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Validity of the Guided Inquiry-Based Laboratory Worksheet on Hydrocarbon Type Tests on Orange Peels (*Citrus* spp.)

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Abstract: *Practical activities in chemistry learning require learning materials that can guide students to engage in scientific inquiry actively. However, practical worksheets used in schools are generally still dominated by procedural instructions and do not fully facilitate students in conducting investigative activities. This study aims to develop a validated guided inquiry-based practical worksheet on testing hydrocarbon types in orange peels (Citrus spp.). This study uses the Educational Design Research (EDR) method, consisting of preliminary and development stages. The worksheet was validated by chemistry education lecturers and chemistry teachers. Validity assessment includes three aspects: the suitability of the worksheet components for the indicators of inquiry skills, language, and graphics. The validation results show that the guided inquiry-based practical worksheet achieved an overall validity percentage of 86%, placing it in the highly valid category. The developed worksheet provides structured guidance for students to conduct scientific investigation activities and integrates the concept of hydrocarbons with a contextual learning approach using orange peels as a natural material. Therefore, the developed worksheet is considered valid and appropriate as a learning resource for chemistry practicums.*

Keywords: *Guided inquiry; laboratory worksheet; validity; hydrocarbons; orange pee*

INTRODUCTION

Life in the 21st century calls for a focus on supporting students in developing a range of worldwide recognized talents and skills (Agmita et al., 2021). The 4Cs (critical thinking, creativity, communication, and cooperation) define the educational focus for the 21st century (Partnership for 21st Century Learning, 2015). Developing these skills requires a learning process that not only focuses on delivering material but also provides active, contextual, and meaningful learning experiences for students (Haryani et al., 2021; Tohani & Aulia, 2022).

The inquiry-based learning approach is one that can facilitate the growth of 4C competencies. A systematic review of inquiry-based chemistry learning by Jegstad (2024) indicates that inquiry learning provides students with opportunities to engage in scientific practices and develop various skills throughout the learning process. However, a case study by Petersen (2022) highlights that implementing independent inquiry activities remains challenging, as

some students are not yet accustomed to carrying out all stages of inquiry without assistance. Therefore, an approach is needed that allows students to engage in the inquiry process while receiving support and guidance from educators. Guided inquiry is one such approach that aligns with these characteristics. Guided inquiry has been applied to various chemistry topics, including thermochemistry (Sutiani & Fayaddah, 2021; Prameswari et al., 2023), chemical equilibrium (Simatupang & Santika, 2021), and benzene and its derivatives (Arfina, 2026).

Beyond its general application in chemistry instruction, the guided inquiry approach is also relevant for laboratory practical activities. Such activities provide students with real-world experiences, thereby enabling a deeper understanding of concepts (Nuai & Nurkamiden, 2022) . However, many school laboratory activities are still conducted using traditional models, such as the "cookbook" or verification-based models, where students essentially merely follow pre-established procedures. This approach can limit opportunities for students to develop critical thinking, problem-solving skills, and creativity, as the focus is placed more on adherence to procedures than on encouraging students to explore independently, analyze problems, make decisions, and design alternative solutions.

Implementing guided inquiry-based practical work requires instructional materials capable of guiding students throughout the investigation process. Laboratory worksheets serve as suitable materials for this purpose. These worksheets assist teachers in aligning instruction with the chosen methods and content while guiding students to remain focused on the subject matter during the learning process (Februanti et al., 2023; (Selmin et al., 2022).

The employment of guided inquiry-oriented lab worksheets during hands-on tasks has been revealed to beneficially influence students' abilities. Rahmawati et al. (2022) established that implementing guided inquiry-oriented lab worksheets focusing on colloids can improve students' scientific process skills by fostering participation in the phases of scientific exploration. In addition to enhancing science process capabilities, it has also been noted that the application of guided inquiry-based laboratory worksheets can elevate students' creative thinking abilities through experimentation and problem-solving tasks (Muhiddin et al., 2023).

However, an analysis of previous research indicates that no study has specifically utilized guided inquiry-based laboratory worksheets for the subtopic of hydrocarbon types. Guided inquiry-based learning regarding hydrocarbon types can be conducted not only theoretically but also through experimental observation. (Rodríguez-Berríos et al., 2024) developed practical activities for the qualitative testing of hydrocarbons using several methods, including the bromine test and the Baeyer test. Both tests allow for the observation of unsaturated hydrocarbon characteristics through changes occurring during the reactions. The study demonstrated that practical activities involving hydrocarbons can link concepts regarding the physical properties and reactions of hydrocarbon compounds to directly observed phenomena.

In addition to the experimental aspect, hydrocarbon instruction needs to be connected to real-life contexts to make the learned concepts more meaningful. Research by Salsabila & Aznam (2024), through a needs analysis for hydrocarbon teaching materials, highlighted the necessity for materials that are more contextual and relevant to everyday life.

In this regard, orange peel shows potential as a material for contextual learning. Orange peel is easily obtained, relates closely to students' daily lives, and contains an unsaturated hydrocarbon compound, limonene, which can be utilized in both the Baeyer and bromine tests.

The novelty of this research is found in creating a laboratory worksheet based on guided inquiry that incorporates orange peel

(*Citrus* spp.) as a learning context for hydrocarbon type testing. The developed laboratory worksheets are designed to facilitate students in carrying out the stages of scientific investigation through contextual practicum activities. This study focuses on validating the quality of the laboratory worksheet as an instructional tool.

Before a product is utilized in educational contexts, product validation helps to evaluate both its quality and usefulness, hence a critical stage in the research of development (Laili & Azizah, 2024; Putri & Novita, 2024). This study concentrated on judging the laboratory worksheet's design quality as a developmental output rather than on evaluating students' conceptual knowledge. A validity assessment is conducted to determine the alignment of the laboratory worksheet components with inquiry skill indicators, linguistic aspects, and graphical aspects.

The development of laboratory worksheets in this study was conducted using the Educational Design Research (EDR) approach, which enables the systematic development of educational products. Therefore, this study aims to produce laboratory worksheets for practical testing of the types of hydrocarbons from orange peels (*Citrus* spp.) that are validated based on the assessment of expert validators.

LITERATURE REVIEW

Laboratory Worksheets

Laboratory worksheets are student guides that develop cognitive skills and support all aspects of learning, including research and problem-solving activities, in line with the learning outcome indicators (Solihah et al., 2023).

Laboratory worksheets have several strategic functions to support the learning process. These include: (1) They can serve as a medium to support the teaching process and reduce students' dependence on the teacher's direct role. (2) They help students understand and master subject matter better. (3) They can help students become more independent, encouraging them to be more proactive and involved in teaching and learning activities (Sari et al., 2025).

Guided Inquiry

According to Sanjaya (2006), the inquiry-based learning method comprises a series of educational activities emphasizing critical and analytical thinking processes to identify and expose solutions for a certain problem.

Guided inquiry-based learning consists of a series of instructional activities that engage students in the process of systematically, logically, critically, and analytically investigating a problem, enabling them to construct their own ideas with confidence (Jaya et al., 2022). In practice, students are given the opportunity to discover knowledge through investigation and problem-solving activities under the guidance of a teacher; this ensures that the learning process remains focused while maintaining the students' active involvement (Ariani & Ratnawulan, 2022). In chemistry education, this approach can be implemented through systematically structured experimental activities, with appropriate guidance provided throughout the investigation process (Orosz et al., 2022). A systematic review by Adauyah & Aznam (2024) also examines the application of guided inquiry in chemistry education, highlighting its relevance as a pedagogical approach for teaching chemistry.

The advantage of the guided inquiry-based learning model is that the teacher does not simply let the activities carried out by students run unsupervised, so that students who think slowly or students with low intelligence can still participate in the activities carried out, and students with high thinking skills can dominate the activities (Kolo Mauk et al., 2022; Lazonder & Harmsen, 2016). The disadvantages of the guided inquiry-based learning model are that it takes a long time, has a low success rate if the number of students is large, and requires facilities and resources (W. P. Siregar et al., 2023).

Validity of Laboratory Worksheets

Validity assessment is a crucial component in the development of instructional materials, as it serves to evaluate whether a product meets pre-established criteria (Nieveen, 1999).

In chemistry education, expert validation is frequently employed to assess the quality of instructional materials designed to support specific learning objectives. For instance, Sholahuddin et al. (2024) evaluated guided-inquiry-based student worksheets by examining several aspects, including content, presentation, media, and language. Such evaluations demonstrate the use of expert assessment to review instructional materials throughout the development process.

In this study, the validity of laboratory worksheets was assessed based on the alignment between the components of the worksheets and indicators of inquiry skills, as well as on aspects of language and graphic design. The alignment aspect is grounded in inquiry skill indicators adapted from the National Research Council (2012) and Lou et al. (2015). These indicators are used to determine whether the components within the worksheets such as questions, instructions, and tasks are consistent with the inquiry skills targeted in the laboratory activities. This assessment aims to ensure coherence between the intended inquiry skills and the activities presented in the worksheets.

The language and graphic design aspects are evaluated using criteria adapted from assessment instruments developed by the National Education Standards Agency (BSNP). The language criteria are used to assess the accuracy and clarity of the language employed in the worksheets, including its communicative and dialogic characteristics. Meanwhile, the graphic design criteria encompass the visual presentation of the worksheets, such as sizing, cover design, and content layout.

METHODS

This research employs the Educational Design Research (EDR) method as outlined by Plomp & Nieveen (2013), comprising the preliminary research, development (or prototyping), and assessment stages. This study is limited to the preliminary research and prototype development stages of the Plomp model and does not extend to the assessment stage. Consequently, the research focuses on determining the validity of the developed laboratory worksheets and does not examine their practicality or effectiveness in classroom implementation.

The preliminary research stage was conducted to identify learning needs and issues related to chemistry laboratory work, specifically regarding the topic of hydrocarbons. This stage encompassed an analysis of learning outcomes and needs, and a literature review on inquiry-based models. A needs analysis was carried out by distributing questionnaires to chemistry teachers to gather information on learning challenges and the need for guided inquiry-based laboratory worksheets.

The development or prototyping phase involves designing and developing a guided-inquiry-based laboratory worksheet on hydrocarbons, utilizing a hydrocarbon-type identification test that employs orange peel (*Citrus* spp.). This development process encompasses the creation of an initial prototype, expert validation, and subsequent revision. The developed laboratory worksheet underwent expert validation to assess its suitability based on inquiry skill indicators, language usage, and graphic design elements. The validation results were then used to revise and refine the laboratory worksheet.

The instrument employed a 1–4 Likert scale by Riduwan (2015). Validation data were analyzed using a descriptive quantitative method, based on the percentage of scores calculated according to the following formula.

$$P = \frac{\sum X}{\sum X_{max}} \times 100\%$$

Where P is the validity percentage, ∑X is the sum of scores obtained, and ∑Xmax is the sum of maximum scores.

Next, the percentages for each indicator within each aspect are averaged to obtain the overall average validity score for the aspect. The average is calculated using the following formula.

$$\underline{P} = \frac{\sum_{i=1}^{n} P_i}{n}$$

Where $\underline{P}$ is the average validity percentage of the linguistic aspect, P_i is the validity percentage of the i-th indicator, and n is the number of indicators in the aspect

The percentage of the result score can be interpreted using the score interpretation criteria.

Table 1. Score Interpretation Category

%	Validation Category
0-20	Highly invalid
21-40	Invalid
41-60	Quite Valid
61-80	Valid
81-100	Highly valid

(Riduwan, 2015)

The product's validity category is assessed based on the final score interval obtained. The product is developed until the minimum score is achieved in the valid category. Even after being declared valid, the product is still revised based on suggestions and input from the validator.

RESULT AND DISCUSSION

This research developed a guided, inquiry-based laboratory worksheet on testing hydrocarbon types in orange peel (*Citrus* spp.). This research was conducted in several stages to develop a guided inquiry-based laboratory worksheet on the subtopic of hydrocarbon types. It involved gathering data on feasibility—based on assessment instruments from the National Research Council (2012), Lou et al. (2015), and the National Education Standards Agency (BSNP) (2014). The study employed the Educational Design Research framework proposed by Plomp and Nieveen (2013) and was limited to the development phase, specifically focusing on the development phase—namely, the evaluation of the initial prototype by validators.

Preliminary Research

The development of a laboratory worksheet on the sub-topic of hydrocarbon type testing in orange peel began with a needs analysis aimed at identifying the problems and requirements regarding the development of such a worksheet for the topic of hydrocarbons. Needs analysis can help identify limitations in existing chemistry learning resources and determine the need for inquiry-oriented instructional materials (Purwanto et al., 2025) .

Results from the needs analysis questionnaire revealed issues regarding learning activities—specifically, the limited scope of practical work on the topic of hydrocarbons, particularly concerning the sub-topic of hydrocarbon types. This contrasts with the views of Bialagi & Kadir Kilo (2024), who state that practical activities on hydrocarbons are essential, as they serve as an effective method for enhancing the understanding of high school students.

Beyond the feasibility of conducting practical work, the teaching methods employed also warrant attention. Questionnaire results indicate that most teachers rely on demonstration methods. While this approach helps students observe chemical processes or phenomena, students often act merely as observers, with limited opportunities to conduct experiments firsthand (Fung & Ng, 2026). In the context of learning about hydrocarbons, (Sasongko & Haryanto, 2016) found that inquiry-based learning is more effective than demonstration methods in enhancing student engagement and learning outcomes. Therefore, practical activities are needed that allow students to actively participate in the stages of inquiry, while still receiving guidance from their educators.

Practical work that fosters inquiry skills requires the support of appropriate

laboratory worksheets. An analysis of existing worksheets reveals that those currently in use tend to be "cookbook-style" and confirmatory in nature. These characteristics limit students' opportunities to engage in problem formulation, hypothesis generation, data analysis, and conclusion drawing—key components of the inquiry process.

Given these findings, there is a need to develop laboratory worksheets that systematically integrate experimental activities with the stages of guided inquiry. These worksheets focus on the subtopic of identifying types of hydrocarbons in orange peels (Citrus spp.), utilizing materials familiar from everyday life as a learning context. The use of a relevant context in teaching hydrocarbons aligns with research by Salsabila & Aznam (2024), who identified a need for the development of contextual chemistry teaching materials for the topic of hydrocarbons, as well as the work of Siregar et al. (2024) who developed a contextual-based chemistry module for the same subject matter.

Development or Prototyping Phase

During the development phase, the researcher designed laboratory worksheets by aligning them with the Learning Outcomes (CP), Learning Objectives (TP), and Learning Objective Flow (ATP) as stipulated by the Independent Curriculum. The initial product development stage involved drafting the laboratory worksheets. These worksheets were comprehensively structured based on the inquiry stages outlined by Lou et al. (2015) and included several additional sections: a cover page, instructions for use, Learning Outcomes (CP), Learning Objectives (TP), and Learning Objective Flow (ATP), and the steps of the inquiry model.

Following the drafting of the laboratory worksheet, it was validated by three chemistry lecturers and two high school chemistry teachers. The validation covered three aspects: the alignment of worksheet components with inquiry skill indicators, language usage, and graphic design. This validation process served to refine the previously drafted guided-inquiry laboratory worksheet, with the results guiding the subsequent revision (Simatupang & Santika, 2021).

1) Validation of the alignment between laboratory worksheet components and inquiry skill indicators

The validation of the alignment of laboratory worksheet components aims to determine the degree of correspondence between these components and the indicators of inquiry skills. The criteria for these inquiry skill indicators are based on the inquiry skills framework proposed by the National Research Council (2012) and Lou et al. (2015). The scores obtained were then processed using the scoring criteria established by Riduwan (2015).

The percentages derived from the validation of the alignment of the laboratory worksheet components are presented in Table 2 below.

Table 2. Table of percentage results for the validation of component alignment with inquiry skill indicators

Laboratory Worksheet Components	Percentage (%)	Validation Category
Title	85	Highly Valid
Formulating the Problem	90	Highly Valid
Formulating Hypothesis	85	Highly Valid
Collecting Data	90	Highly Valid
Analyzing Data	90	Highly Valid
Testing the Hypothesis	90	Highly Valid
Drawing Conclusions	90	Highly Valid
Average	88,6	Highly Valid

As shown in Table 2, the validation results for the alignment of the laboratory worksheet components with the inquiry skill indicators yielded scores of 85% and 90%, both of which fall into the "highly valid" category.

The lowest percentage, 85%, was recorded for the components concerning the title and the formulation of hypotheses. The initial title used for the laboratory worksheet was "Testing for Hydrocarbon Saturation in Orange Peels (Citrus spp.)." The validator suggested replacing the word "Saturation," as this term refers to a concept that the students themselves are intended to discover. This suggestion was accepted, and the title of the developed laboratory worksheet was subsequently changed to "Testing for Types of Hydrocarbons in Orange Peels (*Citrus* spp.)."

The components regarding problem formulation, data collection, data analysis, hypothesis testing, and drawing conclusions achieved a score of 90%, placing them in the "highly valid" category. According to the validator's assessment, these components are well-aligned with the inquiry skill indicators. Nevertheless, one validator suggested separating the instructions for experiments to be conducted by the students from those for procedures not performed by the students. The suggestion was accepted; consequently, in the developed worksheet, the experimental instructions were separated—distinguishing between experiments to be conducted by the students and those that would not—to ensure that the procedure-design process could proceed effectively.

Overall, the validation results regarding the alignment of laboratory worksheet components with inquiry skill indicators yielded an average percentage of 88.6%, placing it in the "highly valid" category. This finding is consistent with the study by (Fauziah et al., 2022), who developed guided-inquiry-based laboratory worksheets and validated the alignment of their components with inquiry skill indicators. Their research demonstrated that the alignment of worksheet components with inquiry skill indicators is a crucial aspect in the development of inquiry-based laboratory materials. Consequently, the guided-inquiry-based laboratory worksheets developed in this study have met the validity criteria concerning the alignment of their components with inquiry skill indicators, as assessed by the validators.

2) Validation of language aspects

Validation of the language aspects in the laboratory worksheets refers to the language indicators from the National Education Standards Agency (BSNP), which include five indicators: straightforwardness, communicativeness, dialogic and interactiveness, appropriateness to student development, and compliance with language rules.

The percentages obtained from the validation results of the language aspects in the laboratory worksheets are shown in Table 3 below.

Table 3. Table of percentages for language validation results

Language Aspect	Percentage (%)	Validation Category
Straight Forward	87	Highly Valid
Communicative	90	Highly Valid
Dialogic and Interactive	85	Highly Valid
Conformity to Student	83	Highly Valid
Conformity with Language Rules	90	
Average	87	Highly Valid

Based on Table 3, the validation results for the language aspect of the laboratory worksheets showed a percentage of 83%, 85%, 87%, and 90%, with a highly valid interpretation. The lowest percentage was observed for the indicator of suitability to students' developmental level, at 83%. This aspect encompasses the appropriateness of the language to students' intellectual development and to their level of emotional development. Validator 3 argued that the language used did not reflect appropriateness to the students' The lowest percentage was recorded for the indicator regarding alignment with students' developmental levels, at 83%. This aspect encompasses the suitability of the language used in relation to the students' intellectual and emotional development. The low score in this area stemmed from the views of several validators who considered the language insufficiently aligned with the students'

developmental stage. The author accepted this feedback and subsequently revised the text by simplifying the language and tailoring it to the students' developmental needs.

The dialogic and interactive indicator achieved a score of 85%, falling into the "highly valid" category. This result indicates that, according to the validators' assessment, the language used in the laboratory worksheet supports dialogic and interactive communication through the presentation of questions and instructions that guide students to engage in inquiry activities.

The straightforward indicator obtained a percentage of 87%, categorized as highly valid. This indicates that the language used in the laboratory worksheets is very good in terms of sentence structure accuracy, sentence effectiveness, and standardized terminology.

The communicative indicator obtained a percentage of 90%, categorized as highly valid. This indicates that the language used in the laboratory worksheets conveys messages clearly, is easy to understand, and effectively supports student understanding.

The communicative indicator achieved a score of 90%, falling into the "highly valid" category. This result indicates that, according to the validators' assessment, the language used in the laboratory worksheet effectively conveys information, instructions, and questions clearly and understandably. The use of communicative language supports the clear presentation of information and instructions at each stage of guided inquiry, allowing the worksheet to serve as an effective guide for conducting practical activities.

Overall, the validation results for the linguistic aspect yielded an average percentage of 87%, falling into the "highly valid" category. These results align with the study by (Daulay & Sugiharti, 2025) , which reported that the linguistic aspect of the developed worksheet achieved a validity percentage of 85%, also classified as "highly valid."

3) Validation of graphic aspects

The validation of the graphic aspects of the laboratory worksheet is based on the graphic indicators established by the National Education Standards Agency (BSNP), which encompass three criteria: size, cover design, and content design. The validation results for these graphic aspects are presented in Table 4 below.

Table 4. Table of percentages for graphic validation results

Graphic Aspect	Percentage (%)	Validation Category
Laboratory Worksheet Size	80	Valid
Laboratory Worksheet Cover Design	86	Highly Valid
Laboratory Worksheet Content Design	84	Highly Valid
Average	83,3	Highly Valid

As shown in Table 4, the validation results for the graphic aspects yielded a score of 80% (categorized as "valid"), while other components scored 86% and 84% (categorized as "highly valid").

The size component of the laboratory worksheet received a score of 80%, falling into the "valid" category. This indicates that the size of the worksheet meets the criteria for the presentation of teaching materials and aligns with the requirements for presenting its content. Although it received the lowest percentage among the graphic components, it still meets the established validity criteria. Nevertheless, this aspect could be further optimized to enhance the comfort of students when reading and using the laboratory worksheet.

The cover design component received a score of 86%, categorized as "highly valid." This suggests that, according to the validators, the cover design meets the established graphic criteria, specifically regarding the choice of fonts, layout, use of color, and the presentation of illustrations. A cover design that is proportionally structured and aligned with the content helps clarify the identity of the material and provides an initial overview

of the subject matter. Thus, the cover design is considered to have met the validity criteria regarding visual presentation.

The content design component received a score of 84%, also categorized as "highly valid." This indicates that the presentation of the content meets the established graphic criteria, including layout consistency, paragraph arrangement, the use of illustrations, and the presentation of information. Therefore, the content design is considered to have met the validity criteria in terms of visual presentation and layout organization.

Overall, the validation results for the graphic design aspect yielded an average percentage of 83%, placing it in the "highly valid" category. This finding aligns with research by (Ma'sumah & Mitarlis, 2021), which reported that the graphic design aspect of the developed worksheet achieved a validity percentage of 88%, also falling into the "highly valid" category.

CONCLUSION

This research resulted in a guided-inquiry-based laboratory worksheet focused on identifying hydrocarbon types in citrus peels (*Citrus* spp.), developed using the Educational Design Research (EDR) framework. Validation results indicate that the developed laboratory worksheet falls into the "highly valid" category regarding the alignment of its components with indicators for inquiry skills, language use, and graphic design. These findings suggest that the product meets validity criteria based on expert evaluations, making it suitable for subsequent trial phases to assess its practicality and effectiveness in an educational setting.

From the perspective of chemistry education, this study contributes to the development of laboratory teaching materials that integrate hydrocarbon concepts with the stages of scientific inquiry. The worksheet does more than provide experimental procedures; it is designed to guide laboratory activities in accordance with specific inquiry skill indicators. Utilizing citrus peels as a practical context offers an alternative way to connect chemical concepts with materials encountered in everyday life. In the context of science and technology, this development demonstrates the application of inquiry-based design principles to systematically organize chemical experiments while leveraging natural materials as a learning context. Nevertheless, this study has not yet empirically tested the effectiveness of using citrus peels for laboratory work, nor has it evaluated the impact of the worksheet on students' inquiry skills. Consequently, further research is required to examine the product's practicality and effectiveness through classroom trials and to evaluate its application within a broader chemistry education context.

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REFERENCE

Adauyah, R., & Aznam, N. (2024). Guided Inquiry Learning Model in Chemistry Education: A Systematic Review. *Jurnal Penelitian Pendidikan IPA*, *10*(3), 77–87. https://doi.org/10.29303/jppipa.v10i3.6373

Agmita, N., Suyana, I., & Feranie, S. (2021). Desain LKPD Berbasis Masalah untuk Melatihkan Keterampilan Abad Ke-21. *Journal of Teaching and Learning Physics*, *6*(2), 90–99. https://doi.org/10.15575/jotalp.v6i2.10984

Arfina, R. (2026). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Inkuiri Terbimbing pada Materi Benzena dan Turunannya untuk Kelas XII SMA/MA. *JEANS: Journal of Educational and Applied Natural Sciences 2026, 1, 1 Journal of Educational and Applied Natural Sciences Journal Homepage*. https://doi.org/10.21831/jser.v.xxxxx

Ariani, R., & Ratnawulan, R. (2022). Pengembangan Multimedia Interaktif IPA Terpadu berbasis Inkuiri Terbimbing dengan Tema Energi dalam Kehidupan Terintegrasi Pembelajaran Abad 21. In *Jurnal Penelitian dan Pembelajaran Fisika* (Vol. 8, Number 1). https://doi.org/10.24036/jppf.v8i1.116460

Bialangi, N., Arviani, A., & Kilo, A. K. (2024). Penguatan Pemahaman Dasar Kimia Organik melalui Pembelajaran Materi Senyawa Hidrokarbon bagi Siswa SMKN 1 Analis Kimia Gorontalo. Damhil: *Jurnal Pengabdian kepada Masyarakat*, 3(2), 211-218. https://doi.org/10.37905/damhil.v3i2.29750

Daulay, N. A. S., & Sugiharti, G. (2025). Development of Problem-Based Learning E-Module to Enhance Students' Critical Thinking on Acid-Base Material. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education), 7*(2), 185–194. https://jurnal.unimed.ac.id/2012/index.php/jipk

Fauziah, C., Suhanda, H., & Suryatna, A. (2022). Pengembangan LKPD Praktikum Berbasis Inkuiri Terbimbing Percobaan Pasta Gigi Gajah (Elephant Toothpaste Experiment) Pada Subtopik Pengaruh Katalis Terhadap Laju Reaksi. *Jurnal Riset Dan Praktik Pendidikan Kimia*. https://doi.org/10.17509/jrppk.v10i2.52239

Februanti, N., Sahputra, R., & Sartika, R. P. (2023). Development of Discovery Learning-Based Student Worksheets on Chemical Equilibrium Material. *Hydrogen: Jurnal Kependidikan Kimia*, *11*(5), 686. https://doi.org/10.33394/hjkk.v11i5.8994

Fung, C. H., & Ng, S. P. (2026). The Benefits and Challenges of Using the Demonstration Method in STEM Education: A Systematic Literature Review. In Education Sciences (Vol. 16, Number 1). *Multidisciplinary Digital Publishing Institute* (MDPI). https://doi.org/10.3390/educsci16010161

Haryani, E., Cobern, W. W., Pleasants, B. A. S., & Fetters, M. K. (2021). Analysis of teachers' resources for integrating

the skills of creativity and innovation, critical thinking and problem solving, collaboration, and communication in science classroom. *Jurnal Pendidikan IPA Indonesia*, *10*(1), 92–102. https://doi.org/10.15294/jpii.v10i1.27084

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. https://doi.org/10.56248/educativo.v1i1.44

Jegstad, K. M. (2024). Inquiry-based chemistry education: a systematic review. In *Studies in Science Education* (Vol. 60, Number 2, pp. 251–313). Routledge. https://doi.org/10.1080/03057267.2023.2248436

Kolo Mauk, F., Komisia, F., & Tukan, M. B. (2022). Perbandingan Hasil Belajar Yang Menerapkan Model Pembelajaran Berbasis Masalah Dan Inkuiri Terbimbing. *EDUCATIVO: JURNAL PENDIDIKAN*, *1*(2), 465–472. https://doi.org/10.56248/educativo.v1i1.66

Laili, B. A., & Azizah, U. (2024). Development of Guided Inquiry-Oriented Electronic Student Worksheets to Improve Students' Metacognitive Skills on Chemical Equlibirum Material. *Asian Journal of Science Education*, *6*(2), 62–72. https://doi.org/10.24815/ajse.v6i2.40191

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

Lou, Y., Blanchard, P., & Kennedy, E. (2015). Development and validation of a science inquiry skills assessment. *Journal of Geoscience Education*, *63*(1), 73–75. https://doi.org/10.5408/14-028.1

Ma'sumah, A., & Mitarlis. (2021). Pengembangan LKPD Berorientasi STEM dengan Model PjBL Materi Larutan Elektrolit Nonelektrolit dengan Memanfaatkan Bahan Sekitar. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *3*(1), 22–34. https://doi.org/10.24114/jipk.v3i1.23222

Muhiddin, M. A., Agussalim, & Arsyad, A. A. (2023). Penerapan Model Inkuiri Terbimbing Berbantuan LKPD Berbasis Praktikum untuk Meningkatkan Kemampuan Berpikir Kreatif Peserta Didik. *Qalam : Jurnal Ilmu Kependidikan*, *12*(1), 1–10. https://doi.org/10.33506/jq.v12i1.2488

National Research Council. (2012). *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. The National Academies Press.

Nieveen, N. (1999). *Prototyping to Reach Product Quality*. https://doi.org/10.1007/978-94-011-4255-7_10

Nuai, A., & Nurkamiden, S. (2022). Urgensi kegiatan praktikum dalam pembelajaran ilmu pengetahuan alam di sekolah dasar dan menengah. *SEARCH: Science Education Research Journal*, 1(1), 48-63. https://e-jurnal.iainsorong.ac.id/index.php/jaser/article/view/1240

Orosz, G., Németh, V., Kovács, L., Somogyi, Z., & Korom, E. (2022). Guided inquiry-based learning in secondary-school chemistry classes: a case study. *Chemistry Education Research and Practice*, *24*(1), 50–70. https://doi.org/10.1039/d2rp00110a

Partnership for 21st Century Learning. (2015). *P21 framework definitions. Partnership for 21st Century Learning.* https://files.eric.ed.gov/fulltext/ED519462.pdf

Petersen, M. R. (2022). Strategies to Scaffold Students' Inquiry Learning in Science. *Science Education International*, *33*(3), 267–275. https://doi.org/10.33828/sei.v33.i3.1

Plomp, T. & Nieveen, N. (2013). *Educational design research: An introduction*. In T. Plomp & N. Nieveen (Eds.), Educational design research: Part A: An introduction (pp. 10–51). SLO.

Prameswari, P. A. M., Rahmanpiu, & Maysara. (2023). Pengembangan Lembar Kerja Peserta Didik Berbasis Inkuiri Terbimbing Untuk Meningkatkan Hasil Belajar Siswa Kelas XI SMA pada Materi Termokimia. *Jurnal Pendidikan Kimia FKIP Universitas Halu Oleo*, *8*(1). https://doi.org/10.36709/jpkim.v8i1.5

Purwanto, R., Situmorang, M., & Sudrajat, A. (2025). A Needs Analysis of Inquiry-Based Virtual Laboratory for Acid–Base Titration. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *7*(1), 47–58. https://doi.org/10.24114/jipk.v7i1.67602

Putri, R. F., & Novita, D. (2024). Development of Guided Inquiry Oriented with Chemical Representations e-Worksheets to Train Science Process Skills on Chemical Equilibrium. *Hydrogen: Jurnal Kependidikan Kimia*, *12*(2), 243. https://doi.org/10.33394/hjkk.v12i2.11146

Rahmawati, T., Suhanda, H., Istighfari, F., Sabilla, A., & Suryatna, A. (2022). Implementation of Practicum Worksheets Based on Guided Inquiry on the Topic of Colloids to Improve Students' Science Process Skills. *Jurnal IPA Dan Pembelajaran IPA)*, *6*(4), 409–422. https://doi.org/10.24815/jipi.v6i3.28354

Riduwan. (2015). *Skala Pengukuran Variabel-Variabel Penelitian*. ALfabeta.

Rodríguez-Berríos, R. R., Rivera-González, U., Cardona-Rivera, A. E., & Narváez-Lozano, G. A. (2024). Qualitative Test for Hydrocarbons: A Laboratory Experiment to Reinforce the Different Types of Reactions and Mechanisms in Organic Chemistry. *Journal of Chemical Education*, *101*(8), 3396–3403.

https://doi.org/10.1021/acs.jchemed.4c00101

Salsabila, S., & Aznam, N. (2024). Indonesian Journal of Chemical Education Analysis of Teacher Needs for A Contextual Chemistry Module Based on Multiple Representation Integrated Islamic Values in Hydrocarbon Materials. *Indonesian Journal of Chemical Education*, *1*(2), 63–69. https://doi.org/10.21831/ijce.v1i2.81342

Sanjaya, W. (2006). *Strategi pembelajaran berorientasi standar proses pendidikan*. Kencana.

Sari, D. U., Chairuddin, C., & Karunia, K. (2025). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Online Berbantuan Geogebra Book pada Materi Komposisi Fungsi Kelas XI SMA. *Teorema: Teori Dan Riset Matematika*, *10*(1), 49. https://doi.org/10.25157/teorema.v10i1.17171

Sasongko, N. D., & Haryanto. (2016). Keefektifan Metode Inquiry terhadap Keaktifan dan Hasil Belajar Siswa Kelas X Pembelajaran Kimia. *Jurnal Inovasi Teknologi Pendidikan*, 3(1), 40–52. https://doi.org/10.21831/tp.v3i1.8277

Selmin, Y., Bunga, Y. N., & Bare, Y. (2022). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Inkuiri Terbimbing Materi Sistem Organisasi Kehidupan. *Spizaetus: Jurnal Biologi Dan Pendidikan Biologi*, *3*(1), 41. https://doi.org/10.55241/spibio.v3i1.52

Sholahuddin, A., Normina, N., & Iriani, R. (2024). Improving students' scientific literacy : Development of guided inquiry-based student worksheets on buffer solution material. *Jurnal Pendidikan Kimia*, *16*(2), 152–158. https://doi.org/10.24114/jpkim.v16i2.56718

Simatupang, L., & Santika, I. (2021). Pengembangan Lembar Kerja Siswa (LKS) Berbasis Inkuiri Terbimbing Pada Pokok Bahasan Kesetimbangan Kimia. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *3*(1), 76–85. https://doi.org/10.24114/jipk.v3i1.24098

Siregar, T., Yawan, S. F., & Panggabean, F. T. M. (2024). Development of Contextual-Based Chemistry Modules on Hydrocarbon Compound Materials. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *6*(1), 20–29. https://doi.org/10.24114/jipk.v6i1.56563

Siregar, W. P., Irawati, S., Jumiarni, D., Ahmad Saddam Husein, Irwandi Ansori, & Syarif Hidayat. (2023). Rancangan Perangkat Pembelajaran Model Inkuiri Terbimbing untuk Meningkatkan Literasi Sains. *Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi*, 1–8. https://doi.org/10.33369/diklabio.7.1.1-8

Solihah, A., Habibie, M. T., & Kamali, A. S. (2023). Validasi Lembar Kerja Peserta Didik (LKPD) Berbasis Multiple Intelligences. Article Info. *Jurnal Inovasi Dan Teknologi Pendidikan JURINOTEP*, *2*(1), 2023–2024. https://doi.org/10.46306/jurinotep.v2i1

Sutiani, A., & Fayaddah. (2021). Pengembangan Lembar Kerja Siswa (LKS) Berbasis Model Pembelajaran Inkuiri Terbimbing Pada Materi Termokimia. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *3*(2), 106–115. https://doi.org/10.24114/jipk.v3i2.28174

The National Education Standards Agency (BSNP). (2014). *Instrumen Penilaian Buku Teks Pelajaran SMP/MTs dan SMA/MA*.

Tohani, E., & Aulia, I. (2022). Effects of 21st Century Learning on the Development of Critical Thinking, Creativity, Communication, and Collaboration Skills. *Journal of Nonformal Education*, *8*(1), 46–53. https://doi.org/10.15294/jne.v8i1.33334