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Development of an Educational and Innovative KIT to Support a Practicum on Reaction Rates

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Abstract: This research is a development study that aims to design and assess the feasibility of an integrated laboratory kit for reaction materials. The development of the kit follows the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. The research was conducted at SMA Negeri 3 Kota Kubu Raya using purposive sampling. The research subjects consisted of 12 students from class XI MIPA 2 for a small-scale trial and 25 students from class XI MIPA 1 for a large-scale trial. Data were collected through written tests and student response questionnaires. The analysis included instrument validity testing, learning outcome analysis, and assessment of student responses to the KIT. The validation results showed that the developed KIT was suitable for use as a learning medium in terms of media and content. Student responses were also very positive, with an average questionnaire score of 80% for the learning aspect, 80% for the media aspect, and 73% for the visual communication aspect. Overall, the developed reaction KIT was considered practical, interesting, and effective for use in chemistry laboratory activities at school.

Keywords: Development; Laboratory KIT; Reaction Rate

Introduction

Chemistry is one of the branches of natural science that plays an important role in connecting various disciplines, so it is often considered the central science in the development of science (Suleman et al., 2023). As a scientific discipline, chemistry systematically studies the structure and composition of matter, the physical and chemical properties of substances, and the various changes that accompany them. The primary focus of chemical studies lies in understanding the composition of matter, the interactions between particles at the molecular level, and the mechanisms by which matter undergoes transformation through chemical reactions ((Defista & Aznam, 2024). Chemistry is one of the important subjects taught at the senior high school level (SMA/SMK/MA) because it plays a strategic role in equipping students with a basic understanding of various natural phenomena and their application in everyday life (Baihaqie et al., 2024; Ishma & Novita, 2021; Wijayadi, 2017; Wulandari et al., 2024).

In the chemistry learning process, practical activities are an important component that cannot be separated, because they play an important role in supporting the effectiveness of learning and provide opportunities for students to test and apply the theories they have learned in a real context. Through these activities, it is hoped that understanding of the material will become more in-depth and applicable (Akbar et al., 2024). In chemistry education, laboratory practicals are one of the activities carried out as part of the teaching process, aimed at providing students with the opportunity to directly observe various chemical phenomena and processes, thereby making their understanding of chemical concepts more concrete and profound (Sari et al., 2023; Ulfah & Mayasari, 2025). One of the chemistry topics that requires practical work is reaction rate (Jelita et al., 2021).

Reaction rate material covers various abstract concepts, such as reaction order, collision theory, and a number of factors that influence the speed of a chemical reaction (Muhtar, 2023; Muliaman, 2021; Widarti et al.,

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2022). This topic is considered challenging by students because it requires the ability to integrate macroscopic, microscopic, and symbolic aspects simultaneously in the understanding process (Nurrahmah & Nawawi, 2023). Based on the findings of research conducted by Setianingsih and Roshayanti (2022). The level of students' understanding of reaction rate material is still low, reaching only 36.87%. A similar condition was found at SMA Negeri 12 Tidore Kepulauan, where 88% of students had difficulty learning this topic, indicating that this material is quite complex for most students (Fatah et al., 2024). The low level of understanding of students regarding this material is reflected in their difficulty in explaining abstract concepts and their inability to systematically complete basic calculations (Santa et al., 2024)

One of the main factors causing these difficulties is the limited laboratory facilities and infrastructure, which has an impact on the limited implementation of practical activities (wulandari et al., 2024). Although students have gained practical experience, teachers report that the availability of tools and materials is still very limited, so that practical work cannot be carried out optimally (Arvianti et al., 2024; Podolsky et al., 2019).

This situation has resulted in a low level of learning experience for students, as not all students have the opportunity to interact directly with practical tools and materials. Therefore, strategic steps are needed to improve students' understanding of reaction rate material through the development of learning media that can encourage their active involvement. One of alternative solutions that can be implemented is the use of Integrated Instrument Components (KIT) practical media as an effort to optimize the learning process in the laboratory (Adipat et al., 2021; Jelita et al., 2021). A practical KIT is a learning tool consisting of a set of tools, materials, and experiment guides specifically designed to facilitate students in conducting group experiments in the classroom (Marsya & Sucahyo, 2023). The existence of this media plays an important role in supporting students to follow the learning process and improve their understanding of the material in a more optimal way (Izzania & Widhiastuti, 2020). Previous research indicates that the use of practical kits contributes significantly to supporting chemistry learning. Specifically, in the subject of acids and bases, the application of practical kits can improve students' understanding of concepts to a level of 90.83% (Jelita et al., 2021) . A similar phenomenon was also found in Electrochemistry, where the use of practical kits resulted in a classical completion rate of over 90% (Juwita, 2015). Meanwhile, in Stoichiometry learning, the practical KIT successfully improved classical concept understanding by 72, 73% (Raehanah & Mubarak, 2025).

Research on the development of practical kits for reaction rate material has been conducted, and the results show that the practical kits designed are effective and have a high level of practicality, namely 91.89%, making them suitable for use in the learning process (Trimayanto & Novita, 2019). In addition, confirms that practical kits serve as effective learning media in improving students' understanding of reaction rate concepts while honing their scientific process skills.

Based on the literature review, practical kits have been shown to have various advantages that are effective in improving learning outcomes and providing a variety of learning achievements for students. Considering this, researchers were encouraged to develop practical kits on the subject of reaction rates as an effort to support a more effective and varied learning process.

Method

This type of research is a research and development (R&D) study that employs the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The objective of this study is to evaluate the feasibility of the developed Integrated Instrument Component (IIC) laboratory and to gather student feedback. The research was conducted at SMA Negeri 3 Kubu Raya. The research population consisted of all 11th-grade students at SMA Negeri 3 Kubu Raya during the second semester of the 2023/2024 academic year, totaling 44 students.

The experimental class was selected using purposive sampling from all Grade XI MIPA classes, with 16 Grade XI MIPA students as research subjects. The instruments used included a needs questionnaire, a validation sheet, a student response questionnaire, as well as pre-test and post-test sheets. Data collection was conducted through questionnaires and written tests.

Quantitative data analysis on the validation sheet and student response questionnaire was conducted based on assessment results using a Likert scale. The scores and criteria for the Likert scale can be seen in Table 1.

Table 1. Likert scale

Criteria	Score
81%-100%	Very interesting
61%-80%	Interesting
41%-60%	Quite interesting
21%-40%	Not very interesting
0% - 20 %	Not interesting

The scores obtained were then analyzed by calculating the average value using ng Formula 1.

$$\overline{x} = \frac{\sum x}{n} \quad (1)$$

$\overline{x}$ = Average Score
$\sum x$ = Total score for each
N = Number of Ratings

Based on average calculations, the percentage of validation results and student response questionnaires was obtained. The validation assessment categories based on percentages can be seen in Table 2.

Table 2. Assessment Categories

Percentage	Score
V > 80%	Highly Valid
61 % < V ≤ 80 %	Valid
41% < V ≤ -60%	Sufficiently Valid
21% < V ≤ 40%	Less Valid
V ≤ 20 %	Not Valid

The percentage of student responses can be classified into categories of score interpretation according to the Likert scale shown in Table 3.

Table 3. Assessment Categories

Percentage	Score
81 % - 100 %	Highly Valid
61 % - 80 %	Valid
41% - 60%	Sufficiently Valid
21% - 40%	Less Valid
0% - 20 %	Not Valid

Result and Discussion

Analysis

The analysis stage is an important process for drawing conclusions related to the implementation of activities. In this study, the analysis stage includes material analysis, student characteristic analysis, task analysis, and the formulation of learning objectives. The results of the analysis stage are as follows.

Material Analysis

The material developed in the KIT of this practicum is Reaction Rate. Based on the results of observations conducted by researchers, it was found that many grade XI MIPA students had difficulty understanding this material. This difficulty resulted in low student understanding of the concept of Reaction Rate. Low interest and motivation among students are also factors that influence the learning process of reaction rate material. This situation arises because teachers have not utilized teaching aids such as learning media or laboratory experiments that could clarify the concepts of this material. Therefore, the researcher developed a learning medium aimed at supporting the chemistry learning process, particularly in laboratory activities.

Characteristic Analysis

The characteristics of the students indicate a diversity of academic abilities in chemistry, including high, medium, and low levels of ability. Based on the results of the subject analysis, students' cognitive abilities in chemistry are still around the average KKM score of 75. In addition, students have never participated in practical work using the KIT practical work, so the KIT practical work learning media is still relatively new to them.

Task Analysis

Task analysis is conducted to identify the skills possessed by students and to be developed during the learning process. The tasks designed in the practicum guide include the ability of students to investigate the factors that affect the reaction rate, conduct experiments related to these reaction rate factors, and conclude the results of the factors that affect the reaction rate.

Desain

The design stages carried out in the development of the KIT for the reaction rate practical material are the selection of the form of media presentation to identify learning media that are suitable for the characteristics of the material, as well as conducting initial design, which includes the design of the media to be developed and the creation of practical guides. The initial framework of the laboratory manual consists of an introduction, the main content of the manual, which includes detailed and sequential presentation of the material, and learning activities. Each activity involves observing simple experiments conducted by students in groups, collecting data, analyzing data, and drawing conclusions.

Development

After completing the design stage, the next stage is the development of KIT for practical work, which are formulated to support the implementation of learning activities in an optimal, effective, and efficient manner.

Making Practical Tools

The equipment for the reaction rate experiment was made using five ½ cm diameter PVC pipes, one T-shaped pipe, pipe glue, two used bottles, two pieces of used inner tubes, and chemical materials consisting of 5 grams of calcium carbide (CaC_2) for the experiment on the effect of surface area on reaction rate, and two tablespoons of sodium carbonate for the experiment on the effect of concentration on reaction rate.

The process begins by preparing two used bottles (e.g., Floridina beverage bottles) to serve as solution containers. The bottle caps are then pierced in the center using a nail to create an opening for the pipe. This hole is then enlarged by heating it over a candle flame so that the pipe can be fitted snugly.

Next, a piece of used inner tube is cut into a 5 x 5 cm square to be used as a reinforcement ring for the connection. The center of the ring is drilled to match the size of the pipe socket, then the ring is installed inside the bottle cap to strengthen and seal the connection between the pipe and the bottle cap.

The end of the PVC pipe cap is then cut using a saw to connect it to the assembly. The final step of this process is to assemble all components on the bottle cap, including the hole, reinforcement ring, and pipe, ensuring all parts are securely fitted and ready for use in the experiment.

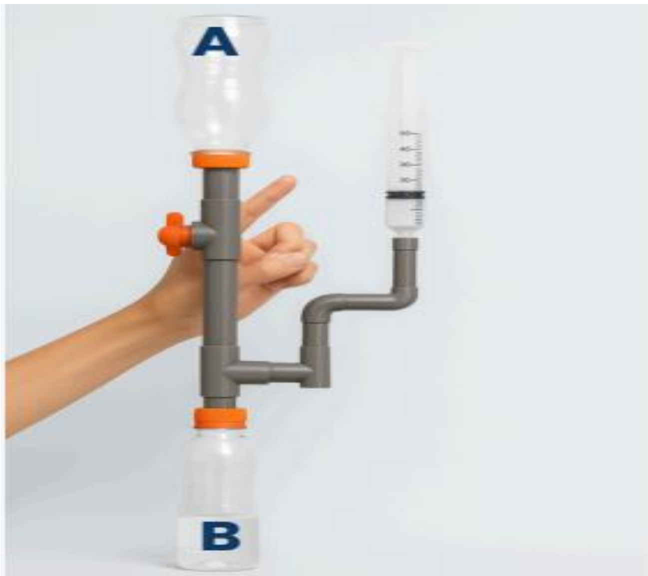

Figure 1. Reaction Rate Design KIT

Implementation

The KIT practicum products that have been developed require a validation process to ensure their feasibility and quality. The level of product validity can be determined through assessments conducted by experts (Aisyah & Fatisa, 2022). In this study, validation was carried out by subject matter experts and media experts. The validation process was carried out before the product was tested on students, with the aim of identifying and correcting any shortcomings.

Media Expert Validation

Media validation conducted by two experts aimed to evaluate the suitability of the appearance of the developed reaction rate practicum KIT. The assessment was carried out by filling out a questionnaire by media experts, focusing on two main aspects, namely media engineering and visual communication. The results of the validation process are presented in Figure 2.

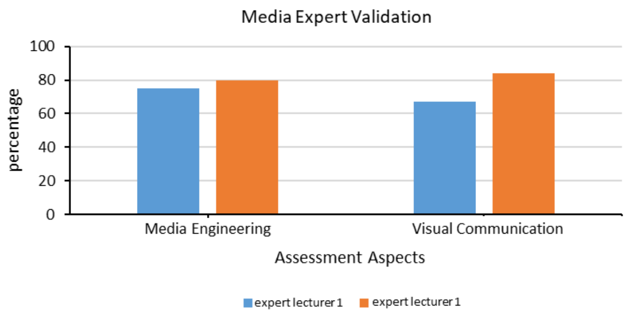

Figure 2. Material Expert Validation Chart

The validity assessment by media experts shown in Figure 2 indicates that the average validity percentage is in the range of 66–85%. The assessment by media expert I on the media engineering aspect resulted in a total score of 15, with an average validity percentage of 75%. Meanwhile, the assessment by media expert II also obtained a total score of 16, with an average validity percentage of 80%. In the visual communication aspect, media expert 1 produced a total score of 20 with an average percentage of 66.67%. Meanwhile, media expert 2 obtained a score of 25 with an average percentage of 83.33%. These results indicate that the KIT of the reaction rate practicum is deemed suitable for use without requiring revision.

Subject Matter Expert Validation

Material validation was conducted to evaluate the suitability and accuracy of the learning materials contained in the developed practical guide. The assessment of the practical guide by subject matter experts is presented in Figure 3.

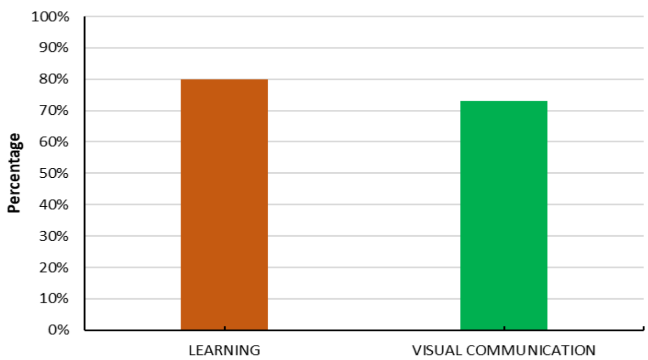

Figure 3. Subject Matter Validation

The validity assessment by subject matter experts shown in Figure 3 indicates that the average validity percentage ranges from 66 to 85%. The assessment by media expert I on the learning aspect resulted in a total score of 17, with an average validity percentage of 85%. Meanwhile, the assessment by media expert II also obtained a total score of 16, with an average validity percentage of 80%. In the visual communication aspect, media expert 1 achieved a total score of 22 with an average percentage of 88%. Meanwhile, subject matter expert 2 achieved a score of 25 with an average percentage of 83.33%. These results indicate that the KIT component of the reaction rate laboratory experiment is deemed suitable for use without requiring revisions.

Initial Field Trials

The initial field trial in this study involved a sample of 44 students. The trial was conducted in classes XI MIPA I and XI MIPA II at SMA Negeri 3 Kubu, which were selected based on the considerations of the grade XI chemistry teacher.

Initial Product Revision

Based on the results of a questionnaire responses regarding the learning media in the form of a reaction rate practicum tool during the initial field trial stage, the product was revised based on suggestions and input from six respondents. These revisions were made to improve the practicum tool media before it was implemented in the main field trial.

Student Responses

A small-scale product trial was conducted on 25 students in class XI MIPA 2 with heterogeneous abilities. The students were selected based on their daily test scores for the even semester of the 2021/2022 academic year. The students were divided into 5 groups, each of which conducted the practical experiment according to the procedures and instructions outlined in the practical experiment guide. The two groups that had completed the practical experiment were then given a response questionnaire to assess their feedback on the KIT of the researcher's practical experiment. Based on the student response questionnaires, the average score for the learning aspect was 80%, falling into the "very valid" category. For the media aspect, the average score was 80%, and for the visual communication aspect, the average score was 73%, falling into the "valid" category. The results of the student response questionnaire can be seen in the image. The response graph of the students can be seen in Figure 4.

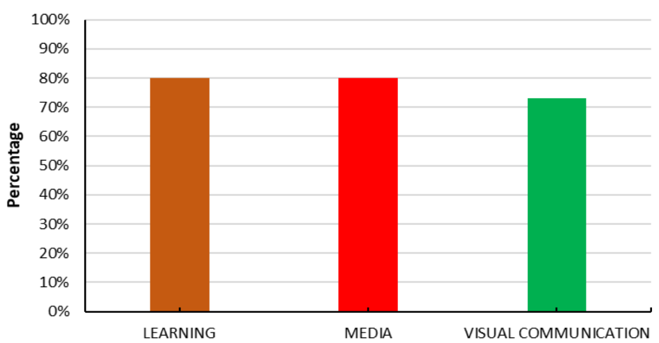

Figure 4. Response From Students

Main Field Trial

In this study, field tests were conducted on 14 grade XI MIPA SMAN 3 Kubu students selected based on agreement with the chemistry teacher. The selection of subjects included five students with high ability, five with moderate ability, and four with low ability. Before using the reaction rate practical equipment, students were asked to fill out a questionnaire to obtain data on their responses to the reaction rate practical KIT media that was developed.

Evaluation

The KIT developed by researchers demonstrates a number of functional advantages. This KIT is designed to improve time efficiency in conducting practical work, as teachers no longer need to prepare tools and materials separately. Additionally, this KIT has the potential to serve as an effective self-learning tool for students, as it is equipped with an integrated laboratory manual. However, the limitations of this KIT lie in its scope of application, which is currently restricted to reaction rates, and its physical durability, which requires maintenance to prevent damage.

Conclusion

Based on the results of research conducted at SMAN 3 Kubu Raya on the development of the KIT for reaction rate experiments for 11th grade science students, it can be concluded that this tool KIT is highly suitable for use as a learning medium in chemistry laboratories. The validity test results indicate that this KIT meets the necessary criteria, both in terms of media quality and the suitability of the material content with the competencies students are expected to achieve. Therefore, this KIT not only functions as an experimental aid, but also serves as a learning tool that can facilitate a deeper and more contextual understanding of concepts. The students' response during the initial trial showed that this KIT was classified as "very interesting" with a rating of 86.6%. This suggests that the design of the KIT successfully attracted students' interest in conducting practical activities, thereby increasing their active involvement during the learning process. The attractiveness of the KIT is also supported by its ease of use, clear instructions, and systematic layout, which help students feel more confident in conducting experiments independently or in groups.

The effectiveness analysis results shown by an N-Gain value of 0.52, which falls into the "moderate" category, indicate that the use of this KIT provides a significant improvement in understanding the concept of reaction rate. This suggests that the tool effectively helps students connect theoretical knowledge with practical applications, making learning more meaningful and engaging. The effectiveness also confirms that the KIT can be used as an efficient alternative to practical media, especially in situations where conventional laboratory equipment is limited. Considering the validity, positive student responses, and improved learning outcomes, it can be confirmed that the KIT for reaction rate experiments is suitable for use as an innovation in chemistry education in secondary schools. The existence of this KIT has the potential to support interactive, practice-based learning, enhance students' motivation to learn, and develop their scientific skills in observing, analyzing, and drawing conclusions from the results of the experiments conducted.

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Author Contributions

Conceptualization: N, F, R, Methodology: N, F, R, Validation: H, Z, Writing research: N; Editing research data: N, F, R

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Conflicts of Interest

No conflict of interest.

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