Geographical Skills. *Review of International Geographical Education Online*. https://doi.org/10.33403/rigeo.833857

Hardiansyah, H., Noorhidayati, N., dan Mahrudin, M. (2018). Keragaman Jenis Vegetasi Di Kawasan Rawa Tanpa Pohon Desa Bati-Bati Kabupaten Tanah Laut Sebagai Materi Pengayaan Materi Mata Kuliah Ekologi Lahan Basah. *Wahana-Bio Jurnal Biologi Dan Pembelajarannya*, *10*(1), 28–42.

Hasan, Y. S., & Sukariasih, L. (2019). Penerapan Model Pembelajaran Inkuiri Terbimbing Untuk Meningkatkan Keterampilan Proses Sains dan Hasil Belajar Peserta Didik, *4*(2), 94–98.

Huang, Q., Kuang, Y., Zhou, H., Li, X., & Yin, L. (2024). Biodiversity Conservation in Xishuangbanna, China: Diversity Analysis of Traditional Knowledge Related to Biodiversity and Conservation Progress and Achievement Evaluation. *Diversity*, *16*(5), 260. https://doi.org/10.3390/d16050260

Jaya, T. D., Tukan, M. B., & Komisia, F. (2022). Penerapan Pendekatan Inkuiri Terbimbing Untuk Melatih Keterampilan Proses Sains Siswa Materi Larutan Penyangga. *Educativo: Jurnal Pendidikan*, *1*(2), 359–366.

Jones, P. A., Frischer, D., Mueller, S., Le, T. K., Schwanes, A., Govindaraju, A., … Lee, J. A. (2022). Methylothon: A Versatile Course-Based High School Research Experience in Microbiology and Bioinformatics With Pink Bacteria. *Journal of Microbiology and Biology Education*, *23*(2). https://doi.org/10.1128/jmbe.00227-21

Khadijah, S., Fajriah, N., & Budiarti, I. (2022). Pengembangan E-LKPD Berbasis Etnomatematika Melalui Kerajinan Anyaman Pada Materi Lingkaran. *JMSCEdu*, *2*, 73–83.

Kurniawan, D. A., Astalini, A., & Husna, S. M. (2023). Study of Critical Thinking Skills, Science Process Skills and Digital Literacy: Reviewed Based on the Gender. *Jurnal Penelitian Pendidikan Ipa*, *9*(4), 1741–1752. https://doi.org/10.29303/jppipa.v9i4.1644

Larassati, F., & Rachmadıartı, F. (2021). The Development of E-Book Based on Modified Free Inquiry on Ecology Topic to Train Critical Thinking Skills in Class X High School Students. *Berkala Ilmiah Pendidikan Biologi (Bioedu)*, *10*(2), 302–313. https://doi.org/10.26740/bioedu.v10n2.p302-313

Lati, W., Supasorn, S., & Promarak, V. (2012). Enhancement of Learning Achievement and Integrated Science Process Skills Using Science Inquiry Learning Activities of Chemical Reaction Rates. *Procedia - Social and Behavioral Sciences*, *46*, 4471–4475. https://doi.org/10.1016/j.sbspro.2012.06.279

Listiono, B., & Winarni, S. (2019). Pengembangan Lembar Kerja Peserta Didik Pembelajaran Lompat Jauh Gaya Menggantung Menggunakan Pendekatan Problem-Based Learnig. *Pedagogika: Jurnal Ilmu-Ilmu Kependidikan*, *8*(2), 257–264. https://doi.org/10.21070/pedagogia.v8i2.2421

Mandasari, F., Iwan, I., & Damopolii, I. (2021). The Relationship Between Science Process Skills and Biology Learning Outcome. *Journal of Research in Instructional*, *1*(1), 23–32. https://doi.org/10.30862/jri.v1i1.9

Maryani, U., Bistari, B., Halidjah, S., Kartono, K., dan Pranata, R. (2023). Peningkatan Sikap Ilmiah Siswa Melalui Model Inkuiri Terbimbing Pada Materi FPB dan KPK Kelas IV Di Sekolah Dasar Negeri 34 Pontianak Selatan. *As-Sabiqun*, *5*(3), 475–491. https://doi.org/https://doi.org/10.36088/assabiqun.v5i2.3005

Masruhah, G. D., Wahyuni, S., & Jember, U. (2022). Pengembangan E-LKPD Berbasis Inkuiri Terbimbing Untuk Meningkatkan Keterampilan Proses. *SAP (Susunan Artikel Pendidikan)*, *7*(1).

Matsna, F., Rokhimawan, M., dan Rahmawan, S. (2023). Analisis Keterampilan Proses Sains Siswa Melalui Pembelajaran Berbasis Praktikum Pada Materi Titrasi Asam-Basa Kelas XI SMA/MA. *Dalton Jurnal Pendidikan Kimia Dan Ilmu Kimia*, *06*(01), 21–28. https://doi.org/https://doi.org/10.31602/dl.v6i1.9187

Mazidah, I. N. (2023). Profile of the Implementation of Guided Inquiry-Based Interactive E-Module in Science Learning. *Studies in Philosophy of Science and Education*, *4*(2), 43–55. https://doi.org/10.46627/sipose.v4i2.275

Mr, M. P., Bundu, P., & Yahya, M. (2024). Development of Guided Inquiry Learning Model Based on Educational Games to Improve Elementary Students' Science Process Skills. *Ijim*, *2*(3), 365–380. https://doi.org/10.69693/ijim.v2i3.190

Mutammimah, H., Rochsantiningsih, D., & Asib, A. (2019). Inquiry-Based Learning in English Teaching at a Candidate School of IB PYP: Implementation and Benefits. *Langkawi Journal of the Association for Arabic and English*, *5*(2), 115. https://doi.org/10.31332/lkw.v5i2.1297

Nisa, A. F., & Utaminingsih, R. (2020). Pengembangan Lembar Kegiatan Peserta Lidik IPA berbasis Pendekatan Kontekstual Kelas V Sekolah Dasar. *Trihayu Jurnal Pendidikan Ke-SD-An*, *6*(3). https://doi.org/https://doi.org/10.30738/trihayu.v6i3.8146

Ou, K.-L., Chu, S.-T., & Tarng, W. (2021). Development

of a Virtual Wetland Ecological System Using VR 360° Panoramic Technology for Environmental Education. *Land*, *10*(8), 829. https://doi.org/10.3390/land10080829

Peng, L., Deng, Y., & Jin, S. (2022). The Evaluation of Active Learning Classrooms: Impact of Spatial Factors on Students' Learning Experience and Learning Engagement. *Sustainability*, *14*(8), 4839. https://doi.org/10.3390/su14084839

Perdana, Y., Suryana, S., Mulyadi, H., Miftahuddin, A., & Sandjaya, T. (2023). Studi Jaringan Dan Kolaborasi Ilmiah Dalam Entrepreneurship Menggunakan Analisis Bibliometrik Dan Vosviewer. *Responsive*, *5*(4), 247. https://doi.org/10.24198/responsive.v5i4.44557

Qamariyah, S. N., Rahayu, S., Fajaroh, F., & Alsulami, N. M. (2021). The Effect of Implementation of Inquiry-Based Learning With Socio-Scientific Issues on Students' Higher-Order Thinking Skills. *Journal of Science Learning*, *4*(3), 210–218. https://doi.org/10.17509/jsl.v4i3.30863

Rahayu, S., Ladamay, I., Wiyono, B. B., Susanti, R. H., & Purwito, N. R. (2021). Electronics Student Worksheet Based on Higher Order Thinking Skills for Grade IV Elementary School. *International Journal of Elementary Education*, *5*(3), 453–460.

Rahmawati, I., Julaiha, S., Muri'ah, S., Basith, A., & Khalidah, K. (2021). Implementation Contextual Teaching Learning (CTL) Model in Fiqh Lessons at MTs Darul Muta'alimin Samarinda. *Syamil Jurnal Pendidikan Agama Islam (Journal of Islamic Education)*, *9*(2), 99–116. https://doi.org/10.21093/sy.v9i2.3356

Ruhter, L. (2022). Using the UDL Framework in Inquiry-Based Science Teaching to Support Students With Extensive Support Needs in Inclusive Classrooms. *Inclusive Practices*, *1*(4), 139–146. https://doi.org/10.1177/27324745221093766

Safitri, D., Nurdiyanti, N., & Fadhillah, N. (2018). Motivasi Dan Hasil Belajar Kognitif Siswa Melalui Model Pembelajaran Inkuiri Terbimbing. *Biosel: Biology Science and Education*, *7*(2), 107. https://doi.org/10.33477/bs.v7i2.648

Safitri, E. (2023). A Comprehensive of the Guided Inquiry Learning Model in Education: A Review. *Journal of Digital Learning and Distance Education*, *2*(7). https://doi.org/10.56778/jdlde.v2i7.268

Samputri, S., & Arif, R. N. (2023). Analisis Keterampilan Proses Sains Peserta Didik menggunakan Model Discovery Learning. *Pedagogika*, *14*(2), 188–193. https://doi.org/10.37411/pedagogika.v14i2.2760

Sari, N., Istiyono, E., Purbani, W., & Retnawati, H. (2023). The Effect of the Guided Inmeta-Analysis Study of the Effect of Guided Inquiry Model on Critical Thinking Skills of Students Science Concepts. *Jurnal Pendidikan Matematika Dan Ipa*, *14*(1), 82. https://doi.org/10.26418/jpmipa.v14i1.54483

Senisum, M., Susilo, H., Suwono, H., & Ibrohim, I. (2022). GIReSiMCo: A Learning Model to Scaffold Students' Science Process Skills and Biology Cognitive Learning Outcomes. *Education Sciences*, *12*(4), 228. https://doi.org/10.3390/educsci12040228

Sentosa, Z. S. G. F., Marjanah, & Setyoko, S. (2024). The Influence of the Guided Inquiry Learning Model on Students Ecoliteracy Attitudes on Waste Recycling Materials. *Jurnal Pijar Mipa*, *19*(1), 37–43. https://doi.org/10.29303/jpm.v19i1.6261

Suyatmo, S., Yustitia, V., Santosa, T. A., Fajriana, F., & Oktiawati, U. Y. (2023). Effectiveness of the Inquiry Based Learning Model Based on Mobile Learning on Students' Creative Thinking Skills: A Meta-Analysis. *Jurnal Penelitian Pendidikan Ipa*, *9*(9), 712–720. https://doi.org/10.29303/jppipa.v9i9.5184

Syahgiah, L., Zan, A. M., & Asrizal, A. (2023). Effects of Inquiry Learning on Students' Science Process Skills and Critical Thinking: A Meta-Analysis. *Jipt*, *1*(1), 16–28. https://doi.org/10.24036/jipt/vol1-iss1/9

Thiagarajan, & et al. (1976). Instructional development for training teachers of exceptional children: A sourcebook. *Journal of School Psychology*, *14*(1), 75. https://doi.org/10.1016/0022-4405(76)90066-2

Tyas, R. A., Pujianto, P., & Suyanta, S. (2021). Students' Science Process Skill in Volcanoes Eruption Disaster Preparedness and Mitigation. *Jurnal Ilmu Pendidikan*, *27*(1), 1. https://doi.org/10.17977/um048v27i1p1-7

Wahyudi Deky, Y. A. H., & Raden Wakhid Akhdinirwanto. (2023). Efektivitas E-Modul Cooperative Learning Berbantuan Sigil Software Untuk Meningkatkan Keterampilan Proses Sains. *Jurnal Inovasi Pendidikan Sains (JIPS)*, *4*(2), 90–97. https://doi.org/10.37729/jips.v4i2.3666

Wahyudi, N., & Hisbullah. (2024). Kepraktisan LKPD pada Materi Pencernaan Manusia Berbasis Pembelajaran Interaktif Guru dan Siswa. *Journal of Management Science & Engineering Research*, *1*(1), 23–36.

Widyanti, R., Distrik, I. W., & Wahyudi, I. (2020). Pengaruh Teknik Pembelajaran Pictorial Riddle Berbantukan LKPD Berbasis Inquiry Learning Terhadap Keterampilan Proses Sains pada Materi Pemantulan Cahaya. *Tarbawi : Jurnal Ilmu Pendidikan*, *16*(1), 37–45. https://doi.org/10.32939/tarbawi.v16i01.522

Wu, X. B., Sandoval, C., Knight, S. L., Jaime, X., Macik,

M., & Schielack, J. F. (2021). Web-Based Authentic Inquiry Experiences in Large Introductory Classes Consistently Associated With Significant Learning Gains for All Students. *International Journal of Stem Education*, *8*(1). https://doi.org/10.1186/s40594-021-00290-3

Yulianti, E., Zhafirah, N. N., & Hidayat, N. (2021). Exploring Guided Inquiry Learning With PhET Simulation to Train Junior High School Students Think Critically. *Berkala Ilmiah Pendidikan Fisika*, *9*(1), 96. https://doi.org/10.20527/bipf.v9i1.9617

Yunianti, A. U., Wasis, W., & Nur, M. (2019). The Effectiveness of Guided Inquiry Learning Model to Improve Science Process Skill on Heat Matter. *Journal of Physics Conference Series*, *1417*(1), 12080. https://doi.org/10.1088/1742-6596/1417/1/012080

Zachariah, A. M., Meenu, S., Vijayalakshmi, G., & Pothen, L. (2022). Inquiry Learning-an Effective E Learning Approach for Knowledge Retention. *International Journal of Health Sciences*, 7756–7762. https://doi.org/10.53730/ijhs.v6ns2.6982