
Development of a Guided Inquiry-Based Chemistry Laboratory Manual with Learning Videos for Grade X Senior High School

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Abstract

Chemistry learning in senior high schools level often encounters challenges due to the abstract nature and broad scope of the material, which make it difficult for students to understand and lead to low learning outcomes. One solution is laboratory practice, which provides direct learning experiences. An observation at Methodist El Shadday Senior High School showed that no chemistry laboratory manual was available, and the textbooks used did not include practical activities. This research was conducted to design a chemistry laboratory manual based on the guided inquiry model. The guided inquiry model was selected as it guides students to ask questions, develop hypotheses, conduct experiments, and draw conclusions. The manual also introduces laboratory tools, materials, and safety guidelines to ensure safe laboratory activities. The research applied a Research and Development (R&D) approach using the ADDIE model up to the development stage. The product was validated by three chemistry lecturers and three chemistry teachers using instruments based on BSNP standards. Validation by lecturers showed scores of 88.46% for content, 82.5% for presentation, 87.03% for language, 88.88% for graphics, and 89.39% for guided inquiry. Teacher validation showed 96.66% for content, 96.66% for presentation, 96.29% for language, 96.82% for graphics, and 95.54% for guided inquiry. All results were categorized as feasible. The results show that the laboratory manual developed is suitable to be used as a learning resource. It is anticipated that this product will help improve students' academic performance as well as their scientific process skills through hands-on laboratory activities.

Keywords: Chemistry laboratory manual, guided inquiry, learning video, Science Process Skills, laboratory activities

1. Introduction

As an experimental science, chemistry involves abstract and complex concepts, making it difficult to learn solely through reading or lectures. Many high school students perceive

chemistry as a difficult subject, which reduces their interest and is reflected in generally low learning outcomes. Astafani et al. (2024), through a systematic review, showed that difficulties in learning chemistry are caused by both internal factors, such as low motivation and cognitive abilities, and external factors, such as ineffective teaching methods and limited supporting facilities.

According to (Siregar & Harahap, 2020), an effective strategy to improve students' understanding of chemical concepts is through authentic scientific activities, namely laboratory practice. (Rahmawati, 2019) explained that laboratory practice enables students to directly interact with the material, thereby increasing curiosity, conceptual understanding, learning motivation, and skills in handling laboratory equipment. This finding is supported by (Haryati et al., 2021) and (Mujahidin, 2021), who demonstrated that well-implemented laboratory practices can significantly improve conceptual understanding and scientific skills among high school students. This is consistent with the Kurikulum Merdeka, which emphasizes not only mastery of concepts but also the development of scientific process skills, including observation, problem formulation, experimental design, data analysis, and conclusion drawing principles that align with laboratory practice.

For laboratory practice to be effective, several conditions must be met, including adequate facilities, the availability of appropriate tools and materials, and supporting teaching resources. One relevant resource is a laboratory manual. However, conventional manuals are often merely procedural and do not fully support students' conceptual understanding. Therefore, a more systematic practicum guidebook that integrates an effective learning model is needed. One of the learning models that can support practicum activities is the guided inquiry model, which encourages students to actively seek and investigate information critically, logically, and analytically (Pranoto & Sudiyanto, 2024). This model not only helps students understand practicum procedures more effectively but also promotes active engagement in independently discovering concepts and theories. In addition, the guided inquiry model makes practicum activities more structured and aligned with the learning outcomes (CP) and learning objectives (ATP) stated in the Merdeka Curriculum (Prasetyo & Rosy, 2021). Research by (Putri, 2021) also demonstrated that an inquiry-based laboratory guidebook is effective in helping students understand practicum activities and discover relevant scientific concepts.

Initial observations at Methodist Senior High School, Perbaungan, revealed that chemistry learning was not yet optimal because students still perceived chemistry as difficult and laboratory practice was rarely conducted. Teachers acknowledged the importance of laboratory activities but noted that limited media and teaching resources hindered effective learning interactions. The textbooks used did not provide adequate practical guidelines, so teachers relied only on worksheets (LKS), which were not effectively implemented. This finding is consistent with (Nufus & Sakti, 2021), who reported that conventional worksheets, being largely procedural, are less effective because they do not encourage active participation or scientific thinking. In addition, interviews showed that low learning outcomes were also influenced by the limited variety of learning media. Questionnaire data indicated that 77,3% of students were interested in using a more comprehensive laboratory manual, and 95,5% stated that such a manual would be very helpful in understanding concepts before and during practice. These findings highlight the need for structured and accessible laboratory teaching materials.

The novelty of this study lies in the development of a guided inquiry-based chemistry laboratory manual enriched with instructional videos. The addition of videos as an introduction

is expected to stimulate students' interest and strengthen conceptual understanding (Talib et al., 2017). According to (Putra & Rahayu, 2022), integrated videos enable students to learn essential concepts and understand practicum procedures before conducting laboratory activities. This is supported by the findings of (Hartati & Siregar, 2024), which indicate that the use of instructional videos can enhance students' conceptual understanding in chemistry learning. Consequently, students become better prepared and have a clearer understanding of the objectives of the practicum to be conducted.

This development is motivated by the absence of practicum teaching materials that integrate the guided inquiry learning model with audiovisual media in schools. Therefore, this study aims to develop and evaluate the feasibility of a guided inquiry-based chemistry practicum guidebook equipped with instructional videos for grade X senior high school students

2. Methods

This study employed a Research and Development (R&D) approach with the objective of creating and evaluating the feasibility of a product, namely a Guided Inquiry-Based Chemistry Laboratory Manual with learning videos for tenth-grade high school students in the second semester.

The research and development model applied was the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) (Rayanto & Sugianti, 2020), with the research limited to the Development stage. The Chemistry Laboratory Manual underwent validation by three chemistry lecturers and three chemistry teachers who assessed its feasibility as instructional material for grade X chemistry learning in senior high school.

2.1. Data Collection Tools

Data were collected using the following methods:

1. Preliminary Analysis: Data were obtained through interviews with chemistry teachers, student needs questionnaires, and an analysis of teaching materials currently used in the school.
2. Design of Learning Materials and Media: Learning objectives, content, activities, and the structure of the chemistry laboratory manual were developed based on the results of the preliminary analysis.
3. Development of the Chemistry Laboratory Manual: The product developed was a guided inquiry-based chemistry laboratory manual equipped with learning materials, learning outcomes and objectives, laboratory worksheets, safety guidelines, an introduction to laboratory tools and materials, and instructional videos accessible via barcode/QR code. Each practicum activity was designed according to the guided inquiry syntax, starting from problem orientation, hypothesis formulation, data collection, data analysis, to conclusion. The developed manual was validated by three chemistry lecturers and three high school chemistry teachers. Validation focused on content, presentation, and language feasibility, with results presented in the form of scores and feedback for product refinement.

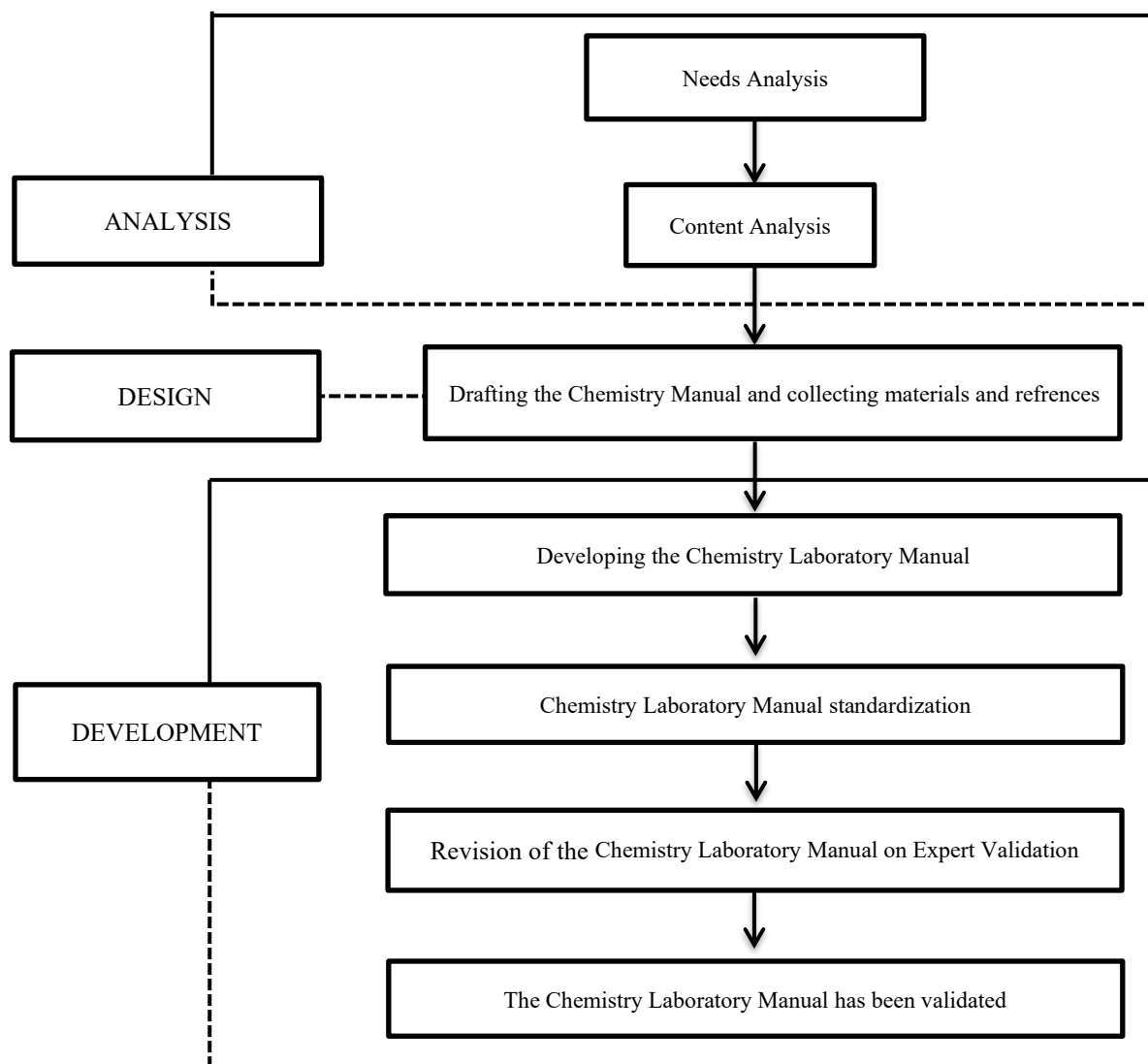
This study was limited to the Development stage of the ADDIE model, focusing on the design and validation of a guided inquiry-based chemistry laboratory manual prior to classroom

implementation. The Implementation and Evaluation phases will be addressed in subsequent studies following the completion of the chemistry laboratory manual's development

The entire sequence of the ADDIE model research procedure is presented in Figure 1.

Figure 1.

Development Procedure of the Chemistry Manual Laboratory



2.2. Data Analysis

Data analysis for feasibility validation was carried out to assess the extent to which the developed chemistry laboratory manual met the feasibility standards. The validation process used an instrument based on the standards of the National Education Standards Board (BSNP). The assessment employed a Likert scale with the following categories: 1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree. After the validators completed the validation

instrument by giving scores according to the assessed aspects, the results were analyzed qualitatively. The feasibility percentage was then calculated using the following formula:

$$\text{Feasibility Percentage} = \frac{\text{obtained score}}{\text{maximum score}} \times 100\%$$

The feasibility of the guided inquiry-based chemistry laboratory manual with learning videos was analyzed descriptively and qualitatively by comparing the obtained percentage scores with the feasibility criteria presented in Table 1.

Table 1.

Criteria for Product Feasibility Based on Percentage Scores

Score	Category
80% - 100%	Very Feasible
60% - 79%	Feasible
40% - 59%	Less feasible
0 ≤ 39%	Not feasible

(Arikunto, 2018)

3. Result and Discussion

3.1. Analysis

The analysis stage was carried out to identify the problems, needs, and initial conditions of chemistry learning at Methodist El-Shadday Senior High School. The initial needs analysis technique, conducted through interviews with the chemistry teacher, was analyzed descriptively to determine the school's level of need for a chemistry practicum guidebook to be developed. The interview aimed to obtain information regarding students' learning outcomes, obstacles in chemistry learning, and the availability of learning media. Descriptive analysis was employed to describe the data as it was, without generalizing or drawing broader (Silvia, 2020). In addition, students' needs were assessed using questionnaires distributed to grade X students via Google Forms, as well as through an analysis of the existing chemistry textbooks.

The results of chemistry teacher interview results presented in Table 2.

Table 2

Summary of Chemistry Teacher Interview Results

No	Question	Summary of Teacher's Response
1	How are the chemistry learning outcomes at SMA Swasta Methodist El- Shadday Perbaungan?	The students' chemistry learning outcomes are generally unsatisfactory; several learning objectives have not been achieved.
2	What are the main factors contributing to the suboptimal learning outcomes?	Students have low motivation and perceive chemistry as difficult due to its abstract concepts and complex learning process.

3	Have you applied any specific learning model in chemistry lessons?	No specific learning model has been applied; teaching mostly uses PowerPoint presentations and textbooks.
4	How important is scientific work or practicum in chemistry learning?	Practicum is very important as it helps students better understand abstract concepts through direct experience.
5	Do you currently use a chemistry laboratory manual?	No, because it is not yet available at the school.
6	If not, what materials are used during practicum activities?	Self-prepared student worksheets, which are still limited in providing technical guidance and theoretical explanations.
7	Do you think a chemistry laboratory manual be developed?	Yes, a more structured chemistry laboratory manual would help students perform practicum activities more effectively and independently.
8	What do you think about developing the laboratory manual using a guided inquiry model?	Very good, as it would make learning more structured and encourage students to actively explore and understand concepts
9	What if the guidebook is equipped with instructional videos?	Very helpful, since audiovisual materials can increase students' interest and engagement in learning.

The interview results show that students' chemistry learning outcomes are still below expectations due to low motivation and the perception that chemistry is a difficult subject. The teacher emphasized the importance of practicum activities in helping students understand abstract concepts; however, the school does not yet have a structured practicum guidebook. The existing materials, such as self-developed worksheets, are still limited and lack detailed guidance on procedures and laboratory safety. Therefore, the teacher supports the development of a guided inquiry-based practicum guidebook equipped with instructional videos to improve students' motivation, understanding, and engagement in chemistry learning. Through guided inquiry-based learning, students can gain a deeper understanding of concepts by constructing their own knowledge, making the learning process more active, meaningful, and aligned with the characteristics of chemistry learning (Malau et al., 2019). The results of students' needs analysis presented in Table 3.

Table 3
Results of Students' Needs Analysis

Aspect	Question	(%)	Interpretasi
Frequency of Practicum	How often do you conduct chemistry practicum?	22,7%	Often
		59,1%	Sometimes
		13,6%	Rarely
		4,6%	Never
Interest in Practicum	How interested are you in joining chemistry practicum?	81,8	Interested
		13,6	Fairly Interested
		4,6%	Less Interested
		0%	Not Interested

Learning Motivation	Does the practicum increase your learning motivation?	72,7%	Motivated
		22,7	Fairly Motivated
		4,6%	Less Motivated
		0%	Not Motivated
Main Difficulties During Practicum	Incomplete tools	68,2%	
		Inadequate procedure	13,6%
		Limited time	27,,3%
		Conceptual difficulties	45,5%
Use of Chemistry Laboratory Manual	Do you use a practicum guidebook during experiments?	54,5%	Yes
		45,5%	No
Effectiveness of Chemistry Laboratory Manual	Does the current practicum guidebook help you?	77,2%	Helpful
		9,1%	Fairly Helpful
		13,6%	Less Helpful
Alternative to Chemistry Laboratory Manual	If not using a guidebook, what do you use?		
		Student Worksheet (LKS)	36,4%
		Teacher Notes	54,5%
		Tidak ada	9,1%
Interest in Chemistry Laboratory Manual	Are you interested in a more structured and detailed practicum guidebook than LKS?	77,3%	Important
		18,2%	Fairly Important
		4,5%	Less Important
Need for Inovatif Media	Would you like a practicum guidebook based on inquiry combined with video?	95,5	Yes
		4,5	No

These findings were supported by student questionnaire results, which indicated that most students preferred practicum activities over lecture-based learning. A total of 77,3% of students expressed interest in a chemistry laboratory manual equipped with instructional videos, while 95,5% agreed that developing a guided inquiry-based chemistry laboratory manual with learning videos would be very helpful.

The researchers also analyzed the textbooks used in the school. The selection of these books was based on the teaching materials currently used in chemistry learning at Methodist El-Shadday Senior High School, Perbaungan. Two textbooks were analyzed (type of textbook in table 4), and the results are presented in Table 5.

Table 4.
Types of Textbooks Analyzed

Book Title	Author's	Publisher	Year of Publication
Kimia untuk SMA/MA Kelas X	Drs. Unggul Sudarmo, M.Pd	Erlangga	2013
Ilmu Pengetahuan Alam SMA	Ayuk Ratna Puspaningsih Elizabeth Tjahjardarmawan Niken R Krisdianti	Masmedia Buana Pustaka	2021

Table 5.*Tabulation of the Evaluation of Two Chemistry Textbooks*

No	Evaluation Component	Average Score	Percentage (%)	Feasibility Criteria
1	Content Feasibility	2,96	74,00 %	Feasible
2	Presentation Feasibility	2,60	65,00 %	Feasible
3	Language Feasibility	2,94	73,50 %	Feasible
4	Graphical Feasibility	2,59	64,75 %	Feasible
5	Guided Inquiry	1,31	32,75 %	Not feasible
	Average Score	12,4	62,00 %	Fairly feasible

Based on the validation results, the two chemistry textbooks obtained an average score of 12.4 (62.00%) and were categorized as fairly feasible. The aspects of content feasibility, presentation, language, and graphics were considered fairly feasible, while the guided inquiry aspect received the lowest score (1.31 or 32.75%) and was categorized as not feasible. This indicates that although the textbooks met the minimum standards as teaching materials, the limitations in providing practicum activities and the lack of integration of the guided inquiry approach remain major weaknesses that require further attention in future development.

3.2. Design

After completing the analysis stage, which served as the initial step in data collection, the researcher proceeded to design a guided inquiry-based chemistry laboratory manual. At this stage, relevant references related to the tenth-grade chemistry curriculum were collected to ensure alignment with the established learning outcomes and learning trajectory. The researcher also selected and designed supporting learning media, including illustrative images, educational websites, and instructional videos, which were later integrated into the manual to facilitate student engagement.

The guided inquiry model was chosen because it aligns with the scientific approach emphasized in the current chemistry curriculum and supports the development of students' higher-order thinking skills. According to (Ananda et al., 2021), guided inquiry allows students to construct understanding through active exploration and teacher guidance.

The guided inquiry learning model applied in this manual consists of five main stages (Depin et al., 2024):

1. Problem Orientation – The teacher creates a conducive learning atmosphere and directs students' attention to the issues under investigation by:
 - a. explaining the learning topic and objectives;
 - b. outlining the key activities to achieve these objectives;
 - c. presenting an introductory learning video to stimulate curiosity and motivation; and
 - d. posing guiding questions to encourage critical thinking prior to the laboratory activity.

2. Formulating Hypotheses – Students propose tentative answers to the presented problems, which are then verified experimentally. This process encourages logical and evidence-based reasoning.
3. Experimentation and Data Collection – Students conduct experiments according to the manual's procedures. Both qualitative and quantitative data are systematically recorded, developing students' scientific process skills such as observation, measurement, and data analysis.
4. Testing the Hypothesis – The collected data are analyzed to validate or refute the initial hypotheses. Students connect empirical findings with theoretical concepts, fostering analytical and evaluative thinking.
5. Drawing Conclusions – Based on the data analysis, students formulate logical conclusions that integrate theoretical and practical chemistry understanding.

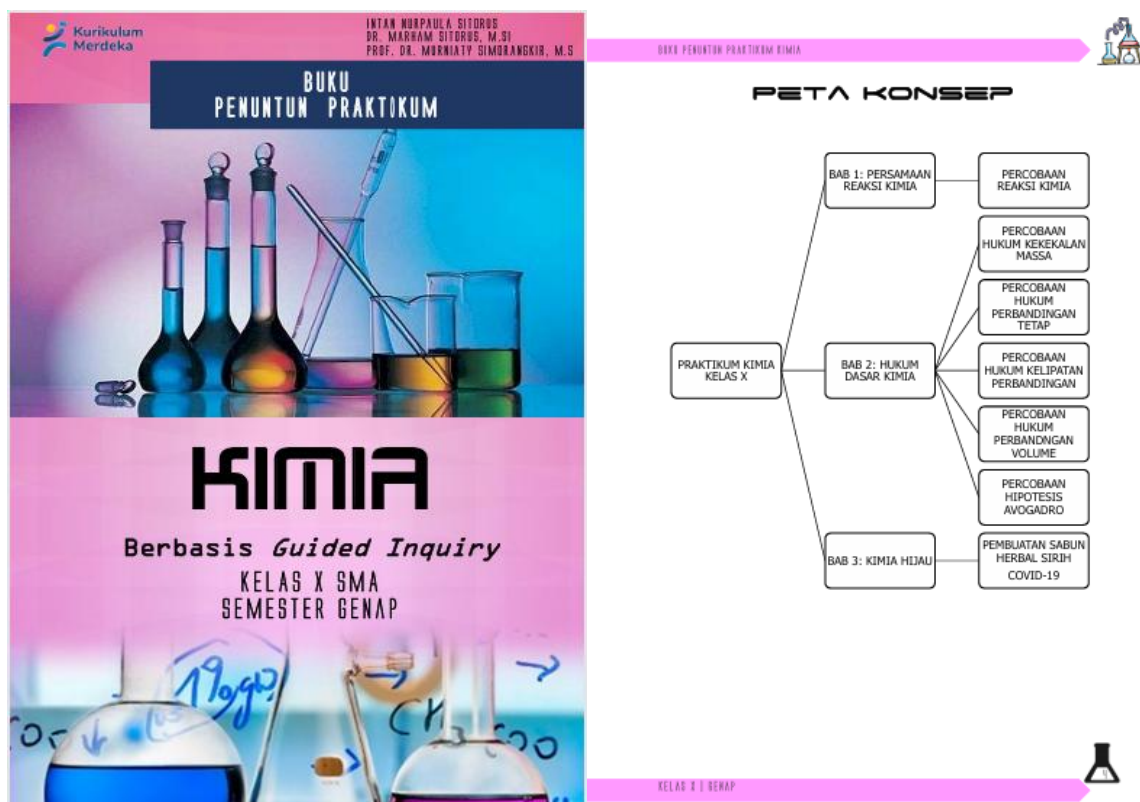
The chemistry laboratory manual's design considered feasibility in terms of presentation and graphical aspects to ensure its suitability for classroom implementation. The manual was developed using *Canva*, resulting in visually appealing and pedagogically sound content. Graphically, it employed an A4 layout with a dominant combination of light red and white tones. This color scheme was selected to create a bright and engaging appearance, differentiating the manual from conventional worksheets that tend to appear monotonous.

The structure of the chemistry laboratory manual was systematically organized into several sections, including the cover page, title page, preface, table of contents, introduction, user instructions, laboratory rules, introduction to laboratory tools and materials, chemical hazard symbols, theoretical review, guided inquiry-based experimental procedures, video learning practicum worksheets, practice questions, and glossary. Through this structure, the manual not only presents experimental procedures but also supports students in developing conceptual understanding, laboratory skills, safety literacy, and critical thinking.

Based on this design, the design of the cover along with several sections of the chemistry laboratory manual is presented in Figure 2.

Figure 2.










Initial Design Layout of the Guided Inquiry-Based Chemistry Laboratory Manual



3.3. Development

The development phase produced a Guided Inquiry–Based Chemistry Laboratory Manual for Tenth-Grade Students, which was complemented by learning videos. The manual consists of three chapters, namely: (1) *Chemical Reactions*, (2) *Basic Laws of Chemistry*, and (3) *Green Chemistry*. In the preliminary section of the manual, an introduction to laboratory tools and chemical materials is provided to familiarize students with the laboratory environment before conducting experiments. This section aims to build students' foundational knowledge about common laboratory apparatus and chemical reagents, particularly for those who are new to laboratory work. The description of laboratory tools and materials is shown in Figure 3.

Figure 3
Description of Laboratory Tools and Materials

Buku Perantara Praktikum Kimia			Buku Perantara Praktikum Kimia		
Pendayagunaan Peralatan Laboratorium			BAHAN-BAHAN KIMIA YANG SERING DIGUNAKAN DALAM PRAKTIKUM		
No	Nama alat	Fungsi alat	Gambar	Nama Bahan	Penjelasan
1	 Tabung Reaksi	Tempat mereaksikan dua larutan/bahan kimia atau lebih, serta sebagai tempat mengembangbiakan mikroba dalam media cair.		Asam sulfat H_2SO_4	Merupakan asam mineral yang kuat. Zat ini larut dalam air pada semua perbandingan. Mempunyai banyak kegunaan dan merupakan salah satu produk utama industri kimia. Massa molar: 98,079 g/mol. Kepadatan: 1,84 g/cm ³ . Rantai molekul: H_2SO_4 Viskositas: 26,7 cP (20 °C).
2	 Gelas Kimia	Tempat untuk melarutkan, menyimpan, mereaksikan zat yang tidak butuh ketelitian tinggi karena kurang presisi takarannya.		Asam nitrat HNO_3	Merupakan cairan korosif yang tak berwarna, dan merupakan asam benzena yang dapat menyebarkan luka bakar. Massa molar: 63,01 g/mol. Kepadatan: 1,51 g/cm ³ . Viskositas: 1,092 mPa.s (0 °C); 0,746 mPa.s (25 °C); 0,617 mPa.s (40 °C).
3	 Kaca Arloji	Digunakan untuk menimbang bahan kimia atau larutan. Melakukan pengeringan terhadap suatu bahan atau larutan kental. Melakukan penguapan zat cair dalam jumlah yang kecil atau sedikit.		Natrium hidroksida $NaOH$	Dikenal sebagai soda kaustik, soda api, atau sodium hidroksida, adalah sejenis basa logam kaustik. Terbentuk dari oksida basa dilarutkan dalam air. Massa molar: 39,997 g/mol. Kelebasan (sKh): -2,43. NFPA 704: 0 3 1.
4	 Labu Erlenmeyer	Berfungsi untuk menampung dan mengukur bahan kimia. Sering digunakan untuk proses titrasi untuk menampung larutan.		Kalium hidroksida KOH	Adalah suatu senyawa anorganik, umumnya disebut sebagai potasium kaustik. Bersama dengan natrium hidroksida, padatan tak berwarna ini adalah suatu basa kuat. Massa molar: 56,1056 g/mol. Kepadatan: 2,12 g/cm ³ . Titik didih: 1.327°C. Larut dalam: Air, Alkoholl, Glycerol.
5	 Lumpang dan Alu	Digunakan untuk menggerus dan menghaluskan zat kimia berbentuk padat.			

The chemistry laboratory manual was designed based on the syntax of the Guided Inquiry learning model, which consists of five main stages: problem orientation, hypothesis formulation, experimentation and data collection, hypothesis testing, and conclusion formulation. At the problem orientation stage, each practicum activity begins with a contextual phenomenon related to the experimental topic. This stage is complemented by an introductory practicum video that can be accessed through a QR code provided on the manual's pages.

The inclusion of instructional videos as an introduction to the practicum further enhances the effectiveness of the chemistry laboratory manual, as it helps students visualize abstract concepts before conducting hands-on experiments. The videos serve as a bridge to visualize theoretical ideas, demonstrate experimental procedures, and foster students' learning motivation prior to the practicum. This aligns with the findings of (Zahra et al., 2023), which showed that the use of instructional videos in guided inquiry-based laboratory learning significantly improved students' science process skills, particularly in the aspects of observation, analysis, and drawing conclusions. The interface of the learning video is displayed in Figure 4

Figure 4
The Interface of The Learning Video



Subsequently, the Guided Inquiry–based practicum activities are systematically organized in each chapter. Students are guided to formulate hypotheses, conduct experiments, collect and analyze data, and draw conclusions independently under teacher supervision. The syntax of the guided inquiry model in chemistry laboratory experiments is shown in Figure 5.

Figure 5
The Syntax Of The Guided Inquiry Model In Chemistry Laboratory Experiments

Buku Perantara Praktikum Kimia

II. Menyusun Hipotesis:

Dengan memperhatikan orientasi masalah dan tujuan diatas, marilah kita merumuskan hipotesis yang relevan!

.....

.....

.....

.....

III. Melakukan Eksperimen dan Pengumpulan Data:

Alat dan Bahan

- Alat

No	Nama Alat	Ukuran	Jumlah
1	Neraca digital		1 buah
2	Spatula		1 buah
3	Labu erlenmeyer	100 mL	1 buah
4	Balon karet		2 buah
5	Gelas ukur	10 mL	1 buah
6	Kertas timbangan		2 lembar

- Bahan

No	Nama Bahan	Jumlah
1	Bubuk soda kue (NaHCO_3)	1 gram
2	Asam cuka (CH_3COOH)	4 mL
3	Aquadest (H_2O)	± 50 mL

Prosedur:

1. Timbang 1 gram soda kue (NaHCO_3) menggunakan neraca digital kemudian masukkan ke dalam balon.
2. Ukur 4 ml asam cuka (CH_3COOH) menggunakan gelas ukur kemudian masukkan kedalam labu erlenmeyer.
3. Pasang balon pada bagian atas labu erlenmeyer dengan benar agar tidak ada gas didalam labu erlenmeyer yang keluar.

Kelas X | Genap

Buku Perantara Praktikum Kimia

4. Timbang massa labu erlenmeyer beserta isinya kemudian catat hasilnya.
5. Tumpahkan soda kue kedalam cuka dengan mengangkat balon ke atas dengan cepat dan amati proses yang terjadi.
6. Setelah soda kue dan cuka habis bereaksi, timbang kembali massa labu erlenmeyer beserta isinya.
7. Kemudian ulangi percobaan dengan mereaksikan langsung soda kue dengan asam cuka menggunakan labu erlenmeyer terbuka. lalu catat hasil pengamatan pada tabel hasil pengamatan.

Hasil Pengamatan:

No	Percobaan	Massa Sebelum Reaksi (gram)	Massa Sesudah Reaksi (gram)
1	Soda kue + asam cuka (wadah tertutup)		
2	Soda kue + asam cuka (wadah terbuka)		

IV. Menguji Hipotesis:

Diskusi:

1. Pada saat larutan asam cuka dan soda kue dicampurkan, ciri-ciri reaksi apa yang muncul pada reaksi ini?
Jawab:.....
2. Bagaimana massa erlenmeyer tertutup beserta isinya sebelum dan sesudah reaksi? Berapa selisih massa sebelum dan sesudah reaksi dalam keadaan tertutup?
Jawab:.....
3. Labu, bagaimana massa erlenmeyer terbuka beserta isinya sebelum dan sesudah reaksi? Berapa selisih massa sebelum dan sesudah reaksi dalam keadaan terbuka?
Jawab:.....

Kelas X | Genap

Buku Perantara Praktikum Kimia

4. Mengapa massa erlenmeyer terbuka beserta isinya pada sesudah reaksi berkurang?
Jawab:.....

V. Merumuskan Kesimpulan:

Rumuskanlah kesimpulan yang kamu dapat setelah melakukan eksperimen diatas!

.....

.....

.....

.....

At the end of each chapter, the chemistry laboratory manual provides practice questions and reflective exercises designed to evaluate students' conceptual understanding of the topics explored through laboratory activities. These exercises also serve as tools for self-assessment and conceptual reinforcement, helping students connect experimental results with the theoretical concepts learned. In addition, the end of the chemistry laboratory manual includes a science process skills assessment instrument aimed at measuring students' abilities during chemistry laboratory activities. The practice questions and the science process skills instrument are shown in Figure 6.

Figure 6
The Practice Questions And The Science Process Skills Instrument

Buku Penuntun Praktikum Kimia

SOAL LATIHAN

1. Tujuan dari percobaan mencampurkan larutan $Pb(NO_3)_2$ 0,5 M dengan NH_4Cl 0,5 M dalam berbagai perbandingan adalah untuk ...
 A. Menentukan laju reaksi pembentukan $PbCl_2$
 B. Mengamati pengaruh konsentrasi terhadap kelarutan $PbCl_2$
 C. Membandingkan warna larutan $Pb(NO_3)_2$ dan NH_4Cl
 D. Membuktikan bahwa semua larutan menghasilkan gas
 E. Mengukur perubahan suhu saat reaksi berlangsung
2. Ketika gelas kaca transparan ditutupan pada lilin yang menyala, air dalam piring naik ke dalam gelas. Hal ini terjadi karena ...
 A. Air mendidih sehingga volumenya bertambah
 B. Oksigen dalam gelas habis terbakar sehingga tekanan udara menurun
 C. Lilin menghasilkan gas CO_2 yang larut dalam air
 D. Gelas menjadi panas sehingga memuai dan menyedot air
 E. Lilin menguapkan air dari piring ke dalam gelas
3. Pada praktikum dua botol yang dihubungkan dengan selang, salah satu botol diberi volume air lebih banyak dari yang lain. Tujuan pemberian perbedaan volume ini adalah untuk ...
 A. Menghasilkan warna air yang lebih pekat
 B. Menunjukkan adanya perbedaan tekanan hidrostatik
 C. Membuat air tidak bercampur dalam selang
 D. Memastikan botol B tetap kosong
 E. Menghilangkan udara dalam selang
4. Gas yang dihasilkan dari reaksi antara soda kue ($NaHCO_3$) dengan asam cuka (CH_3COOH) adalah ...
 A. Oksigen (O_2)
 B. Hidrogen (H_2)
 C. Karbon dioksida (CO_2)
 D. Amonia (NH_3)
 E. Nitrogen (N_2)
5. Pada setiap praktikum, hasil pengamatan harus dicatat dalam tabel. Fungsi utama tabel pengamatan adalah ...
 A. Agar percobaan lebih cepat selesai
 B. Menyimpan data tanpa perlu analisis lebih lanjut
 C. Membantu mengorganisasi data agar mudah dibaca dan dianalisis
 D. Sebagai bukti praktikum meskipun tidak ada hasil yang muncul

Kelas X | Genap

Buku Penuntun Praktikum Kimia

**INSTRUMEN PENELIATAN
KETERAMPILAN PROSES SAINS**

Detunjuk Pengisian:

1. Tulislah terlebih dahulu identitas Anda pada tempat yang sudah disediakan;
2. Bacalah dengan teliti setiap pernyataan di dalam angket ini sebelum memilih menjawab;
3. Isilah sesuai keterampilan siswa dalam praktikum.
4. Isilah dengan tanda check (✓) pada pilihan yang telah disediakan sesuai dengan jawaban Anda.

Skala Penilaian:
 Skor 4 = Sangat Baik
 Skor 3 = Baik
 Skor 2 = Cukup Baik
 Skor 1 = Tidak Baik

Penilai : _____
 Kelompok : _____
 Nama Anggota : 1. _____
 2. _____
 3. _____
 4. _____
 5. _____

No.	Indikator	Aspek yang Dinilai				
			1	2	3	4
1	Mengamati	1. Siswa mengamati perubahan fisik atau kimia selama percobaan				
		2. Siswa mencatat detail yang relevan dalam eksperimen				
		3. Kemampuan menggunakan alat dan instrumen yang sesuai untuk pengamatan				
2	Membandingkan	4. Kemampuan membandingkan hasil pengamatan dengan teori yang ada atau hasil dari percobaan yang berbeda.				
		5. Kemampuan menyusun dan menyimpulkan perbandingan hasil secara sistematis dan logis.				

Kelas X | Genap

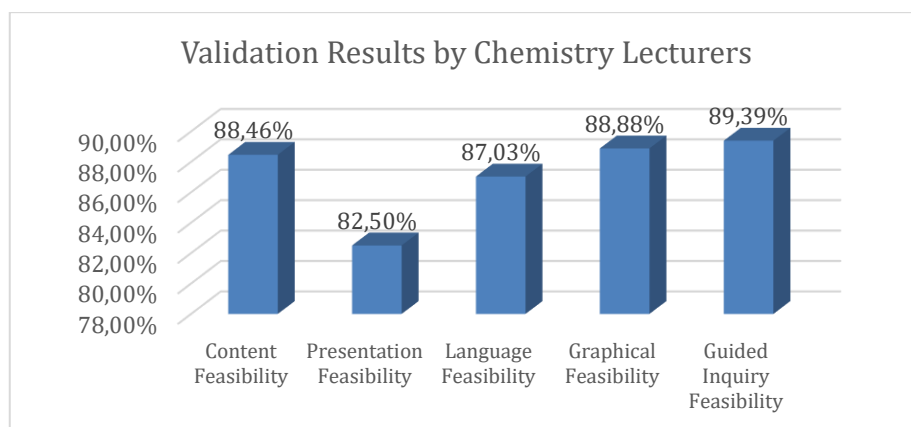
Buku Penuntun Praktikum Kimia

3	Mengklasifikasi	6. Kemampuan mengajukan pertanyaan yang relevan terhadap fenomena atau hasil percobaan yang tidak jelas atau ambigu.				
		7. Kemampuan mencari penjelasan atau solusi untuk pertanyaan atau masalah yang muncul dalam percobaan dengan cara yang tepat.				
4	Mengukur	8. Kemampuan melakukan pengukuran dengan tepat menggunakan alat ukur yang sesuai.				
		9. Kemampuan menggunakan alat ukur dengan benar dan sesuai dengan prosedur yang ada.				
5	Mengkomunikasikan	10. Kemampuan mengkomunikasikan hasil pengamatan dengan jelas dan sistematis				
		11. Kemampuan menyajikan data hasil pengamatan dalam bentuk tabel atau grafik dengan benar dan mudah dipahami.				

Kelas X | Genap

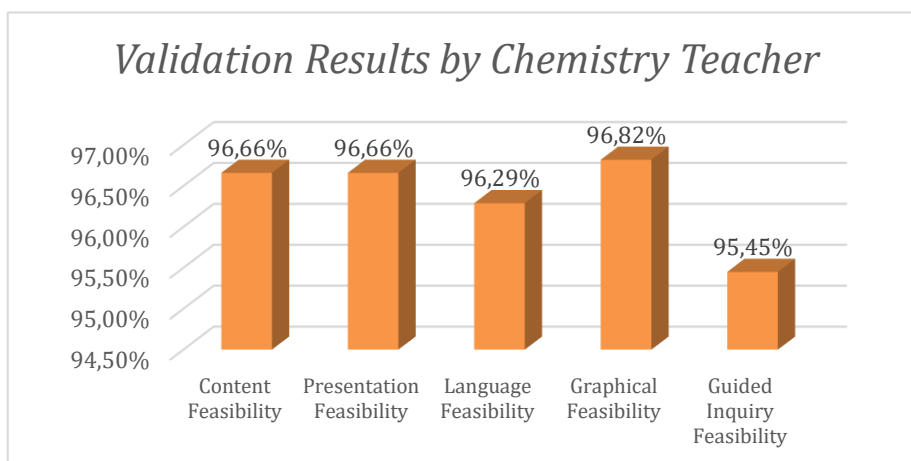
Chemistry Laboratory Manual was designed and developed to be subsequently validated by three chemistry lecturers and three chemistry teachers. A feasibility test was conducted to determine the percentage of the chemistry laboratory manual through a validity assessment. The chemistry guided book validity was measured using an instrument in the form of a questionnaire sheet designed based on the modified BSNP reference. The average percentage results from expert lecturer validators are presented in Figure 7.

Figure 7.
Graph of the Validation Results by Chemistry Lecturers



Based on Figure 7, the content feasibility aspect obtained a percentage of 88.46%, the presentation feasibility aspect reached 82.5%, the language feasibility aspect achieved 87.03%, the graphical feasibility aspect obtained 88.88%, and the guided inquiry feasibility aspect scored 89.39%. All of these results fall into the feasible category. Overall, the findings indicate that the developed chemistry practicum guidebook is considered feasible and appropriate to be used as a learning resource. Furthermore, the results of the validation conducted by chemistry teachers are presented in Figure 8.

Figure 8.
Graph of Validation Results by Chemistry Teacher



Based on Figure 8, the content feasibility aspect obtained a percentage of 96.66%, the presentation feasibility aspect reached 96.66%, the language feasibility aspect achieved 96.29%, the graphical feasibility aspect obtained 96.82%, and the guided inquiry feasibility aspect scored 95.45%. All of these results fall into the fairly feasible category. All of these results fall into the feasible category.

Based on the validation results, the developed chemistry laboratory manual was declared feasible in all aspects, including content, presentation, language, graphics, and guided inquiry. This finding is in line with previous studies. (Rahayu & Sardiana Sari, 2023) found that a guided inquiry-based practicum guide was valid, practical, and effective in improving students' science process skills and critical thinking, with a practicality score of 90.5% and an effectiveness of 88.54%. Similarly, (Azizah et al., 2024) reported that a biology practicum guidebook based on guided inquiry achieved very high expert validation results, ranging from 84.43% to 97.5%, with an overall score of 91%, placing it in the highly valid and practical category. In addition, (Risqi & Wahyuni, 2022) reported that the guided inquiry-based practicum worksheet they developed obtained validation scores of 91% for content, 87% for presentation, and 91% for language aspects, which were categorized as very valid. The practicality aspect also showed positive results, with an average student response of 73% in the high category. These findings further confirm the practicality and effectiveness of guided inquiry-based instructional materials in supporting active and meaningful learning.

Supporting this, (Akmalia et al., 2025) developed a chemistry practicum kit using the guided inquiry model and obtained an average feasibility score of 3.54, which is classified as very feasible. Furthermore, (Adaayah & Aznam, 2024), through a systematic literature review of 11 articles, highlighted that guided inquiry consistently improves metacognition, conceptual understanding, science process skills, critical thinking skills, learning outcomes, and creativity. In addition, (Pramesti et al., 2025) demonstrated that an inquiry-based e-module for ecosystem topics in high school yielded high validation results (86%–94.54%), was very practical according to both teachers (93.75%) and students (95.4%), and effectively improved students' critical thinking skills with an average score of 77.25% (high category).

Thus, the validation of the laboratory manual developed in this study reinforces empirical evidence that guided inquiry-based teaching materials are feasible to be used in improving the quality of chemistry learning, particularly in facilitating students' understanding of abstract concepts through hands-on experience.

4. Conclusion

The researcher successfully developed a Chemistry Laboratory Manual based on the guided inquiry model. Validation by lecturers showed scores of 88.46% for content, 82.5% for presentation, 87.03% for language, 88.88% for graphics, and 89.39% for guided inquiry. Teacher validation showed 96.66% for content, 96.66% for presentation, 96.29% for language, 96.82% for graphics, and 95.54% for guided inquiry, indicating that the developed product is highly feasible for use in chemistry learning.

The use of this practicum guidebook is expected to facilitate meaningful learning by actively engaging students in hypothesis formulation, experimentation, and drawing conclusions, thereby helping them to better understand abstract chemistry concepts. For future research, it is recommended that the study proceed to the implementation and evaluation stages in classroom practice, in order to further examine the effectiveness of the guidebook in

improving student's learning motivation, conceptual understanding, and scientific process skills.

5. References

- 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>
- Akmalia, N., Silaban, R., & Purmaya Sari, R. (2025). Pengaruh Pengembangan Penuntun Dan Kit Praktikum Kimia Terintegrasi Model Inkuiri Dalam Meningkatkan Hasil Belajar Peserta Didik. *Lantanida Journal*, 13(15), 35–50. <https://doi.org/10.22373/lj.v13i1.29193>
- Ananda, R. M., Sitorus, M., & Silaban, R. (2021). Development of Integrated Natural Science Practicum Guide Integrated Inquiry Approach to Improve Student Learning Outcomes. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, 4(1), 330–336. <https://doi.org/10.33258/birle.v4i1.1606>
- Arikunto, S. (2018). *Dasar-Dasar Evaluasi Pendidikan* (R. Damayanti, Ed.; 3rd ed.). Bumi Aksara.
- Azizah, N., Wardani, I. B., & Fauzi, I. S. (2024). Journal of Science and Technological Education The Development of Biology Practicum Guidebook using Scientific Approach Based on Guided Inquiry for Senior High School Students. *Journal of Science and Technological Education*, 3(1), 1–12. www.meta.amiin.or.id
- BNSP. (2015). Lembar Validasi. In *Jurnal Pendidikan Matematika*.
- Depin, Nurwahid, H., Sulla, F. Y., & Barella, Y. (2024). Inquiry Learning: Pengertian, Sintaks Dan Contoh Implementasi Di Kelas. *Indonesian Journal on Education and Learning*, 1(2), 39–43.
- Hartati, S., & Siregar, S. A. (2024). Pemanfaatan Video Pembelajaran Dalam Pembelajaran Kimia Untuk Meningkatkan Pemahaman Konsep Kimia. *Journal of Chemistry Education and Integration*, 3(2), 111. <https://doi.org/10.24014/jcei.v3i2.32351>
- Haryati, Setiadi, D., & Ismawati. (2021). Hubungan Pelaksanaan Praktikum Terhadap Hasil Belajar Siswa Pada Materi Fungi Di Sma Swasta Persiapan Stabat. *Jurnal Sintaksis: Pendidikan Guru Sekolah Dasar, IPA, IPS Dan Bahasa Inggris*, 3(1), 65–71. <http://jurnal.stkipalmaksum.ac.id/>
- Malau, S. M., Motlan, Sirait, M., & Lubis, R. H. (2019). The Effect of Guided Inquiry Learning Model and Creativity on Students Science Process Skills. *Journal of Transformative Education and Educational Leadership*, 1, 29–37. <https://www.researchgate.net/publication/342957532>
- Mujahidin. (2021). Pengaruh Pelaksanaan Praktikum Terhadap Keterampilan Generik Sains Siswa. *Jurnal Binomial Volume*, 4, 140–153.
- Nufus, V. F., & Sakti, N. C. (2021). Pengembangan Lembar Kerja Peserta Didik Elektronik Berbasis Flipbook Pada Mata Pelajaran Ekonomi Kelas XI. *Jurnal PTK Dan Pendidikan*, 7(1). <https://doi.org/10.18592/ptk.v7i1.4633>
- Pramesti, A. A., Sofiyana, M. S., & Malahayati, E. N. (2025). Pengembangan E-Modul Berbasis Inkuiri Terbimbing Guna Meningkatkan Keterampilan Berpikir Kritis Siswa dalam Pembelajaran Ekosistem di Tingkat SMA. *Jurnal Motivasi Pendidikan Dan Bahasa*, 3(1), 147–165. <https://doi.org/10.59581/jmpb-widyakarya.v3i1.4805>

- Pranoto, N. R., & Sudiyanto. (2024). Pengaruh Model Pembelajaran Inkuiri Terbimbing Berbantu Quizizz Terhadap Kemampuan Berpikir Kritis Peserta Didik. *Jurnal Akuntan Publik*, 2(2), 128–145. <https://doi.org/10.59581/jap-widyakarya.v2i1.3617>
- Prasetyo, M. B., & Rosy, B. (2021). Model Pembelajaran Inkuiri Sebagai Strategi Mengembangkan Kemampuan Berpikir Kritis Siswa. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, 9(1), 109–120. <https://doi.org/https://doi.org/10.26740/jpap.v9n1.p109-120>
- Putra, Z. A., & Rahayu, P. (2022). Pengembangan Video Pembelajaran Interaktif dalam Pembelajaran Kimia Berbasis Proyek. *Jurnal Inovasi Pendidikan Sains*, 10(1), 99–110.
- Putri, A. N. (2021). The Development of an Inquiry-Based Laboratory Manual for Student of Biology Education. *Journal of Educational Research and Evaluation*, 5, 105–111. <https://ejournal.undiksha.ac.id/index.php/JERE>
- Rahayu, A., & Sardiana Sari, R. (2023). Guided Inquiry-Based Basic Chemistry Practicum Guidelines and Its Impact on Students' Science Process Skills and Critical Thinking Skills. *Jurnal Pendidikan Kimia Indonesia*, 7(1), 1–9. <https://doi.org/10.23887/jpk.v7i1>
- Rahmawati, S. (2019). Buku Petunjuk Praktikum Kimia Berbasis Green Chemistry Untuk SMA/MA Kelas XI. *Journal of Tropical Chemistry Research and Education*, 1(1), 8–14. <https://doi.org/10.37079/jtcre.v1i1.14>
- Rayanto, Y. H., & Sugianti. (2020). *Penelitian Pengembangan Model Addie Dan R2d2: Teori & Praktek*. Lembaga Academic & Research Institute.
- Risqi, S. W., & Wahyuni, T. S. (2022). Pengembangan Lembar Kerja Praktikum Berbasis Guided Inquiry Bervisi Science, Environmental, Technology And Society (Sets) Pada Materi Larutan Elektrolit Dan Nonelektrolit. *UNESA Journal of Chemical Education*, 11(1), 78–86.
- Silvia, V. (2020). *Statistika Deskriptif* (M. Kika, Ed.; 1st ed.). Penerbit Andi.
- Siregar, A. D., & Harahap, L. K. (2020). Pengembangan E-Modul Berbasis Project Based Learning Terintegrasi Media Komputasi Hyperchem Pada Materi Bentuk Molekul. *Jurnal Penelitian Pendidikan Sains*, 10(01), 1925–1931. <https://doi.org/DOI:10.26740/jpps.v10n1.p1925-1931>
- Talib, C. A., Baharuddin, N. S., Ali, M., Thoe, N. K., Zawadzki, R., & Aliyu, H. (2017). Video-Based Learning In Chemistry Education: Exemplars, Issues And Challenges. *Mathematics And Technology Learning*, 12, 35–51. [Http://Www.Recsam.Edu.My](http://Www.Recsam.Edu.My)
- Zahra, I. R., Chandra, D. T., & Rusdiana, D. (2023). Interactive video's urgency on guided inquiry laboratory to improve integrated science process skills. *Jurnal Penelitian Ilmu Pendidikan*, 16(1), 72–83. <https://doi.org/10.21831/jpip.vxxxx.x00000>