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Development of a Practical Guide on Chemical Reactions to Facilitate Science Process Skills Based on the Problem Based Learning (PBL) Model for Class X at SMA Negeri 1 Seluma

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Abstrak

Penelitian ini bertujuan mengembangkan panduan praktikum materi reaksi kimia berbasis Problem Based Learning (PBL) untuk memfasilitasi keterampilan proses sains peserta didik kelas X di SMA Negeri 1 Seluma. Metode yang digunakan adalah Research and Development (R&D) dengan model ADDIE yang meliputi tahap *Analysis*, *Design*, *Development*, *Implementation*, dan *Evaluation*. Pengembangan dibatasi pada uji kevalidan dan kepraktisan produk. Hasil analisis kebutuhan menunjukkan bahwa praktikum yang dilaksanakan masih bersifat demonstratif dan belum secara sistematis melatih keterampilan proses sains. Berdasarkan temuan tersebut, dikembangkan panduan praktikum yang mengintegrasikan sintaks PBL dengan indikator keterampilan proses sains. Hasil validasi oleh ahli materi, media, dan bahasa menunjukkan rata-rata persentase kevalidan sebesar 97,3 % dengan kategori sangat valid (materi 98,4%, media 95,2%, bahasa 98,4%. Uji kepraktisan melalui respon guru dan peserta didik memperoleh rata-rata persentase sebesar 89% dengan kategori sangat praktis. Dengan demikian, panduan praktikum berbasis PBL yang dikembangkan dinyatakan valid dan praktis serta layak digunakan untuk mendukung pengembangan keterampilan proses sains dalam pembelajaran kimia di SMA.
Kata kunci: Pengembangan, Panduan, Praktikum, Pbl, Keterampilan Proses Sains, Addie.

Abstract

This study aims to develop a practical guide for chemical reactions material based on Problem Based Learning (PBL) to facilitate the science process skills of grade X students at SMA Negeri 1 Seluma. The method used is Research and Development (R&D) with the ADDIE model which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. Development is limited to the product's validity and practicality test. The results of the needs analysis indicate that the practicum carried out is still demonstrative and has not systematically trained science process skills. Based on these findings, a practical guide was developed that integrates PBL syntax with science process skill indicators. The validation results by material, media, and language experts showed an average validity percentage of 97.3% with a very valid category (material 98.4%, media 95.2%, language 98.4%). The practicality test through teacher and student responses obtained an average percentage of 89% with a very practical category. Thus, the developed PBL-based practical guide is declared valid and practical and is suitable for use to support the development of science process skills in chemistry learning in high school..
Keywords: Pengembangan, Panduan, Praktikum, Pbl, Keterampilan Proses Sains, Addie.

Introduction

The 21st century is marked by the acceleration of information flow, the digitalization of education, and economic globalization that requires individuals to have the ability to think critically, adaptively, creatively, and scientifically. In the context of education, the 21st century learning orientation not only emphasizes the mastery of conceptual knowledge, but also the development of scientific thinking skills and problem-solving based on science process skills (KPS) (*EduPhysics: Journal of Physics Education Volume 9 Number 3 , December 2024*, 2024). Science process skills (KPS) are a set of abilities that allow learners to think and act like scientists, including the ability to observe, classify, measure, interpret data, formulate hypotheses, design experiments, predict results, and communicate findings scientifically (Dimyati & Mudjiono, 2023; Journal of Physics Coils, 2024). Through mastery of PPP, students not only acquire concepts by memorization, but also understand the process of forming knowledge scientifically. Thus, science process skills (KPS) are an important foundation in building analytical, critical, creative, and reflective thinking skills in students (Prismasains, 2023; Purnama, 2024).

In chemistry learning, science process skills have a very important position. Chemistry requires not only an understanding of theoretical concepts about the structure, properties, and changes of substances, but also skills in conducting observations, experiments, and data analysis. Topics such as redox reactions, acid-base indicators, and reaction rates are concrete examples where integration between conceptual and experimental learning is essential for learners to build a deep understanding. Therefore, chemistry learning ideally combines conceptual and practicum aspects in a balanced manner, so that it can develop students' scientific thinking skills and laboratory skills (Hidayatullah *et al*., 2024; Jegstad, 2024.

The results of various studies show that the implementation of chemistry learning in secondary schools, including in Indonesia, still faces a number of obstacles. The low frequency of practicum activities, practicum guidelines that are procedural-descriptive, and PPP assessments that are not explicitly carried out are the main obstacles to the development of students' scientific skills (Suprapto & Mulyani, 2021). In addition, there is a limited time allocation for practicum (Pratiwi, Yuliyanti & Hanafi, 2023). Minimal laboratory facilities (Arvianti, Afifi & Keliata, 2024). Lack of contextual or specific practicum guidance (Arini & Darmayanti, 2023; Kholila & Susanti, 2023). As a result, many students are only passive observers in laboratory activities and have not been actively involved in the scientific process that should be the core of science learning.

The findings of a preliminary study conducted at SMA Negeri 1 Seluma in October 2025 confirm this condition. Based on the results of observations, interviews from 2 chemistry teachers, and student questionnaires, it is known that chemistry practicum activities in class X are only carried out on average twice, ideally 3-4 practicum times out of 6-8 meetings on chemical reaction material. The practicum is demonstrative, where the teacher demonstrates the experiment while the students only observe without actively participating in designing or analyzing the experiment. Teachers acknowledge the limitations of laboratory materials and tools, as well as the lack of systematic and contextual practicum guidelines. This condition encourages teachers to choose the demonstration method as the safest and most efficient alternative, so that students only act as observers without being actively involved in the design, implementation, or analysis of experiments. As a result, even though students show enthusiasm for practicum activities, they still experience confusion in understanding the purpose of the experiment, scientific steps, and how to analyze data and draw conclusions, which ultimately causes students' science process skills to not develop optimally.

This gap between actual and ideal conditions shows that the implementation of chemistry practicum in schools has not fully supported the development of PPP. Ideally, each major topic in chemistry learning needs to be equipped with practicum activities that allow learners to identify problems, design experiments, process data, and draw conclusions scientifically. In addition, teachers need structured practicum guidance so that laboratory activities are not only procedural, but also encourage exploration, collaboration, and scientific reflection.

This condition shows that there is a significant gap between the implementation of chemistry learning in the field and the demands of the Independent Curriculum and the 21st century educational paradigm. The modern curriculum emphasizes the importance of developing high-level thinking skills, collaboration, and scientific abilities that can only be obtained through experiential learning activities and inquiry. In an effort to answer these problems, the development of Problem *Based Learning* (PBL) based practicum guidelines is a relevant and potential strategy. PBL places learners as active subjects in learning through authentic problem-solving that requires scientific inquiry, collaboration, and deep reflection (Yunia A., Shyiba, 2024). Through this approach, students not only carry out laboratory procedures, but also play the role of researchers who find concepts through an investigative process. PBL also helps students develop high-level thinking skills, such as critical, creative, and metacognitive thinking, which are the main demands of 21st century learning (Sucipto, 2017; Erayani & Jampel, 2023).

The PBL model is very much in line with the constructivist paradigm, because according to Nurhuda *et al*. (2023), PBL is one of the learning models based on constructivism, students actively build knowledge through exploration and interaction, this is also in line with (Audina *et al*., 2025) conducting a literature review that shows that the application of PBL in chemistry education has succeeded in improving students' science process skills with a success percentage of 75.8%–90%, as well as increasing scientific attitudes and student participation during learning. Several empirical studies show that the use of *Problem-Based Learning (PBL)-based practicum guidelines* in chemistry learning acts as a clear, contextual, and measurable guide, and is able to encourage students to actively explore chemical phenomena through laboratory practice, evaluating experimental results, and reflection. For example, the development of PBL practicum modules has been proven to be validated and accepted by both students and teachers (Jehadut *et al*., 2023), while the application of PBL in chemistry practicum has been found to improve students' science process skills in observation, analysis, and scientific problem solving (Hasanah & Utami, 2017; Sembiring & Sutiani, 2022; Zahrah *et al*., 2025).

Based on the results of development research conducted by Hamidi (2024), the use of Problem-Based Learning-based chemistry practicum guidelines shows a significant increase in the science process skills of high school students, especially in the aspects of formulating hypotheses, controlling variables, analyzing data, and drawing conclusions. These findings indicate that a systematically designed practicum guide not only guides experimental procedures, but also effectively trains learners' critical thinking and problem-solving skills.

The results of the literature review show that the application *of Problem Based Learning* (PBL) is very effective in improving students' *science process skills* and science literacy, as well as collaborative skills in the context of science learning (Duda, Susilo, & Newcombe, 2023). This guide facilitates the integration between theory and practice by providing step-by-step guides, student worksheets (LKS), reflection sheets, and PPP assessment rubrics. Thus, teachers gain practical guidance that can help them design meaningful laboratory activities, while learners can learn independently and collaboratively.

Based on this description, the development of a PBL-based chemistry practicum guide is a strategic step to answer the gap between actual learning practices and the demands of 21st century learning. This guide is expected to facilitate the development of students' science process skills, support teachers in the effective implementation of practicums, and strengthen integration between chemistry theory and practice.

Research Methods

This research uses the Research and Development (R&D) method with the ADDIE model which includes five stages, namely Analysis, Design, Development, Implementation, and Evaluation. This method is used to develop a learning product in the form of a valid and practical chemistry practicum guide based on Problem Based Learning (PBL) on chemical reaction materials at the high school level. The selection of the ADDIE model is based on its systematic and structured characteristics so that it is able to produce learning products that are in accordance with the needs of students and learning objectives. The research was carried out in the even semester of the 2025/2026 school year at SMA Negeri 1 Seluma, Seluma Regency, Bengkulu Province. The subjects in this study include 36 students of class X as product test subjects, two chemistry teachers as collaborators in the learning implementation process, and three expert validators consisting of material experts, media experts, and linguists to assess the feasibility of the developed product.

The development procedure in this study follows the stages of the ADDIE model. In the analysis stage, the researcher identifies learning needs, student characteristics, curriculum analysis, and the condition of laboratory facilities and infrastructure available in schools. The design stage is carried out by designing a practicum guide structure that is adjusted to the Problem Based Learning (PBL) syntax, as well as compiling research instruments used in the data collection process. Furthermore, in the development stage, the researcher prepares a product draft, validates it by experts, and revises the product based on the validator's suggestions and input.

The implementation stage is carried out through limited trials and field tests to determine the implementation of the use of practicum guidelines and the response of students and teachers to the developed products. After that, the evaluation stage is carried out by analyzing the results of the validation and the level of practicality of the product as the basis for refining the final product so that it is suitable for use in chemistry learning in high school. Research data was obtained through observation, interview, documentation, and questionnaire dissemination techniques using a Likert scale of 1–5 to assess the validity and practicality of the product. Data analysis was carried out quantitatively and qualitatively. Validity and practicality data are calculated in the form of percentages, then categorized into very valid/practical, valid/practical, moderately valid/practical, to invalid/practical. The results of the analysis were used as the basis for revising and determining the feasibility of the Problem Based Learning (PBL)-based chemistry practicum guide developed.

Results and discussion

A. Research Results

This study aims to develop a chemistry practicum guide based on Problem Based Learning (PBL) on chemistry reaction materials in class X of SMA Negeri 1 Seluma and determine the level of validity and practicality. The development process refers to the ADDIE model which consists of five stages, namely *Analysis*, *Design*, *Development*, *Implementation*, and *Evaluation*.

1. Results of *the Analysis* Stage

a. Needs Analysis

Based on the results of initial observations and interviews with two chemistry teachers at SMA Negeri 1 Seluma, a number of findings were obtained that show the need for more optimal practicum learning development. The frequency of practicum implementation on chemical reaction materials is still relatively limited, which is only carried out twice out of a total of six to eight meetings. In addition, the implementation of practicum tends to be demonstrative, where the teacher is more dominant in showing experimental steps, so that students are not fully involved in the scientific investigation process. The practicum guide used is still procedural-descriptive, emphasizing more on the work stages without providing enough space for students to formulate problems, develop hypotheses, or analyze data independently.

This condition shows that the assessment of science process skills (PPP) has not been carried out optimally. The assessment instruments used have not been structured to measure each PPP indicator comprehensively, such as formulating hypotheses, identifying and controlling variables, designing experiments, interpreting data, applying concepts, and evaluating. As a result, the assessment process has not been able to provide a complete picture of students' mastery of scientific skills. Findings in the field also show that students still face obstacles, especially in formulating logical hypotheses and in analyzing experimental data precisely and in-depth.

The results of the analysis of student needs further confirm this condition. Most of the students said that practicum activities helped them understand the material better, so it can be said that practicum has an important role in strengthening concept understanding. However, there are still many students who find it difficult when they have to process and interpret the data from the experiments that have been carried out. In addition, they show higher interest when practicum activities are associated with problems that are close to daily life. This shows that there is a discrepancy between the potential of practicum as a means of meaningful learning and its implementation in the classroom that is not fully optimal. Therefore, it is necessary to develop a Problem Based Learning (PBL)-based practicum guide that is designed in a targeted manner to facilitate and assess students' science process skills in a systematic, contextual, and relevant manner to real situations.

b. Analysis of Student Characteristics

Based on observations in the field,

class X students generally have developmental characteristics characterized by high curiosity about the surrounding phenomena. They tend to be active in asking questions, interested in new things, and showing enthusiasm when faced with challenging problems to solve. In addition, students at this level also like collaborative activities, because interaction with peers is an important part of their learning process and social development. Discussion activities, group work, and sharing ideas are often able to increase student engagement and motivation to learn.

Class X students are also relatively responsive to problem-based learning, especially when the problems presented are contextual and close to daily life. These characteristics are very relevant to the syntax of Problem Based Learning (PBL) which emphasizes group investigation, independent solution exploration, and scientific reflection on learning processes and outcomes. Thus, the implementation of PBL is considered to be in line with the needs and characteristics of students, so that it has the potential to increase involvement, understanding of concepts, and science process skills more optimally.

c. Curriculum Analysis

The practicum guide developed refers to the Learning Outcomes (CP) of Chemistry Phase E, namely students are able to observe, investigate and explain phenomena according to scientific work rules in explaining chemical concepts in daily life; apply chemical concepts in environmental management including explaining global warming phenomena; write down chemical reactions and apply basic laws of chemistry; understand atomic structures and their applications in nanotechnology. In the Independent Curriculum, especially in elements that emphasize strengthening students' science process skills. These elements include the ability to observe the phenomenon of changes in substances as the basis for understanding the concept of chemical reactions, designing and conducting scientific investigations systematically, analyzing and interpreting experimental results logically, and communicating experimental results both orally and in writing. These four elements are fully integrated in each stage of practicum activities so that learning is not only results-oriented, but also on the scientific process that students go through.

The material developed in this guide covers the topics of chemical reaction characteristics as well as the factors that influence chemical reactions. The selection of the material is based on its contextual characteristics and allows students to make direct observations of various phenomena of substance changes in the surrounding environment. Thus, the development of this practicum guide is expected to be able to bridge the demands of Learning Outcomes with a more meaningful and systematic implementation of inquiry-based learning. This material is also in accordance with the ADDIE model-based chemical reaction practicum guide, with the flow of learning objectives in this chemical reaction material including: Describing the meaning of chemical reactions, describing the characteristics of chemical reactions, describing the factors that affect chemical reactions.

d. Analysis of Facilities and Infrastructure

An analysis of facilities and infrastructure was carried out to assess the readiness of the learning environment in supporting the implementation of Problem Based Learning (PBL)-based chemistry practicum guidelines. This analysis is important because the success of laboratory learning is determined not only by the quality of the design of the learning device, but also by the availability of adequate facilities, tools, materials, and technical support. Data were obtained through direct observation of the conditions of the chemistry laboratory and interviews with subject teachers. The results of observations showed that the school already had a chemistry laboratory room separate from the regular classroom with basic facilities such as group practicum desks, water sources, material storage cabinets, and good ventilation. In general, the physical condition of the laboratory is considered suitable for the implementation of practicum at the high school level. However, the number of practicum tools is not fully proportional to the number of students in one class, so the implementation of experiments is carried out in groups with alternating distribution of tools.

The availability of basic tools such as chemical beakers, test tubes, measuring cups, drip pipettes, and spirit burners is considered sufficient to support simple experimental activities on chemical reaction materials. The available chemicals are also safe and suitable for school-scale experiments, albeit in limited quantities. This condition requires efficient practicum planning and considering the safety aspects of laboratory work. These findings have direct implications for the design of the practicum guide developed. The product is designed with contextual and realistic principles, which are to use tools and materials that are easy to obtain, optimize group work, and minimize dependence on complex laboratory equipment. Thus, the limitation of facilities is not an obstacle, but rather a basis for pedagogical considerations in designing activities that emphasize the process of scientific thinking rather than just manipulating tools.

So, the results of this analysis show that the readiness of facilities and infrastructure in schools is in the category of sufficient to support the implementation of PBL in chemistry practicum. Despite the quantitative limitations, these conditions still allow for the creation of investigative learning when supported by adaptive device design and effective classroom management strategies. Therefore, the development of practicum guidelines in this study is contextual and responsive to the real conditions of the school so that it has a high level of application in learning practices.

2. Design Stage Results

Initial design of the development of chemistry practicum guidelines to facilitate model-based science process (PPP) skills *Problem Based Learning* (PBL).

Table 4.1 Components of the Chemistry Practicum Guide

Page	Components	Description
1	*Cover*	The first part of the chemistry practicum guide, which is *the cover* that displays the identity of the practicum guide, which contains; title, author's name, and illustration images.
2	Foreword	Displaying a guide preface practicum developed by the author.
3	Table of Contents	Displays the table of contents of the developed practicum guide.
4	Instructions for Use of the Practicum Guide	Contains about instructions for use Practicum Guide.
5	Work Discipline and Safety in the Laboratory	It contains safety rules such as the use of PPE, prohibition of eating/drinking, maintaining cleanliness, and reporting procedures in the event of an accident in the laboratory.
6	Purpose of the Practicum	Explain the competencies expected after the practicum, namely understanding the meaning of chemical reactions, identifying the characteristics of reactions, analyzing the factors that affect the reaction, and communicating the results scientifically.

7	Material Concept Map	Describe the relationship between the characteristics of chemical reactions, influencing factors (temperature, concentration, surface area, catalysts), and the skill of the scientific process developed.
8	Stage 1 PBL (Student Orientation to Contextual Problems)	Stage 1 PBL: Orientation of students to problems. Observe the phenomenon of iron rust as an example of chemical reactions in daily life and begin to identify problems.
9	Formulation of Scientific Questions	Students formulate questions related to the characteristics of chemical reactions and factors that affect the speed or slowness of the reaction.
10	Stage 2 PBL (Organizing Students)	Stage 2 PBL: Organizing students. Students develop hypotheses about the influence of temperature, concentration, surface area, and catalysts, as well as determine variables free, bound, and control.
11	Stage 3 PBL (Guiding Individual and Group Investigations)	Stage 3 PBL: Guiding individual and group investigations. Displays the tools and materials used, such as; beakers, thermometers, stopwatches, HCl solutions,
		$Na_2S_2O_3$, solids, as well as hot water and room temperature as an experimental material.
12	Practicum Implementation (Experiment 1)	Students mixed $Na_2S_2O_3$ with HCl and observed changes in color, gas formation, sediment, and temperature changes as evidence of the formation of new substances.
13	Practicum Implementation (Experiment 2)	Comparing the reaction rate at room temperature and higher temperatures to prove that the increase in temperature accelerates the chemical reaction.
14	Practicum Implementation (Experiment 3)	Compare reactions in dilute and concentrated solutions to show that concentration affects reaction speed.
15	Practicum Implementation (Experiment 4)	Compare the form of solids (powder and flakes) and catalyst usage to see differences in reaction speeds.
16	Stage 4 PBL (Developing and Assessing Outcome Achievement)	Stage 4 PBL: Develop and assess the achievement of results. Students record data systematically, analyze the results of experiments, and draw conclusions based on evidence Empirical.
17	Stage 5 PBL (Analyzing and evaluating the problem-solving process)	Stage 5 PBL: Analyze and evaluate the problem-solving process. Students answer analysis questions, reflect on the experiment process, and evaluate scientific problem-solving.
18	Bibliography	Featuring scientific references that support the development of the guide, including resources on PBL, the Independent Curriculum, and science learning.

3. Development Stage Results

a. Product Validation

The product validation process is carried out systematically by involving three validators who have competence according to their fields, namely one material expert, one media expert, and one linguist. The subject matter expert is in charge of assessing the suitability of the curriculum, the correctness of scientific concepts, the depth of the material and the suitability with the PBL approach. Media experts evaluate aspects of design attractiveness, clarity of layout, graphic consistency, and ease of use of practicum guides, while linguists assess sentence clarity, accuracy of scientific terms, readability, and suitability to the level of learners. The assessment process uses a Likert scale with a score range of 1 to 5 to measure the feasibility level of each aspect assessed. This scale allows validators to provide assessments in a more objective and structured manner, so that the validation results can be analyzed to determine the level of product validity and become the basis for revising and refining the developed practicum guidelines. The results of the validation test of the three validators can be seen in the following table

Table 4.2 Results of Validity Assessment of the Practicum Guide for Subject Matter Experts

No.	Assessment Indicators	Expert Score	Max Score	Percentage	Criteria
1.	Compatibility with Curriculum	20	20	100 %	Highly Valid
2.	The Truth of Scientific Concepts	25	25	100 %	Highly Valid
3.	Depth of Material	23	25	92 %	Highly Valid
4.	Compatibility with PBL Approach	55	55	100 %	Highly Valid
Total Instrument Items		**123**	**125**	**98,4 %**	**Highly Valid**

The first validator, namely the material expert, gave a score of 98.4%, which is included in the very feasible category. This assessment reflects that the content of the chemical reaction material presented in the guide is relevant, in accordance with the demands of the curriculum, the correctness of the scientific concept, and the conformity with the PBL approach. In addition, the materials selected have also been adjusted to the local conditions and potential of students, thus encouraging active involvement in practicum activities.

Table 4.3 Results of Validity Assessment of Media Expert Practicum Guide

No.	Assessment Indicators	Expert Score	Max Score	Percentage	Criteria
1.	Design Attractiveness	25	25	100 %	Highly Valid
2.	Layout Clarity Location	22	25	88 %	Highly Valid
3.	Consistency Graphics	13	15	86, 67 %	Highly Valid
4.	Facilities Usage	59	60	98,3 %	Highly Valid
Total Instrument Items		**119**	**125**	**95,2 %**	**Highly Valid**

The second validator, the practicum guide media expert, gave a score percentage of 95.2%, which shows that in terms of design attractiveness, layout clarity, graphic consistency, and ease of use, this guide has been very well compiled. The guide is considered to have met the pedagogical standards required in a practicum-based learning medium.

Table 4.4 Results of Validity Assessment of the Linguist Practicum Guide

No.	Indicator Assessment	Score Members	Score Max	Percentage	Criteria
1.	Sentence Clarity	38	40	95 %	Highly Valid
2.	Accuracy Scientific Terms	10	10	100 %	Highly Valid
3.	Readability	25	25	100 %	Highly Valid
4.	Compatibility with Student Level	50	50	100 %	Highly Valid
Total Instrument Items		**123**	**125**	**98,4 %**	**Highly Valid**

The third validator, the linguist, gave an assessment of 98.4%, which is also included in the very feasible category. This shows that the guide has been prepared by paying attention to linguistic aspects such as clarity of sentences, accuracy of scientific terms, and readability, as well as the language used is in accordance with the cognitive development and characteristics of high school students in class X, so that it does not cause confusion in understanding the instructions and the content of the material.

Table 4.5 Overall Validation Results Data

No.	Validator	Percentage	Categories
1	Material Expert	98,4 %	Highly Valid
2	Media Member	95,2 %	Highly Valid
3	Linguist	98,4 %	Highly Valid
Overall Average	**97,3 %**	**Highly Valid**	

The results of the validation conducted by three expert validators showed that the chemical reaction material practicum guide developed by the researcher was in the "very feasible" category to be used in the learning process. The three validators gave a score above 81%, so it can be concluded that the practicum guide developed has a high quality of instructional material, media, and language, and is very feasible to be implemented in chemistry learning in schools. This assessment strengthens the validity of the product as a contextual learning medium based on *Probelm Based Learning* (PBL) that supports the understanding of the concept of chemical reactions in a more applicative and meaningful way for students.

d. Product Revision

The validation test that has been carried out by expert validators has obtained results and there are several parts that need to be revised or improved. This is done so that the practicum guidelines developed by the researcher get better results. The revision or improvement stage is carried out based on comments and suggestions for improvement from the validator on the developed practicum guidelines.

d. Limited Trial

A limited trial was conducted on 12 students in class X to find out the extent to which they could understand the content of the guide independently. During the activity, students are asked to read and use the guide as appropriate in learning. The researcher conducts observations to see the parts that make students doubt, ask, or need additional explanation. After the activity, a short interview was conducted to dig up information about words, sentences, or instructions that were considered difficult to understand. Then students respond to find out the students' assessment of the level of language clarity, ease of understanding the content, and attractiveness of the presentation. The results of this limited trial are used as a basis for revising the editorial, correcting unfamiliar terms, simplifying sentences that are too complex, and refining the presentation order to make the guide more communicative and easy to understand before proceeding to the next stage of the trial.

1. Direct Observation Results

Observations were carried out using observation sheets of science process skills and student activity that had been prepared beforehand. The aspects observed included participation in group discussions, the ability to formulate hypotheses, and the accuracy and neatness in filling in the data table of the results of the experiment. Based on the results of observations, in general, students showed very good participation in group discussions. They actively expressed their opinions, asked questions, and were involved in the decision-making process during the trial activities. In the aspect of hypothesis formulation, most students are able to formulate temporary conjectures that are relevant to the given problem and show the existence of logical relationships between variables. Filling in the observation result table, students have shown good ability to record data sequentially and systematically in accordance with the results of the experiment. This shows that the guidance used can help students develop science process skills optimally at the limited trial stage.

2. Student Interview Results

Interviews were conducted to obtain a deeper picture of the readability and usefulness of practicum guides from various perspectives on students' academic abilities. The questions asked focus on the clarity of the instructions in the guide, the most helpful parts in understanding the experiment, the difficulties experienced in formulating hypotheses and analyzing the data, and suggestions for improving the guide. Based on the results of the interviews, most of the students stated that the practicum guide was quite helpful, especially in the problem identification and variable determination section. These stages are considered to make it easier for them to understand the direction of the experiment and formulate hypotheses in a more structured manner. However, some students revealed that they still need more concrete examples, especially in drawing conclusions based on experimental data. These findings show that although the problem-based learning stage has facilitated students' science process skills, the aspects of data analysis and conclusion drawing still need to be strengthened to make understanding more optimal.

3. Student Response Results

Students' perception of the clarity of instructions, the attractiveness of the activity, and the ease of following the practicum flow showed that the majority of students responded positively to the integration of activity steps with contextual problems. However, there are inputs related to the need to simplify the redaction of experimental instructions.

4. Limited Trial Reflective Analysis

Reflectively, the results of the limited trial show that the problem-based learning practicum guide has been able to activate the cognitive and social dimensions of students through group discussion and investigation activities. High student participation in discussions shows that a problem-based approach is effective in building collaborative interactions as well as encouraging active engagement during the learning process. In the aspect of hypothesis formulation, it is still found that not all students are able to construct scientific conjectures systematically and logically. This indicates that although the learning stages have been designed to facilitate science process skills, learners still need reinforcement at the analysis and conclusion drawing stages. Thus, the success of the implementation of the model does not only depend on the presentation of contextual problems, but also on the clarity of guidance in guiding the scientific thinking of students. Based on the triangulation of data obtained through observations, interviews, and questionnaires, minor revisions were made to the product in the form of simplifying the test instructions to make them more operational and easy to understand. This revision aims to improve readability and strengthen cognitive support for students, especially at the stage of interpretation of experimental results, before the product is implemented in the field trial stage.

d. Field Trials

After revisions or improvements are made based on comments and suggestions for improvement from expert validators, then implement the product. At this stage, the product was implemented by conducting field trials on 36 class X students at SMA Negeri 1 Seluma with 4 aspects that were assessed to determine the practicality of the practicum guide.

a). Teacher's Response

The practicality test is carried out after the validation process is completed. A practicality test is carried out to find out if the practical guide is based on *Problem Based Learning* (PBL) that has been developed is practical or easy to use. The practicality test was carried out on 2 chemistry teachers at SMAN 1 Seluma. The following are the results of the validation score of the practicality aspect of the practicum guide developed.

Table 4.7 Results of the Teacher's Response Test to the Practicum Guide

No.	Aspects that Rated	Score 1	Score 2	Score Max	Average Introduce yourself	Criteria
1.	Facilities Usage	18	18	20	90 %	Very Practical
2.	Clarity Instructions	18	18	20	90 %	Very Practical
3.	Curri culum Fit	16	19	20	87,5 %	Very Practical
4.	Tim e Eligi bilit y	13	12	15	83,3 %	Very Practical
	Learning					
Quant ity		**65**	**67**	**75**	**88 %**	**Very Practical**

The teacher's assessment of the practicality of this guide reached a score of 88%, which is an indicator that this guide is very suitable to be applied in classroom learning activities. The teacher considers that the practicum guide is easy to use in practicum activities, the practicum instructions are prepared clearly and easy to understand, the practicum materials and activities are in accordance with the CP and TP of the Independent Curriculum, as well as the practicum implementation time in accordance with the allocation of learning time. The guide has also integrated local values through the context of chemical reactions in the environment around students, thus providing a more meaningful and contextual learning experience. Teachers also appreciate that this guide is in line with the learning principles of the Independent Curriculum, such as contextual and relevant learning, where the material is related to students' daily lives, and is designed to solve problems. This is very helpful for teachers in developing learning scenarios that are adaptive and responsive to the needs and characteristics of students. With a well-thought-out structure and content, the guide can be used directly by teachers without the need for much revision, which of course saves a lot of time and effort in lesson planning.

a). Student Response

Table 4.8 Results of Student Response Test to Practicum Guidelines

No.	Aspects Assessed	R espond ent Score	Max Score	Intro duce your self	Criteri a
1.	Attractiveness of the Display	500	540	92,6%	V er y P ra ct ic al

2.	Ease of Understanding Material	960	1.080	88,9 %	Very Practical
3.	Contextual Relevance	650	720	90,3 %	Very Practical
4.	Science Process Skills	1.130	1.260	89,7 %	Very Practical
Quantity		**3.240**	**3.600**	**90%**	**Very Practical**

The assessment of the students reached a score of 90%, which is included in the very practical category according to the Azwar (2023) criteria. This score shows that students find the guide attractive, helps develop science process skills (formulating hypotheses, identifying and controlling variables, designing experiments, interpreting data, applying concepts, and evaluating), suitability and helps them better understand chemical reaction material. This guide is considered to be able to present information systematically, equipped with clear pictures and instructions, and in accordance with the phenomena in the student environment. Students also feel that this practicum guide facilitates them to be active in the learning process. The activities are designed to guide the facilitation of students' science process skills. The language used is simple, communicative, and in accordance with the level of understanding of students, so that it is not difficult to understand the content of the material and the stages of practicum. Overall, both students and teachers gave very positive responses to the practicality of the practicum guidelines developed. As such, this guide has proven to be practical, applicable, and feasible for wider use in the study of chemistry on chemical reaction materials. This guide also has the potential to be adapted by other schools, to support meaningful, active, and contextual learning.

2. **Results of *the Evaluation* Stage**

At the evaluation stage in this study, it is carried out at each stage of ADDIE, which aims to analyze the shortcomings in the practicum guidelines developed. Through limited trials and field trials that have been carried out in the developed practicum guide, it can be perfected before it is declared suitable for use as learning materials.

a. Analysis Stage

The results of the evaluation show several strengths, namely observations and in-depth interviews with chemistry teachers so that the needs of practicum are verified contextually. The problems identified are also clear, including the limitations of tools, the absence of practicum guidelines, and the difficulty of students understanding chemical reaction material. In addition, the determination of user targets and the selection of easy-to-obtain practicum materials indicate practical and realistic planning. However, the analysis of students is still based on the teacher's assumptions so it needs to be complemented by direct observation or diagnostic data. The needs questionnaire instrument has also not been explained in detail regarding the indicators, validity, and score results, so it needs to be clarified to make it more scientific and credible.

b. Design Stage

Based on the results of the evaluation, the product design shows some significant strengths. The preparation of the design has been carried out systematically, including layout arrangements, selection of illustrations, and the presentation of structured material content. In addition, evaluation strategies have been designed from the early stages of development, including validation plans by subject matter experts, media experts, and linguists, so that product quality can be controlled academically. The inventory of development tasks and the objectives to be achieved has also been formulated explicitly, showing the existence of targeted and measurable planning. However, there are still several aspects that need to be improved. Pedagogical considerations in the selection of design strategies have not been explained in depth, for example how the visual design used can support students' learning styles and characteristics. In addition, the initial design feasibility test has not been carried out for potential users, such as teachers or instructional design experts, before further development. It is important to ensure that the initial design is truly tailored to the user's needs and is practically effective.

c. Development Stage

The results of the evaluation showed that the product was developed using the Canva application, resulting in an attractive and communicative design. The validation process has also involved three parties, namely material experts, media experts, and linguists, with a score above 81% which is included in the very feasible category. In addition, the researcher conducted revisions based on input from validators, so that it was seen that there was a systematic and continuous product improvement cycle. However, there are still some drawbacks that need to be considered. The report does not include a concrete revision attachment that shows a comparison before and after the improvement, such as a change in the appearance of the page or an editorial improvement, so the improvement process is less visually documented. In addition, the obstacles faced during the development process are not explained, even though the information can be an important reflection material for the development of the next product.

d. Implementation Stage

Based on the results of the evaluation, the product implementation has several strengths. Trial activities have been carried out directly in target schools by involving teachers and students, so that the product is tested in a real learning context. In addition, student worksheets (LKS) and science process skills rubrics are available to measure learning outcomes in a more targeted manner. The level of practicality also showed excellent results, with an average score above 81% of teachers and students belonging to the very practical category. However, implementation is still limited to small scale (12 students) and large scale (36 students), so the sample coverage is still relatively limited. In addition, the report has not presented quantitative and explicit learning outcomes, such as LKS scores and science process skill assessments, so the effectiveness of the product has not been described in a measurable and comprehensive manner.

f. Evaluation Stage

Based on the results of the evaluation, the assessment process has been carried out comprehensively at each stage, starting from needs analysis, product validation, to practicality tests. The evaluation indicator uses a Likert scale with a clear calculation formula and refers to Azwar (2023), so that data analysis is carried out systematically and measurably.

In addition, the evaluation also contains open feedback from validators who provide qualitative input for product improvement. However, the evaluation has not been equipped with triangulation data from external parties, such as independent evaluators, so the objectivity of the results can still be improved. In addition, there has been no analysis of the long-term impact of product use and the achievement of curriculum competencies as a whole, so its effectiveness in the context of continuous learning has not been fully defined.

Conclusion

1. The Problem Based Learning (PBL)-based chemistry practicum guide on class X chemical reaction materials developed through the ADDIE model stated with validation results by material, media, and language experts showed an average validity percentage of 97.3% with a very valid category (98.4% material, 95.2% media, 98.4% language).

2. The results of the practicality test showed that the guide obtained a student response of 90% (very practical) and a teacher response of 88% (very practical), making it suitable for use in learning.

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