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Developing Structured Inquiry-Based LKPD to Train Science Process Skills

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Abstract

Science learning in the 21st century requires student-centered approaches that promote scientific thinking and Science Process Skills (SPS). Inquiry-based learning provides opportunities for students to engage in scientific activities; however, its implementation requires structured learning materials that systematically facilitate SPS development. This study aimed to develop and evaluate the feasibility, readability, and practicality of a structured inquiry-based Student Worksheet (LKPD) on the excretory system topic to support SPS training. The study employed a Research and Development (R&D) approach using the ADDIE model, limited to the Development stage. The subjects were Grade 11 students (XI IPA 1) at MAN 3 Tangerang. The procedures included needs analysis, LKPD design, expert validation, student readability assessment, and teacher response evaluation. The results showed that the LKPD achieved an average validation score of 83% (very feasible), student readability of 89.8% (very readable), and teacher response of 73.2% (feasible). These findings indicate that the structured inquiry-based LKPD is a feasible learning resource that provides systematic guidance for students to engage in scientific activities and supports SPS training in senior high school biology learning.

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INTRODUCTION

Changes in the Indonesian education curriculum reflect a shift from teacher-centered to student-centered learning, emphasizing students' active roles in constructing knowledge while positioning teachers as facilitators, learning designers, and motivators. In line with this transformation, the scientific approach has become an essential component of science education because it encourages students to actively investigate natural phenomena through observation, experimentation, data interpretation, and scientific communication. Consequently, science learning is expected to develop not only conceptual understanding but also scientific, critical, and analytical thinking skills that are relevant to the rapid advancement of science and technology (Kartika et al., 2022). Scientific learning activities involving investigation, discussion, and interpretation of evidence have also been shown to support the development of students' scientific reasoning and problem-solving abilities (Parmin & Savitri, 2022).

Science Process Skills (SPS) constitute a fundamental component of science learning because they enable students to observe, classify, formulate hypotheses, design and conduct investigations, interpret data, and draw scientific conclusions. These skills are essential for helping students understand scientific concepts meaningfully and apply scientific reasoning in various learning contexts. Nevertheless, previous studies indicate that SPS development in schools remains suboptimal because learning activities are still predominantly teacher-centered and emphasize conceptual knowledge rather than scientific investigation (Kurniawati, 2021).

To address this issue, inquiry-based learning has become one of the most widely implemented approaches for improving students' Science Process Skills. Inquiry learning, including structured and guided inquiry, actively engages students in identifying problems, formulating hypotheses, collecting evidence, interpreting findings, and communicating scientific explanations. Such learning experiences encourage students to develop scientific reasoning while improving conceptual understanding. Previous studies have consistently demonstrated that guided inquiry effectively enhances students' SPS through systematic scientific investigations and reflective learning activities (Suryawanto et al., 2022). Likewise, Hardianti and Permatasari (2023) reported that inquiry-oriented learning sequences emphasizing prediction, discussion, observation, and explanation significantly strengthened students' observation, interpretation, and communication skills. Similar findings were reported by Arslan et al. (2023), who found that argument-driven inquiry improved students' science process skills while simultaneously strengthening their scientific argumentation abilities.

Despite these advantages, successful inquiry learning requires appropriate instructional guidance because students frequently encounter difficulties when conducting independent scientific investigations. Structured inquiry provides systematic scaffolding by guiding students through sequential learning stages, including problem identification, hypothesis formulation, investigation planning, evidence collection, data interpretation, and conclusion drawing. Such structured guidance helps reduce students' cognitive difficulties while maintaining opportunities for active scientific exploration (Lazonder & Harmsen, 2016). Empirical evidence further indicates that guided inquiry supported by structured worksheets enables students to perform scientific investigations more systematically while improving their science process skills and conceptual understanding (Chotimah et al., 2023). Likewise, digital inquiry learning supported by interactive worksheets has been reported to significantly improve students' observation, experimentation, and interpretation skills, thereby facilitating the development of SPS (Sa'adah et al., 2024).

Among various instructional resources, Student Worksheets (LKPD) play an important role in facilitating inquiry-based learning because they provide structured learning guidance that encourages students to actively participate in scientific investigations. Well-designed LKPD guide students through sequential inquiry activities, including problem identification, hypothesis formulation, experimentation, evidence analysis, and scientific communication. Recent studies in biology education have shown that systematically developed instructional materials can effectively integrate scientific activities, contextual learning, and Science Process Skills into meaningful learning experiences (Rahmalia et al., 2025). Similarly, inquiry sequence-based electronic worksheets have been reported to stimulate hands-on skills, mind-on activities, and SPS through structured scientific investigations (Divia et al., 2022). Guided inquiry-based electronic worksheets also enable students to practice SPS through problem formulation, hypothesis development, experimentation, data interpretation, and conclusion drawing (Azahra & Fitrihidajati, 2023). Other development studies have demonstrated that inquiry-oriented worksheets function as effective instructional scaffolds by promoting structured scientific investigations and higher-order thinking

skills (Budiman et al., 2024). In addition, electronic worksheets developed using active learning models have been shown to support students' independent learning through systematic learning activities and clear instructional guidance (Mitasari & Hidayah, 2022). Similar findings have been reported across science disciplines, showing that guided inquiry-based LKPD effectively improve students' Science Process Skills in biology, chemistry, and physics learning (Pitriyani et al., 2025). In biology education, electronic worksheets have also been reported to produce valid and practical learning materials that support student-centered learning (Salsabilla et al., 2024), facilitate SPS through interactive inquiry activities (Alivia & Purnomo, 2026), and simultaneously promote higher-order thinking skills as well as scientific literacy (Rozali et al., 2024).

Furthermore, empirical studies have demonstrated that inquiry-based LKPD developed through systematic instructional design generally possess high levels of validity and practicality while improving students' conceptual understanding, scientific attitudes, and learning outcomes. Effective worksheets do not merely provide procedural instructions but also facilitate hypothesis formulation, evidence collection, critical thinking, and systematic interpretation of scientific data (Sudibyo et al., 2019). Nevertheless, many existing inquiry-based LKPD primarily emphasize learning achievement or selected aspects of SPS rather than explicitly integrating comprehensive Science Process Skills indicators into every stage of inquiry, particularly in abstract biology topics such as human excretory system.

The implementation of inquiry-oriented LKPD also presents practical challenges because many teachers still experience difficulties in designing instructional materials that systematically facilitate students' scientific investigations while addressing diverse learning needs. Consequently, inquiry-based learning materials should not only demonstrate strong academic validity but also provide practical learning guidance that encourages students' active engagement throughout the scientific learning process (Sinuraya & Widianto, 2023). Therefore, developing structured inquiry-based LKPD that explicitly integrates Science Process Skills throughout the learning process has become increasingly important for improving the quality of biology education. Through carefully designed inquiry activities, students are expected not only to acquire conceptual understanding but also to develop scientific reasoning and apply Science Process Skills in both classroom learning and real-life contexts (Nuriantisyah et al., 2023).

Accordingly, this study aimed to develop a structured inquiry-based Student Worksheet (LKPD) on the excretory system topic for Grade 11 students to facilitate Science Process Skills and to analyze teachers' and students' responses toward developed product. The novelty of this study lies in explicit integration of ten Science Process Skills indicators into every stage of structured inquiry, beginning with problem identification and hypothesis formulation and continuing through experimentation, evidence interpretation, conclusion drawing, and scientific communication. In addition, developed LKPD incorporates contextual biological phenomena and simple experimental activities related to students' daily lives, thereby providing continuous opportunities for students to practice comprehensive Science Process Skills throughout learning process.

METHOD

This study employed a Research and Development (R&D) approach to develop a structured inquiry-based Student Worksheet (LKPD) that systematically integrates Science Process Skills (SPS) into biology learning. Since the primary objective was to develop and validate an instructional product rather than evaluate its effectiveness, the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model was adopted as the development framework. The ADDIE model has been widely applied in educational product development because it provides a systematic process for analyzing learning needs, designing instructional materials, developing prototypes, and validating their feasibility before broader classroom implementation (Aribowo et al., 2025). Therefore, this model was considered appropriate for ensuring the content validity, practicality, and usability of developed LKPD.

This study employed a Research and Development (R&D) approach to develop a structured inquiry-based Student Worksheet (LKPD) designed to train Science Process Skills (SPS) on excretory system topic for senior high school students. Since the primary objective was to develop and validate an instructional product rather than evaluate its effectiveness, the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model was adopted as development framework. Development studies using systematic instructional design models are widely applied to produce valid and feasible educational products before classroom implementation (Aribowo et al., 2025). Development process was limited to Development stage, which focused on product

development, expert validation, revision, and preliminary user evaluation (Molenda, 2015).

The research was conducted from March to June 2025 at MAN 3 Tangerang Regency. The participants consisted of Grade 11 students (Class XI IPA 1) in the second semester of the 2024/2025 academic year. The class was selected through purposive sampling based on teacher recommendations and classroom availability (Sugiyono, 2017). Product validation involved one content expert, one media expert, one language expert, and one biology teacher as an instructional practitioner. Expert validation was conducted to ensure the content accuracy, instructional quality, language appropriateness, and practical applicability of the developed LKPD before classroom use (Adeoye et al., 2024).

The development process followed three stages of the ADDIE model. The analysis stage aimed to identify instructional needs through curriculum analysis, learning outcomes, characteristics of the excretory system topic, students' characteristics, and the need to develop Science Process Skills (SPS). Data were obtained through classroom observations and interviews with biology teachers. The Design stage, the LKPD framework was designed according to the stages of structured inquiry. Learning objectives, SPS indicators, inquiry activities, simple experimental procedures, assessment instruments, and worksheet layouts were prepared to ensure alignment between learning objectives and inquiry activities. The Development stage involved producing the initial LKPD prototype, conducting expert validation, revising the product based on validators' recommendations, and implementing a limited readability test involving students. Biology teachers also evaluated the developed LKPD to determine its practicality and suitability for classroom implementation.

Data were collected through observations, interviews, questionnaires, and documentation. The research instruments consisted of observation sheets, interview guidelines, student needs questionnaires, expert validation sheets, student readability questionnaires, and teacher response questionnaires. The feasibility of the developed LKPD was evaluated using a five-point Likert scale adapted from Sugiyono (2017).

Data analysis employed both quantitative and qualitative descriptive techniques. Quantitative data from expert validation, student readability, and teacher responses were converted into percentage scores and interpreted using feasibility criteria ranging from very poor to very feasible. Qualitative data obtained from validators, teachers, and students in form of comments and suggestions were analyzed through data reduction, data display, and conclusion drawing following procedures proposed by Miles et al. (2014). The qualitative findings were used to revise and improve the developed LKPD before its finalization.

Table 1. LKPD Blueprint Based on Structured Inquiry and Science Process Skills

Structured Inquiry Stage	Stage Indicator	SPS Indicator	SPS Sub-Indicator	LKPD Section
Orientation	Identifying problems and issues	Problem identification	Answering questions from relevant topics	Introduction: Includes an illustration of skin excretion; students identify problems and answer questions based on literature and experiments
Hypothesizing	Formulating hypotheses	Hypothesizing	Creating hypotheses to answer questions identified in the previous stage	Hypothesis page: Students write hypotheses based on literature search and identification questions
Planning Experiments	Preparing tools and materials, designing experiments	Experiment design	Listing tools, materials, and experimental procedures	Tools & materials list, experimental steps: Students perform the experiment according to teacher instructions in groups
Conducting Experiments	Performing experiments and collecting information	Observation & classification	Observing, classifying, and applying concepts	Experiment page: Students conduct experiments and collect data to support the hypotheses
Communicating	Presenting experimental results with supporting theory	Communicating	Presenting experimental results with references	Results table: Students record experimental data along with supporting theory and literature
Drawing Conclusions	Making conclusions based on results	Interpreting	Interpreting data and drawing conclusions from observations	Conclusion page: Students interpret results and draw conclusions according to theory

To illustrate the relationship between the structured inquiry stages and the targeted Science Process Skills, the blueprint of the developed LKPD is presented in Table 1.

RESULT AND DISCUSSION

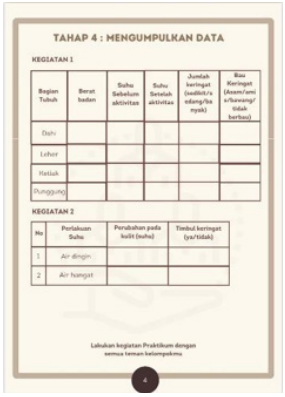
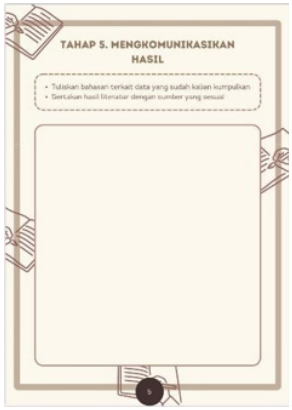
This study developed a structured inquiry-based Student Worksheet (LKPD) on the excretory system topic to train Science Process Skills (SPS) among Grade 11 students. The development process was conducted using the ADDIE model, focusing on development stage, which included needs analysis, product design, expert validation, readability testing, and teacher response evaluation. The results obtained from each stage are presented and discussed based on feasibility, readability, and practicality of developed LKPD.

The needs analysis revealed that biology learning had incorporated several active learning approaches; however, structured inquiry-based LKPD specifically designed to train SPS had not been optimally implemented. Teacher interviews and student questionnaires showed that 66.7% of students experienced difficulties understanding the excretory system topic, 100% required additional learning resources beyond textbooks, and 93.3% had never used LKPD for this topic. These findings indicate the need for instructional materials that provide systematic scientific activities and facilitate students in practicing SPS.

The developed LKPD consists of six structured inquiry stages: orientation, hypothesis formulation, experiment design, data collection, result communication, and conclusion drawing. Each stage integrates SPS indicators, including observation, classification, interpretation, and scientific communication. The inquiry structure was designed to provide students with opportunities to engage in scientific activities progressively. The components and learning flow of the developed LKPD are presented in Table 2.

Table 2. Flow of Structured Inquiry Stages in LKPD Based on SPS

Figure	Description	Figure	Description
 1. Front Cover	Design of the LKPD cover, including the LKPD title, topic title, student identification (group name), author name, and author's institution.	 7. Stage 2 (Hypothesizing)	Design of the hypothesis stage, providing columns for students to write their tentative answers or hypotheses that will be tested through experimentation.
 2. Instructions for Using the E-LKPD	Design of the LKPD usage instructions, including how to complete the LKPD, estimated time, and the stages of Structured Inquiry.	 8. Stage 3 (Experiment Design)	Design of the experiment stage, including the list of materials, tools, and step-by-step procedures. This stage allows students to perform experiments under teacher supervision.

Figure	Description	Figure	Description
	Design of the preface, containing the author's introduction and an overview of the LKPD for users.		Design of the data collection stage, providing tables for students to record experimental results. Students are also expected to include group discussion outcomes and literature findings.
3. Preface		9.Stage 4 (Data Collection)	
	Design of the table of contents, including all sections of the LKPD and corresponding page numbers.		Design of the communication stage, including instructions to write discussions on experimental results from Stage 4. Students should relate results to hypotheses and support them with relevant theories and literature.
4. Table of Contents		10. Stage 5 (Communicate)	
	Design of the learning outcomes and objectives, serving as a guide for students to achieve the learning targets in the developed LKPD.		Design of the conclusion stage, providing a section for students to summarize all information from the experiment. Conclusions should reflect all observations from the beginning to the end of the experiment.
5. Learning Outcomes		11. Stage 6 (Conclusions)	
	Design of the orientation stage, including images and several guiding questions for students to observe, discuss, and formulate appropriate answers.		Design of the final page, a Google Form, which can be accessed by teachers if the LKPD is administered online.
6. Stage 1 (Orientation)		12. Google Form	

The integration of structured inquiry stages with Science Process Skills (SPS) indicators constitutes one of the main strengths of the developed LKPD. Through sequential inquiry activities, students are systematically guided to identify problems, formulate hypotheses, collect and analyze evidence, and communicate scientific findings. Such a learning sequence facilitates students' active engagement in scientific investigations while promoting the development of SPS. These findings are consistent with previous studies reporting that inquiry-based worksheets encourage students' participation in scientific practices and effectively enhance science process skills (Buhera et al., 2024; Jannah et al., 2025). Likewise, inquiry-oriented learning environments have been shown to promote students' active involvement in scientific investigations and strengthen science process skills through evidence-based reasoning and investigative activities (Setiawaty et al., 2024).

The feasibility of the developed LKPD was evaluated by content, media, and language experts. The overall validation score reached 83%, indicating that the product was very feasible for classroom implementation (Table 3). Among the evaluated aspects, language obtained the highest score (92.8%), suggesting that the instructions, terminology, and scientific explanations were clear and appropriate for senior high school students. In contrast, the content aspect received the lowest score (73.5%), indicating the need for several revisions, particularly to strengthen the alignment between inquiry activities and the targeted SPS indicators. Nevertheless, the overall validation results demonstrate that the developed LKPD fulfills the essential quality criteria of instructional materials. This finding is supported by previous research show student worksheets developed through systematic R&D procedures generally achieve high validity and positive user responses prior to classroom implementation (Fadilla et al., 2025). Similar results were reported by Maulida and Yuliani (2023), who found that a guided inquiry-based electronic worksheet designed to train integrated science process skills achieved high levels of validity and practicality, indicating well-designed inquiry worksheets can effectively facilitate students' scientific activities. Furthermore, Febrina and Qomariyah (2024) reported that a guided inquiry-based electronic worksheet on the excretory system demonstrated high content validity, reinforcing the suitability of inquiry-oriented worksheets for biology topics that require students to analyze scientific phenomena and engage in structured investigative activities.

Table 3. Expert Validation Results of LKPD

Validation Aspect	Percentage (%)	Category
Content	73.5	Feasible
Media	82.2	Very Feasible
Language	92.8	Very Feasible
Average	83.0	Very Feasible

The overall expert validation results indicate that the developed LKPD meets the criteria for classroom implementation. High validation scores suggest that the worksheet has achieved adequate content accuracy, instructional design, media quality, and language appropriateness to support structured inquiry learning. These findings are consistent with Prasasti and Ratnasari (2026), who reported that guided inquiry-based LKPD achieved high levels of validity, practicality, and effectiveness, demonstrating that inquiry-oriented worksheets can facilitate scientific investigations while training students' science process skills. Similar evidence was reported by Ulfayantik et al. (2022), who found that guided inquiry-based instructional media meeting the criteria of validity, practicality, and effectiveness effectively supported scientific investigation and the development of students' science process skills. Likewise, Elvanuari et al. (2024) demonstrated that inquiry-based worksheets on the excretory system were highly feasible based on expert evaluation, while Buhera et al. (2024) emphasized that systematic expert validation is essential to ensure alignment between worksheet components, learning objectives, and targeted science process skills. Consistent results were also reported by Wangsa and Indah (2024), who found that biology e-worksheets developed to train science process skills achieved very high validity and practicality, supporting their implementation in biology learning. Furthermore, Oktaria et al. (2023) reported that an inquiry-oriented electronic module designed to develop science process skills demonstrated very high validity across content, pedagogical, and media aspects, reinforcing the importance of systematic validation in producing inquiry-based instructional materials suitable for classroom implementation.

Student readability testing yielded an average score of 89.8%, which was categorized as very readable. The highest score was obtained for the substance aspect (90.9%), followed by language (90.2%), presentation (90.0%), and graphics (88.0%) (Table 4). These findings indicate that students were able to understand the learning instructions, inquiry procedures, and experimental activities with minimal difficulty, suggesting

that the developed LKPD is accessible and user-friendly for senior high school students.

Table 4. Student Readability of LKPD

Aspect	Percentage (%)	Category
Graphics	88.0	Very Readable
Presentation	90.0	Very Readable
Language	90.2	Very Readable
Substance	90.9	Very Readable
Average	89.8	Very Readable

High readability is a crucial characteristic of inquiry-based instructional materials because clear instructions, logical organization, and systematic presentation enable students to focus on scientific investigations rather than on interpreting the learning materials themselves. The very high readability score obtained in this study indicates that the developed LKPD can effectively guide students through each stage of structured inquiry with minimal difficulty. This finding is consistent with Qalfin et al. (2024), who reported that digital student worksheets providing well-organized learning activities created meaningful learning experiences and promoted students' active engagement during science instruction. Likewise, Sa'adah et al. (2024) demonstrated that inquiry learning supported by digital worksheets encouraged students to participate actively in observation, investigation, and data interpretation, thereby strengthening science process skills. Similar evidence was presented by Buhera et al. (2024), who found that inquiry-based worksheets with structured learning activities enhanced students' engagement in scientific investigations. Furthermore, Amini et al. (2022) reported that guided inquiry worksheets with clear and systematic learning procedures helped students perform investigations more effectively while improving their conceptual understanding. Collectively, these studies support the present finding that a highly readable inquiry-based LKPD can facilitate students' participation in scientific learning activities and contribute to the development of science process skills.

Teacher responses toward the developed LKPD reached 73.2%, indicating that the product was considered feasible for classroom implementation. This result suggests that the LKPD provides sufficient instructional guidance to assist teachers in organizing structured inquiry activities and facilitating students' scientific investigations. The positive teacher responses also indicate that the learning activities, experimental procedures, and worksheet organization are practical for classroom use. These findings are consistent with previous studies emphasizing that inquiry-based instructional materials should provide appropriate scaffolding to ensure their practicality and support teachers in implementing student-centered learning effectively (Hamidah, 2022; Suardika, 2023).

CONCLUSION

This study developed a structured inquiry-based Student Worksheet (LKPD) on the excretory system topic for Grade 11 students to support the training of Science Process Skills (SPS). The LKPD was developed through the Development stage of the ADDIE model, involving instructional needs analysis, product design, expert validation, readability assessment, and teacher response evaluation. The developed product integrates structured inquiry stages with SPS indicators, providing students with opportunities to engage in scientific activities, including problem identification, hypothesis formulation, experimentation, data analysis, and scientific communication.

The evaluation results indicate that the developed LKPD has high feasibility based on expert validation, high readability based on student responses, and adequate practicality according to teacher evaluations. These findings demonstrate that the structured inquiry-based LKPD can be used as an alternative biology learning resource that provides systematic guidance for students in conducting scientific investigations and practicing science process skills.

This study was limited to product development and preliminary evaluation and did not examine the effectiveness of the LKPD in improving students' Science Process Skills through experimental comparison. Further studies are recommended to implement the developed LKPD in broader educational contexts and evaluate its effectiveness using experimental or quasi-experimental research designs.

REFERENCES

Adeoye, M. A., Wirawan, K. A. S. I., Pradnyani, M. S. S., & Septiarini, N. I. (2024). Revolutionizing Education : Unleashing the Power of the ADDIE Model for Effective Teaching and Learning. *Jurnal Pendidikan Indonesia*, 13(1), 202–209. https://doi.org/10.23887/jpiundiksha.v13i1.68624

Alivia, N., & Purnomo, T. (2026). Validitas E-LKPD Interaktif Pencemaran Lingkungan Berbasis Inkuiri Terbimbing untuk Melatihkan Keterampilan Proses Sains Kelas X SMA. *BioEdu*

Berkala Ilmiah Pendidikan Biologi, 15(1), 114–122. https://doi.org/10.26740/bioedu.v15n1.p114-122

Amini, F. N., Roektiningroem, E., & Wilujeng, I. (2022). Development of Student Worksheet Based on Guided Inquiry Assisted by Phet Simulation to Improve Concept Comprehension. *Journal of Science Education Research*, 6(1), 46–50. https://doi.org/10.21831/jser.v6i1.48244

Aribowo, L. A., Kholil, P. A., & Wulandari, T. D. (2025). Development of Science E-Module Based on Case Method to Im- prove Students ' Problem Solving Skills. *Unnes Science Education Journal,* 14(1), 197–203. https://doi.org/10.15294/usej.v13i1.25433

Arslan, H. O., Genc, M., & Durak, B. (2023). Exploring the effect of argument-driven inquiry on pre-service science teachers' achievement, science process, and argumentation skills and their views on the ADI model. *Teaching and Teacher Education,* 121(103905). https://doi.org/10.1016/j.tate.2022.103905

Azahra, N., & Fitrihidajati, H. (2023). Pengembangan Lembar Kerja Peserta Didik Elektronik Berbasis Inkuiri Terbimbing Materi Perubahan Lingkungan untuk Melatihkan Keterampilan Proses Sains Kelas X SMA. *BioEdu Berkala Ilmiah Pendidikan Biologi,* 12(3), 744–753. https://doi.org/10.26740/bioedu.v12n3.p743-752

Budiman, P. M., Hariyani, S., & Suminar, T. (2024). Development of Science Worksheet Based on Multiple Intelligences with Guided Inquiry Model to Improve Critical Thinking Skills of Elementary School Students. *Journal of Primary Education*, 13(1), 23–34. https://journal.unnes.ac.id/journals/jpe/article/view/11302/1366

Buhera, R., Ayu, S. B., & Nurohman, S. (2024). Enhancing Students ' Science Process Skills Through Design Worksheet-Based Inquiry Integrated PhET Simulation on Acid and Base Material. *JIPI (Jurnal IPA Dan Pembelajaran IPA),* 8(3), 267–285. https://doi.org/10.24815/jipi.v8i3.39762

Chotimah, A. P., Setyawarno, D., & Rosana, D. (2023). Effect of Guided Inquiry Model by PhET Simulations Worksheet on Science Process Skills and Mastery of Concepts. *Journal of Science Education Research,* 7(2), 100–105. https://doi.org/10.21831/jser.v7i2.63953

Divia, B. C., Herlina, K., Viyanti, V., Abdurahman, A., & Ertikanto, C. (2022). Learning of Inquiry Sequences-Based E-Student Worksheet Assisted by Canva to Stimulate Hands-On Skills , Mind-On Activity , and Science Process Skills. *Indonesian Journal of Science and Mathematics Education*, 05(3), 318–329. https://doi.org/10.24042/ijsme.v5i3.13905

Elvanuari, T. A., Zulfiani, Z., & Supriyati, E. (2024). Development of e-worksheet based on search , solve , create , and share (SSCS) Islamic context to improve science process skills on excretory system material. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 10(1), 195–210.

Fadilla, A. N., Herdini, H., & Holiwarni, B. (2025). Development of Student Worksheets Based on the Nature of Science (NoS) on Chemical Bonds Topic. *Unnes Science Education Journal,* 14(1), 16–27. https://doi.org/10.15294/usej.v13i1.19221

Febrina, D. S., & Qomariyah, N. (2024). Validity of Electronic Student Worksheet Based on Guided Inquiry on Excretion System Material to Train Critical Thinking Skills of High School Students. *BioEdu Berkala Ilmiah Pendidikan Biologi,* 13(2), 481–489. https://doi.org/10.26740/bioedu.v13n2.p481-489

Hamidah, A. (2022). Keterampilan Proses Sains Mahasiswa Biologi melalui Penerapan Model Pembelajaran Inkuiri Terbimbing pada Praktikum Fisiologi Hewan. *BIOEDUSAINS: Jurnal Pendidikan Biologi Dan Sains,* 5(1), 295–303. https://doi.org/10.31539/bioedusains.v5i1.3590

Hardianti, R. D., & Permatasari, I. U. (2023). Promoting Students ' Science Process Skills Through Predict Discuss Explain Observe Discuss Explain Implementation. *Unnes Science Education Journal,* 12(1), 1–6. https://doi.org/10.15294/usej.v12i1.65648

Jannah, M., Prasetyo, Z. K., & Ungirwalu, S. Y. (2025). Using Guided Inquiry-Based Electronic Science Worksheets Assisted by Virtual Laboratories on the Science Process Skills of Middle School Students. *Jurnal Pendidikan Indonesia*, 14(1), 1–10. https://doi.org/10.23887/jpiundiksha.v14i1.82740

Kartika, L., Distrik, I. W., & Pujiati. (2022). Scientific Approach-Based Student Worksheet to Improve Elementary School Student ' S Scientific. *Indonesian Journal of Science and Mathematics Education*, 05(3), 297–308. https://doi.org/10.24042/ijsme.v5i2.13779

Kurniawati, A. (2021). Science Process Skills and Its Implementation in the Process of Science Learning Evaluation in Schools. *Journal of Education Research,* 5(2), 16–20. https://doi.org/10.21831/jser.v5i2.44269

Lazonder, A. W., & Harmsen, R. (2016). Meta-Analysis of Inquiry-Based Learning: Effects of Guidance. *Review of Educational Research,* 86(3), 681–718. https://doi.org/10.3102/0034654315627366

Maulida, R. U., & Yuliani, Y. (2023). Electronic Student Worksheet Based on Guided Inquiry: Train Integrated Science Process Skills on Photosynthesis Topic for 12th Grade in Senior High School. *BioEdu Berkala Ilmiah Pendidikan Biologi,* 12(3), 724–734. https://doi.org/10.26740/bioedu.v12n3.p723-733

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative Data Analysis: A Methods Sourcebook (3rd Ed.).* SAGE Publications.

Mitasari, R. A., & Hidayah, R. (2022). Development of E-worksheet based on Problem Based Learning to Improve Student ' s Metacognitive Ability.

Journal of Science Education Research, 6(2), 66–74. https://doi.org/10.21831/jser.v6i2.53067

Molenda, M. (2015). In Search of The Elusive ADDIE Model. *Performance Improvement,* 54(2), 40–43. https://doi.org/10.1002/pfi

Nuriantisyah, P., Winarni, E. W., & Koto, I. (2023). Pengembangan Lembar Kerja Peserta Didik Berbasis Inkuiri Terbimbing Berbantuan Multimedia untuk Meningkatkan Keterampilan Proses Sains dalam Pembelajaran IPA di Kelas IV. *Jurnal KAPEDAS: Kajian Pendidikan Dasar*, 2(1), 60–71.

Oktaria, S. A., Rahmad, M., & Anwar, L. (2023). Validity of Electronic Module Based on Process Oriented Guided Inquiry Learning Model to Train Students ' Science Process Skills. *Journal of Science Education Research*, 7(1), 46–54. https://doi.org/10.21831/jser.v7i1.51600

Parmin, P., & Savitri, E. N. (2022). Prospective Science Teachers ' Problem-solving Skills through Sci- ence-integrated Learning. *Unnes Science Education Journal,* 11(2), 51–56. https://doi.org/10.15294/usej.v11i2.59602

Pitriyani, A., Purnamasari, S., & Rahmaniar, A. (2025). Penggunaan LKPD berbasis Inkuiri Terbimbing untuk Meningkatkan Keterampilan Proses Sains Siswa pada Materi Getaran dan Gelombang. *Jurnal Pendidikan MIPA*, 15(2021), 731–740.

Prasasti, N. H. D., & Ratnasari, E. (2026). Development of LKPD on Passive Transport Materials Based on Guided Inquiry to Train Science Process Skills. *BioEdu Berkala Ilmiah Pendidikan Biologi*, 15(2), 365–375. https://doi.org/10.26740/bioedu.v15n2.p365-375

Qalfin, M., Saptono, S., Ellianawati, E., & Dewi, N. R. (2024). Effectiveness of Differentiated Digital Student Worksheets Based on Socio-Scientific Issues to Improve Students ' Science Literacy. *Unnes Science Education Journal,* 13(2), 86–93. https://doi.org/10.15294/usej.v13i1.10030

Rahmalia, U. C., Sudarmin, S., & Ellianawati, E. (2025). Development of Biotechnology E-Module Loaded with Ethnoscience to Equip Students with Science Process Skills & Science Literacy. *Unnes Science Education Journal*, 14(2), 341–351. https://doi.org/10.15294/usej.v14i2.25221

Rozali, D., Suyanti, R. D., & Dewi, R. (2024). Development of science LKPD based on inquiry training on HOTS-science literacy skills. *Inovasi Kurikulum,* 21(2), 1099–1112.

Sa'adah, S., Andini, F. S., & Yusup, I. R. (2024). Improving Students ' Science Process Skills through Level of Inquiry Learning Assisted by Liveworksheet on The Concept of Environment Change. *Jurnal Penelitian Pendidikan IPA*, 9(7), 3983–3991. https://doi.org/10.29303/jppipa.v10i7.8120

Salsabilla, F. W., Destiansari, E., & Meilinda, M. (2024). Development of electronic students' worksheets based on problem-based learning on air pollution material. *Biosfer: Jurnal Pendidikan Biologi*, 17(2), 337–349. https://doi.org/10.21009/biosferjpb.34117

Setiawaty, S., Lukman, I. R., Imanda, R., Sudirman, S., & Rauzatuzzikrina, R. (2024). Integrating Mobile Augmented Reality Applications through Inquiry Learning to Improve Students' Science Process Skills and Concept Mastery. *Jurnal Pendidikan IPA Indonesia*, 13(1), 90–102. https://doi.org/10.15294/jpii.v13i1.48891

Sinuraya, J., & Widianto, Y. (2023). Improving Science Process Skills through Scientific-Based Student Work Sheet with The Assistance Of The Algodoo Program in Learning Physics. *Jurnal Pendidikan Fisika*, 12(1), 70–75.

Suardika, I. G. P. (2023). Peningkatan Keterampilan Berpikir Kritis dan Keterampilan Proses Sains melalui Penerapan Model Pembelajaran Inkuiri Terbimbing dalam Pembelajaran Biologi. *SCIENCE: Jurnal Inovasi Pendidikan Matematika Dan IPA*, 3(1), 74–80.

Sudibyo, E., Naini, A. F., & Sabtiawan, W. B. (2019). The Effectiveness of Student Worksheet to Train Science Process Skills. *Jurnal Penelitian Pendidikan IPA,* 4(2), 70–74.

Sugiyono. (2017). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D.* Alfabeta CV.

Suryawanto, A. M., Subali, B., & Haryani, S. (2022). Implementation of Guided Inquiry Model with MURDER Strategy to Improve Elementary School Students ' Science Process Skills. *Journal of Primary Education*, 11(3), 313–326. https://doi.org/10.15294/jpe.v11i3.72385

Ulfayantik, S., Jatmiko, B., & Supardi, Z. A. I. (2022). Development of Online Learning Media using Guided Inquiry to Improve Science Process Skills of Elementary School Students Assisted by Microsoft Office 365. *JPPS (Jurnal Penelitian Pendidikan Sains),* 11(2), 142–151. https://doi.org/10.26740/jpps.v11n2.p142-151

Wangsa, I. K. K., & Indah, N. K. (2024). Validitas E-LKPD Berbasis Liveworksheets untuk Melatihkan Keterampilan Proses Sains pada Materi Struktur Sel Tumbuhan. *BioEdu Berkala Ilmiah Pendidikan Biologi,* 13(1), 197–206. https://doi.org/10.26740/bioedu.v13n1.p197-206