Journal of Natural Science and Integration
P-ISSN: 2620-4967 | E-ISSN: 2620-5092
Vol. 8, No. 2, October 2025, pp 390-400

Available online at:
http://ejournal.uin-suska.ac.id/index.php/JNSI
DOI: 10.24014/jnsi.v8i2.32974

Design and Trial of Probing Prompting-Based Electronic Learner Worksheet (E-LKPD) on Chemical Bonding Material

Neti Afrianis[1]*, Nurhaliza Gustin[2]

[1] *Department of Chemestry Education, Universitas Islam Negeri Sultan Syarif Kasim Riau, Indonesia.*
[2] *SMPN 04 Kuantan Mudik Riau, Indonesia*

**Correspondence Author: neti.afrianis@uin-suska.ac.id*

ABSTRACT
The rapid development of digital technology in education necessitates innovative learning media that actively engage students. A preliminary study conducted at SMA Negeri 12 Pekanbaru indicated that chemistry instruction predominantly relies on printed materials and PowerPoint presentations, which contributes to low levels of student participation and understanding. This study aims to design and evaluate the validity and practicality of a Probing Prompting-based Electronic Learner Worksheet (E-LKPD) focused on chemical bonding, as well as to examine its potential impact on students' learning engagement. Employing a Research and Development (R&D) approach following the Borg and Gall model, the study was limited to five stages: data collection, planning, development, initial field trials, and product revision. Participants included two expert validators, two chemistry teachers, and twelve students from class X MIPA 6. Data were analyzed descriptively to determine the percentages of validity and practicality. Validation by material and media experts yielded scores of 90% and 88.63%, respectively, indicating a very high level of validity. Practicality assessments by teachers and students resulted in scores of 86.25% and 84.89%, respectively, confirming that the E-LKPD is highly practical. The novelty of this research lies in the integration of the Probing Prompting learning model with a digital worksheet platform (Liveworksheet), enhancing interactivity and inquiry-based learning in chemistry. The developed E-LKPD provides an innovative medium for teachers to improve students' conceptual understanding and foster self-directed learning in the digital era.

Keywords: *electronic learner worksheet (E-LKPD), probing prompting, chemical bonding.*

INTRODUCTION

The rapid advancement of educational technology has significantly transformed the teaching and learning process, compelling innovations in the development of interactive and student-centered learning media. When creating technology-based learning media, it is essential that the media are engaging for students and can be easily accessed online (Hidayah, A. N., et al., 2020). Additionally, the selection of learning media should consider several factors, including the characteristics of the subject matter, ease of use, appropriateness to the allocated time, alignment with learning objectives, and potential to enhance student creativity (Karsini & Rotinga, 2020). Learning media play a crucial role in the instructional process by facilitating the delivery of information and supporting learning activities (Sya'idah, F. A. N., et al., 2020). Various forms of learning media, such as modules, Learner Worksheets (LKPD), handouts, and packaged books, can be accessed conveniently through electronic devices or the internet (Karsini & Rotinga, 2020). LKPD, in particular, is designed to enable students to comprehend the material independently by

following structured learning stages. One of the advantages of LKPD development is that it can be tailored to the specific context of students and school characteristics (Wirdani, R., et al., 2019).

The use of LKPD during learning activities has been shown to promote student independence in acquiring and understanding knowledge. However, LKPD usage may result in learning inefficiencies and reduced effectiveness if it is monotonous or lacks technological integration. Therefore, innovations such as electronic LKPD (E-LKPD) are required to improve learning quality (Sya'idah, F. A. N., et al., 2020). E-LKPD can be designed to provide interactive and engaging learning experiences that are accessible to all students (Purnama, 2020). The development of LKPD can be further enhanced by aligning learning activities with the steps of specific learning models. One learning model suitable for E-LKPD development is the Probing Prompting model. The term "probing" refers to examining or investigating, while "prompting" refers to guiding or encouraging. Therefore, the Probing Prompting learning model involves guiding students' thinking and exploring their perspectives through structured questioning, which facilitates the development of critical thinking processes. This approach aligns with contemporary educational objectives, which emphasize learners' active construction of knowledge. Moreover, this learning model can stimulate deeper understanding by encouraging students to connect prior knowledge and experiences to the problems being addressed (Karwati, N. P. R., et al., 2018). Despite these technological advances, a preliminary study conducted at SMA Negeri 12 Pekanbaru revealed that chemistry instruction is predominantly reliant on conventional resources, such as textbooks, PowerPoint presentations, and printed worksheets provided by publishers. The limited integration of technology-based learning media has contributed to low student engagement and hindered comprehension, particularly for complex topics such as chemical bonding. This situation highlights the urgent need to develop interactive and digital learning resources that support independent learning while enhancing conceptual understanding.

Previous research has examined the development of digital worksheets (E-LKPD) in science education, demonstrating improvements in both learning outcomes and digital literacy. For example, Karsini (2020) reported that reliance on textbooks without supporting LKPD reduced student interest and engagement in learning. Similarly, Marnesya (2020) found that, although scientific approaches were applied using LKPD, modules, and PowerPoint materials in teaching colloidal system topics at SMAN 3 Batusangkar, the Probing Prompting questioning technique was not implemented, resulting in limited student participation. However, most of these studies have primarily focused on media design or feasibility validation, with minimal attention given to the application of learning models that actively promote inquiry, critical thinking, and problem-solving skills. Furthermore, the Probing Prompting learning model, which emphasizes structured questioning, guided reflection, and active knowledge construction, has rarely been integrated into digital worksheets. This indicates a research gap in the combination of interactive digital media with inquiry-based pedagogical strategies capable of enhancing students' reasoning and analytical abilities.

The Probing Prompting learning model is inherently student-centered, encouraging learners to construct knowledge through scaffolded questioning and reflective thinking. Integrating this model into Electronic Learner Worksheets (E-LKPD) provides an opportunity to create a dynamic, interactive learning environment aligned with 21st-century educational competencies, including critical thinking, communication, collaboration, and self-directed learning. Digital worksheets enriched with structured questioning techniques can further promote cognitive engagement, metacognitive awareness, and deeper understanding, enabling students to actively interact with learning content rather than passively receiving information. In chemistry, chemical bonding is recognized as a particularly abstract topic, requiring learners to interpret concepts across multiple representational levels macroscopic, microscopic, and symbolic. Many students struggle to connect these representations, leading to misconceptions and limited academic achievement. Therefore, developing interactive and visually engaging E-LKPD through digital platforms such as

Liveworksheet is essential for facilitating meaningful exploration and comprehension. By allowing students to manipulate representations, respond to guided prompts, and receive immediate feedback, digital worksheets can scaffold conceptual understanding while encouraging inquiry-based learning.

Based on these considerations, this study aims to design and evaluate the validity and practicality of a Probing Prompting-based Electronic Learner Worksheet (E-LKPD) focused on chemical bonding. The novelty of this research lies in the integration of the Probing Prompting learning model with a digital worksheet platform a combination that has rarely been implemented in chemistry education. The outcomes of this study are expected to advance the field of digital learning innovation, offering educators an effective tool to enhance students' analytical skills, engagement, and independence in mastering complex chemical concepts.

METHODOLOGY

This study employed a Research and Development (R&D) approach with the objective of producing a valid and practical digital learning medium, specifically a Probing Prompting-based Electronic Learner Worksheet (E-LKPD) on chemical bonding material. The development process followed the Borg and Gall (1983) model, which comprises ten stages: (1) research and information collection, (2) planning, (3) preliminary product development, (4) preliminary field testing, (5) main product revision, (6) main field testing, (7) operational product revision, (8) operational field testing, (9) final product revision, and (10) dissemination and implementation. Due to constraints in time and scope, this study was limited to the initial stages, up to the preliminary product revision, with a primary focus on analyzing the validity and practicality of the developed E-LKPD.

The research object in this study was the E-LKPD developed in accordance with the Probing Prompting learning model. Research participants included two material experts, one media expert, two chemistry teachers, and twelve students from class X MIPA 6 at SMA Negeri 12 Pekanbaru. The broader population consisted of all tenth-grade students enrolled at the school during the 2024/2025 academic year. A purposive sampling technique was employed to select participants based on criteria such as active engagement in chemistry learning, teacher recommendations, and familiarity with digital learning tools. Expert validators were chosen based on their specialization in chemistry education and digital media development to ensure a comprehensive evaluation of content accuracy and instructional design.

Data collection instruments comprised interview sheets, validation sheets, and practicality questionnaires. Interviews were conducted with both teachers and students to explore learning needs, classroom challenges, and prior experiences related to chemical bonding instruction. The validation sheets evaluated four key aspects: content quality, language clarity, presentation design, and alignment with the Probing Prompting learning model. Meanwhile, practicality questionnaires were administered to teachers and students to assess usability, clarity, and the overall appeal of the E-LKPD. Prior to data collection, all instruments underwent review and validation by a senior lecturer in chemistry education from UIN Suska Riau to ensure their appropriateness and reliability.

Data analysis was conducted using a combination of quantitative and qualitative descriptive techniques. Quantitative data from the validation and practicality sheets were processed using percentage formulas to determine the levels of validity and practicality, providing a clear measure of the E-LKPD's quality and effectiveness. Qualitative data from interviews were analyzed thematically to complement the quantitative findings, offering deeper insights into participants' experiences, perceptions, and suggestions for improving the learning media. This comprehensive approach ensured that the evaluation captured both the technical quality of the E-LKPD and its

practical applicability in supporting student-centered, inquiry-based chemistry learning which is calculated as follows:

$$\text{P (\%)} = \frac{skor\ yang\ diperoleh}{skor\ tertinggi} x\ 100\% \quad (1)$$

The percentage results were interpreted based on the criteria proposed by Riduwan (2013), where scores of 0–20% indicate "invalid," 21–40% "less valid," 41–60% "fairly valid," 61–80% "valid," and 81–100% "very valid." Qualitative data collected from open-ended responses were analyzed thematically to extract suggestions, feedback, and comments from experts, teachers, and students. These qualitative insights provided contextual depth to the quantitative findings and informed refinements in the design and functionality of the E-LKPD. In the final stage, both quantitative and qualitative analyses were synthesized to evaluate the overall feasibility of the developed learning media. Validation data from experts assessed the accuracy, relevance, and alignment of the content with the Probing Prompting learning model, while practicality data from teachers and students measured the ease of use, clarity, interactivity, and overall learning experience. This comprehensive methodological approach ensured that the resulting Probing Prompting-based E-LKPD not only met established standards of validity and practicality but also functioned effectively as an innovative, interactive digital learning resource capable of supporting conceptual understanding, inquiry-based exploration, and active student engagement in chemistry education.

RESULT AND DISCUSSION

Data Collection Stage

The data collection stage aimed to identify challenges encountered during the chemistry learning process and to inform the development of an effective digital learning medium. Field observations at SMA Negeri 12 Pekanbaru revealed that the instructional media predominantly consisted of PowerPoint presentations, material summaries, and printed worksheets provided by publishers. The use of technology-based media was minimal and had not been implemented effectively. This limitation negatively impacted student learning outcomes, with many students performing below the minimum mastery criteria, indicating a gap between instructional methods and desired learning competencies.

In addition, the learning process lacked full implementation of constructivist principles. Students were largely passive recipients of information rather than active participants in knowledge construction. This observation underscores the necessity of developing digital learning media that not only deliver content but also actively engage students in inquiry-based learning. The Probing Prompting learning model was identified as an appropriate pedagogical framework, as it encourages learners to construct their own understanding through structured and guided questioning, fostering critical thinking and self-directed learning.

A thorough literature review was conducted to align the development of the E-LKPD with Core Competencies (KI), Basic Competencies (KD), learning indicators, and learning objectives specific to chemical bonding. Information from textbooks and recent studies was utilized to design the discourse materials, practice exercises, and competency assessments integrated within the E-LKPD. These design elements ensured that the digital worksheet not only presented content effectively but also guided students in connecting macroscopic, microscopic, and symbolic representations of chemical bonding. By systematically combining field observations and literature-based curriculum analysis, this stage provided a solid foundation for developing an interactive, student-centered E-LKPD. The insights gained from this process informed the creation of learning

activities that promote conceptual understanding, scaffolded inquiry, and active engagement, ultimately addressing the limitations of conventional chemistry instruction and supporting the goals of 21st-century science education.

Planning Stage

The planning stage focused on designing a Probing Prompting-based Electronic Learner Worksheet (E-LKPD) in accordance with the structured syntax of the model. The development process began with the creation of a comprehensive storyboard, as illustrated in Figure 1, which mapped the logical progression of learning activities and ensured that each component aligned with constructivist learning principles. This step was essential to guarantee that the E-LKPD would support active knowledge construction, scaffolded inquiry, and meaningful engagement with chemical concepts.

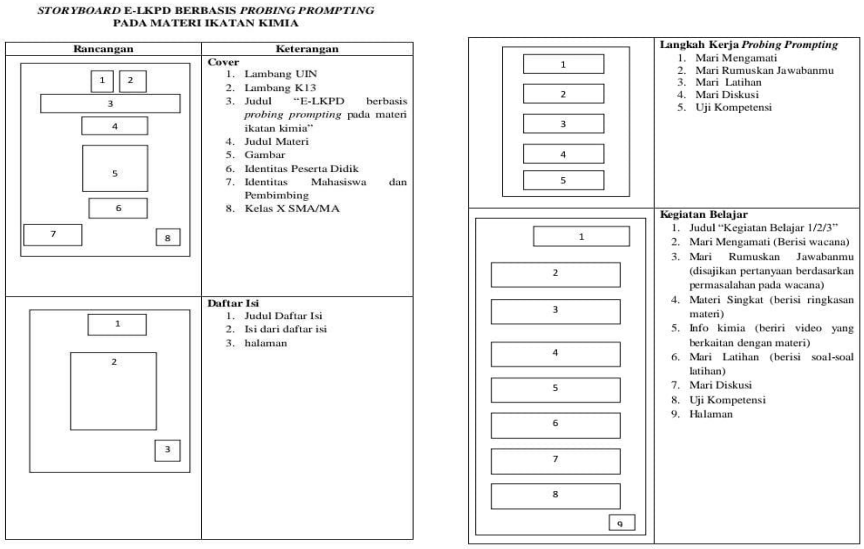

Figure 1. *Storyboard*

To enhance the instructional content, supporting multimedia elements including illustrations, educational videos, and animations were selected from open educational resources such as pngtree.com and youtube.com. These resources were chosen to facilitate visualization of abstract chemical concepts, helping Students Bridge macroscopic, microscopic, and symbolic representations. The materials were then compiled and refined using Microsoft Publisher and Adobe Photoshop, exported as a cohesive PDF, and uploaded to the Liveworksheet platform to enable interactive online use, with the final E-LKPD structured around three sequential learning activities: Learning Activity 1 covering Lewis structures and ionic bond formation, Learning Activity 2 focusing on covalent bonding and molecular properties, and Learning Activity 3 addressing coordination covalent bonds, polarity, and metallic bonding.

The E-LKPD was implemented with a series of interactive questioning sequences designed to guide students' reasoning processes. By incorporating the Probing Prompting syntax, the E-LKPD was able to facilitate connections between learners' prior knowledge and newly introduced chemical concepts, thereby promoting critical thinking, reflective learning, and deeper conceptual understanding. The Probing Prompting syntax integrated into the E-LKPD comprised five structured activities. In the first activity, "Let's Observe," students were instructed to carefully examine pictures, formulas, or other contextual situations presented in the E-LKPD. In the second activity, "Let's Formulate Answers," students were guided to construct responses based on the provided discourse and their prior knowledge. During the third activity, "Let's Practice," students

answered questions supplied by the teacher to reinforce understanding. The fourth activity, "Let's Discuss," involved students presenting their findings under teacher guidance and engaging in collaborative communication to share and evaluate discussion outcomes. Finally, the fifth activity, "Competency Test," required students to complete assessment questions as evidence of their mastery and comprehension of the material.

Through the implementation of these activities, students' engagement and cognitive involvement were observed to increase, as they were systematically guided from observation to independent reasoning and knowledge application. The structured sequence of the Probing Prompting syntax provided a clear scaffold for learners, enabling the gradual construction of conceptual understanding and fostering analytical skills. These findings indicate that the integration of inquiry-based learning strategies within digital worksheets can effectively enhance both learning outcomes and students' critical thinking abilities, aligning with previous studies on the benefits of interactive and guided learning media.

Figure 2. Interface and Learning Flow of the Probing Prompting-Based E-LKPD on Chemical Bonding Material

Validation Results Analysis

Prior to implementation, the research instruments were validated by experts from UIN Suska Riau to ensure that the questionnaires and assessment rubrics were appropriate for evaluating both the validity and practicality of the E-LKPD. The results of material expert validation are presented in Table 1.

Table 1. Material Expert Validity Test Results

No.	Assessment Aspect	Score	Criteria
1.	Content Quality	90.00%	Very Valid
2.	Language Quality	91.66%	Very Valid
3.	Presentation Quality	87.50%	Very Valid
4.	Probing Prompting	91.66%	Very Valid
	Total	**90.00%**	**Very Valid**

The content of the E-LKPD, developed based on the Probing Prompting model, was aligned with the curriculum requirements for chemical bonding material. Language quality was ensured by employing grammatically correct, communicative, and clear sentences, while the presentation of material was organized systematically and logically, complemented with colorful and engaging visuals. The Probing Prompting aspect facilitated students in developing ideas and understanding the material more effectively. This finding aligns with Suherman's opinion cited in Karsini (2020), stating that Probing Prompting learning presents a sequence of questions that guides and explores students' ideas, thereby stimulating a cognitive process that connects prior knowledge and experience with newly acquired information.

Validation by material experts resulted in an average score of 90%, classified as "very valid." This high score indicates that the developed content is well-aligned with the national chemistry curriculum and meets the criteria for high-quality digital learning materials. The results also demonstrate that the E-LKPD effectively integrates conceptual clarity, learning objectives, and constructivist questioning strategies, ensuring that students are guided to actively construct understanding through inquiry-based learning. In addition, the E-LKPD was assessed by media experts to determine its validity from a design and usability perspective. According to media expert validation, the Probing Prompting-based E-LKPD was deemed valid and suitable for use in the learning process. The results of media expert validation are shown in Table 2.

Table 2. Media Expert Validity Test Results

No.	Assessment Aspect	Score	Criteria
1.	Media Display	95.83%	Very Valid
2.	Software	75.00%	Valid
3.	Media Usage	87.50%	Very Valid
	Total	**88.63%**	**Very Valid**

The overall validation score from media experts was 88.63%, categorized as "very valid." Among the assessed aspects, media display achieved the highest score of 95.83%, reflecting attention to layout consistency, color schemes, visual clarity, and overall attractiveness. These features enhanced usability and student engagement, confirming that the E-LKPD design supports interactive and visually guided learning. Specifically, text and image sizes, use of colors, layout placement, and illustrations were optimized to clarify material content, while the cover design was made attractive and aligned with chemical bonding topics. The software aspect received a valid rating, indicating that the E-LKPD is user-friendly, provides interactive features, and is easily accessible. Media usage was rated as very valid, demonstrating that the learning media is practical, simple to use, and reusable, contributing to improved student learning outcomes. This observation is consistent with the findings of Ariani & Meutiawati (2020), who reported that LKPD significantly

impacts learning outcomes, enhancing knowledge, attitudes, and skills. Overall, the validation results confirm that the E-LKPD meets the expected standards for both content quality and media design, supporting its suitability as an innovative digital learning resource in chemistry education.

Practicality Test Analysis

The practicality of the developed E-LKPD was evaluated by two chemistry teachers and twelve students at SMA Negeri 12 Pekanbaru. The results of the teacher assessment are presented in Table 3.

Table 3. Chemistry Teacher Practicality Test Results

No.	Assessment Aspect	Score	Criteria
1.	Content Quality	80.00%	Practical
2.	Language Quality	87.50%	Very Practical
3.	Presentation Quality	92.50%	Very Practical
4.	Media Usage	81.25%	Very Practical
5.	Probing Prompting	91.66%	Very Practical
	Total	**86.25%**	**Very Practical**

Teacher evaluations yielded an average score of 86.25%, classified as "very practical." This indicates that the E-LKPD is efficient, user-friendly, and effectively supports the achievement of learning objectives. The E-LKPD, developed based on the Probing Prompting model, integrates competencies to be achieved by students, employs clear and easily understandable language, presents materials systematically and logically, and includes illustrations that clarify content delivery. In addition, the media is practical, interactive, and straightforward to use, while the Probing Prompting stages facilitate students in developing ideas and understanding the material. These results are consistent with Swarjawa's perspective, which emphasizes that Probing Prompting is a student-centered learning model that allows learners to actively construct their own knowledge (Dewi, et al., 2019). Among the evaluated aspects, presentation quality received the highest score of 92.50%, indicating that a well-organized and coherent material layout enhances instructional delivery and promotes greater student engagement. Student responses to the E-LKPD are summarized in Table 4.

Table 4: Learner Response Test Results

No.	Assessment Aspect	Score	Criteria
1.	View	89.16%	Very Practical
2.	Material	84.37%	Very Practical
3.	Linguistics	79.16%	Practical
4.	Benefits of the *Probing Prompting* Model in E-LKPDs	81.25%	Very Practical
	Total	**84.89%**	**Very Practical**

Student responses demonstrated a mean practicality score of 84.89%, also classified as "very practical." The highest-rated aspect was media view, with a score of 89.16%, suggesting that the combination of digital format and interactive visual elements effectively increased learners' motivation and engagement. Overall, the combined statistical results indicated a strong level of acceptance (M = 85.57%, SD = 2.01), confirming that the E-LKPD meets the usability standards expected of effective digital learning media. The consistency observed between teacher and student evaluations further strengthens the reliability of the E-LKPD as an instructional tool. These findings indicate that the developed media not only facilitates the learning process but also enhances the overall learning experience by promoting interactivity, self-directed exploration, and active engagement with chemical bonding concepts.

Product Revision and Theoretical Discussion

Following the initial field trial, the E-LKPD underwent a series of revisions based on detailed feedback from both teachers and students. Teachers recommended adding additional guiding questions after each discourse segment to better facilitate students' reasoning processes and suggested correcting the narration in the third activity to accurately reflect the number of coordination covalent bonds in H_3PO_4. Students proposed enlarging the video frames and providing clearer instructions for using the interactive elements. All of these recommendations were incorporated into the final version, enhancing both usability and instructional effectiveness. These findings align with constructivist learning theory, which emphasizes that meaningful understanding emerges through guided questioning, reflection, and active knowledge construction. The integration of the Probing Prompting model within a digital platform fosters higher-order thinking, autonomous learning, and interactive engagement, consistent with Vygotsky's socio-cognitive framework. By structuring the E-LKPD around scaffolded questioning, learners are encouraged to connect prior knowledge with new concepts, critically analyze chemical phenomena, and engage in self-directed exploration.

The novelty of this study lies in the application of the Probing Prompting model to a digital E-LKPD, an approach that has been scarcely implemented in chemistry education research. Previous studies primarily examined the Probing Prompting model in printed worksheets or face-to-face instructional contexts. This research, therefore, contributes a new pedagogical approach that integrates inquiry-based questioning with digital accessibility, bridging the gap between traditional teaching methods and modern educational technology.

Implications of the Research

The findings of this study carry important pedagogical and scientific implications. Pedagogically, the Probing Prompting-based E-LKPD offers teachers a practical and interactive tool for promoting student-centered learning in chemistry. It allows students to engage with the material anytime and anywhere, supporting flexible and self-directed learning. The structured questioning sequences strengthen conceptual understanding, facilitate critical thinking, and help reduce misconceptions in abstract chemistry topics. From the perspective of scientific and educational development, this study demonstrates the potential of interactive digital media to implement constructivist learning effectively. The successful integration of guided questioning within a digital worksheet platform suggests that similar approaches could be applied to other scientific subjects, fostering inquiry-based learning and digital literacy simultaneously. Further research is recommended to evaluate the effectiveness of the E-LKPD in larger and more diverse student populations, including experimental investigations to measure learning outcomes and cognitive gains.

CONCLUSION

Based on the results of the validity and practicality assessments, the Probing Prompting-based Electronic Learner Worksheet (E-LKPD) developed in this study is considered valid and feasible for use in chemistry learning, specifically for the topic of chemical bonding. Validation by material and media experts yielded scores of 90.00% and 88.63%, respectively, both classified as "very valid." Practicality evaluations conducted by chemistry teachers and students resulted in scores of 86.25% and 84.89%, respectively, indicating that the E-LKPD is "very practical" and user-friendly. These findings demonstrate that the developed digital media meets the pedagogical and technological requirements of an effective modern learning tool. By integrating the Probing Prompting learning model within a digital platform (Liveworksheet), the E-LKPD provides an innovative alternative that fosters active, inquiry-based, and student-centered learning.

The novelty of this research lies in adapting the Probing Prompting model into an interactive digital worksheet format, contributing significantly to the advancement of chemistry education and digital pedagogy. The developed E-LKPD offers a practical reference for teachers in designing innovative learning resources that enhance students' conceptual understanding, critical thinking, and learning autonomy. Future research is recommended to implement the E-LKPD in larger and more diverse educational settings and to evaluate its effectiveness using experimental or quasi-experimental designs, with a focus on learning outcomes, problem-solving skills, and higher-order thinking abilities.

REFERENCES

Aini, N. A., et al. (2022). Development of problem-based learning-based LKPD in science subjects on force material. *Journal of Basic Education*, 6(2), 45–52.

Ariani, D., & Meutiawati, I. (2020). The effectiveness of LKPD in improving students' learning outcomes, knowledge, attitudes, and skills. *Indonesian Journal of Educational Research*, 9(2), 115–123.

Dewi, A. K. (2023). The influence of interactive digital worksheets based on level of inquiry towards science process skills in elementary school. *PEGEGOG: Journal of Education & Pedagogy*, 6(1), 12–22. https://doi.org/10.5281/zenodo.7554248

Dewi, S., et al., (2022). Development of Auditory Intellectually Repetition (AIR)-Based Student Worksheets for Fourth Grade Science. *Journal of Elementary Education*. 6(1), 24-34.

Hidayah, A. N., Putri, S., & Rahmawati, L. (2020). Development of physics E-LKPD (electronic worksheets) using 3D Pageflip based on problem-based learning on balancing and rotation dynamics. *Scientific Journal of Physics Education (COMPTON)*, 7(2), 36–43

Indriani, N & Lazulva, 2020. Design and Trial of Interactive Student Worksheets with a Scaffolding Approach on Salt Hydrolysis. *Journal of Natural Science and Integration*. 3(1), e-ISSN 2620-5092, 87-105.

Karsini, R., & Rotinga, P. S. (2020). Design and trial of probing prompting-based learner worksheets (LKPD) on periodic system of elements material. *Journal of Chemical Education Research*, 10(1), 53–63.

Karwati, N. P. R., Astuti, P., & Nurhayati, E. (2020). The effect of probing prompting learning model assisted by multimedia on science learning outcomes. *Indonesian Journal of Education Research and Review*, 3(2), 336–345.

Kurniawati, Y. (2020). *Educational research methods.* Pekanbaru: Kreasi Edukasi.

Marbun, E., Sitorus, M., & Tarigan, S. (2023). Development of chemistry electronic student worksheets using a problem-based learning model to improve students' learning outcomes on stoichiometry. *Proceedings of AISTEEL 2023*. https://doi.org/10.4108/eai.19-9-2023.2340588

Marnesya, C. A. and E. (2020). Effectiveness of a Colloidal Systems Module Based on a Scientific Approach with Probing-Prompting Questions on Learning Outcomes. *Journal of Multidisciplinary Research and Development*, 2(4), 80–85.

Miterianifa, dkk. (2020). Analysis of Errors and Scaffolding in Problem Solving Processes On Colloid Topic for Class XI Senior High School. *AIP Conference Proceeding* 2296, 020103-1-020103-8; 108 https://doi.org/10.1063/5.0030457.

Ormancı, U. (2025). The effect of web-assisted guided inquiry approach on science education. *Journal of Science Education and Technology*, 34(2), 145–158. https://doi.org/10.1007/s10956-025-10238-9

Prastowo, A. (2014). *Development of creative and effective learning media.* Yogyakarta: Diva Press.

Purnama, A. (2020). The participation level of junior high school students in online learning during the COVID-19 pandemic. *Scientific Journal of Education*, 11(1), 102–108.

Ramadhan, M. R., & Dewi, S. A. (2023). Teachers' readiness in implementing digital-based learning media for science education. *Indonesian Journal of Science and Education Innovation*, 7(1), 88–97. https://doi.org/10.5281/zenodo.7643021

Riduwan. (2013). *Measurement scale of research variables.* Bandung: Alfabeta.

Sastrawan, E., & Yenti, E., (2020). Design and Trial of Integrated Islamic Student Worksheets (LKPD) on Elementary Chemistry. *JEDCHEM (Journal of Education and Chemistry*), 2(1), 8-18.

Sugiyono. (2016). *Quantitative, qualitative, and R&D research methods.* Bandung: Alfabeta.

Sya'idah, F. A. N., Nurhidayati, S., & Rahma, A. (2020). The effect of blended learning model assisted by E-LKPD on salt hydrolysis material on student learning outcomes. *Journal of Chemistry in Education*, 9(1), 22–30.

Wahyuningsih, D. (2012). The Importance Of Pictures and Videos in Learning Media to Improve Student Understanding. *Journal of Educational Development*, 8(3), 188–195.