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Practical Guide for Determining the Reaction Rate and Reaction Order Based on the *Colorimeter*® Application

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ABSTRAK

Kegiatan praktikum dibutuhkan dalam pembelajaran kimia. Namun, selama pandemi covid-19 diperlukan penuntun praktikum yang compatible untuk digunakan oleh mahasiswa. Oleh karena itu, dibutuhkan penuntun praktikum yang dapat melibatkan mahasiswa secara langsung dalam kegiatan praktikum pada pembelajaran daring maupun blended learning. Tujuan dari penelitian ini untuk mengetahui kelayakan Penuntun Praktikum Penentuan Laju Reaksi dan Orde Reaksi Berbasis Aplikasi Colorimeter® berdasarkan expert judgement dan respon mahasiswa. Penelitian ini menggunakan metode penelitian dan pengembangan (R&D) model 4D(Four-D), dimulai dari tahap define, design, develop dan dissemination. Subyek penelitian berupa penuntun praktikum yang diujicobakan pada uji coba awal sebanyak 6 mahasiswa dan 20 mahasiswa Pendidikan Kimia FKIP Untan pada uji coba utama. Alat pengumpulan data berupa lembar penilaian kelayakan dan angket respon mahasiswa. Hasil penilaian ahli menggunakan uji Gregory menunjukkan kriteria sangat layak dengan nilai validitas 1,00 yang berada pada tingkat sangat tinggi ditinjau dari kelayakan materi, bahasa dan kegrafikan. Hasil uji coba awal dan uji coba utama diperoleh persentase rata-rata 91% dan 94% dengan kriteria sangat baik. Hasil penelitian tersebut mengindikasikan bahwa penuntun praktikum yang dikembangkan layak digunakan dalam kegiatan praktikum serta penuntun praktikum memiliki tampilan yang menarik dan dapat digunakan dalam kegiatan praktikum untuk menunjang pemahaman mahasiswa pada konsep laju reaksi.

ABSTRACT

The practical activities needed in chemistry lessons. However, during the covid-19 pandemic, a suitable practical guide is needed. Therefore, a practical guide that can involve students directly in practical activities in online learning and blended learning is needed. The purpose of this study is to determine the feasibility of the Practical Guide for Determining Reaction Rate and Reaction Order Based on the Colorimeter® Application based on expert judgement and students' response. This study employs a research and development (R&D) using 4D(Four-D) model, starting from define, design, develop, and dissemination stages. This research is limited to the develop stage due to the limited time and ability of the researcher. The subject of this study was a practical guide which was tested to 6 students in the initial trial and 20 students of Chemistry Education FKIP Untan in the main trial. Data collection tools used are the feasibility assessment sheets and students' response questionnaires. The results of expert assessment using the Gregory test closeness model indicate a very feasible criteria with the validity value of 1.00 which in a very high level in terms of the feasibility of the content, language, and graphics. The result of the initial trial and main trial obtained an average percentage of 91% and 94% respectively with very good criteria. The results of this study imply that the practical guide developed is suitable for use in the practical activities. In addition, the practical guide has an attractive appearance and can be used in practical activities to support students' understanding of reaction rates' concepts.

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1. INTRODUCTION

Chemistry has been a part of science that has been acquired and developed based on the experiment on how to learn how things happen. Not only its combined knowledge, which encompasses the concept, fact, and principle of chemistry, but also the discovery process. The study of chemistry involves lab work which gives the opportunity to students to apply the knowledge and theories that have been learned. Lab (practical) work and science have been inseparable from each other. The development and application of chemistry does not only required theoretical learning but also experimental work with a certain standard which provides a better understanding for the students' (Anggraini, 2016; Faika & Side, 2011). This statement is in line with previous study, who stated that students' could acquire first-hand experience and improve scientific attitude through lab work as well as storing the knowledge for the long term (Lasia, 2013; Rustaman et al., 2005). The pandemic of Covid-19 has affected every aspect of human life around the world, especially in the education sector (Crawford et al., 2020; Fauzi, 2020). Due to the implementation of community activity restrictions, face to face learning which includes lab work, cannot be carried out properly. This restriction has complicated the students to carry out the lab work in the labs. It has been proven by the result of an interview with the lecturers of Chemical Kinetics in FKIP Untan. Based on the interview, lab work was dismissed during the Covid-19 pandemic and replaced with online lab work where the students are required to watch and analyze lab work videos. This has resulted in declining students' experience in carrying out the lab work in several stages that also affect the students' capability to understand the concept of chemistry (Nurjanah et al., 2020; Saraswati & Mertayasa, 2020). The lab practical of chemistry also involved lab equipment and chemical substances, which require proper handling and safety procedures that can only be carried out directly in the chemistry lab, even during the pandemic.

The implementation of online learning requires educators to design a teaching plan to carry out the teaching and learning process (Holme, 2020; Jamila et al., 2021). Certainly, the process consumes a great amount of time to be prepared especially when it is related to a laboratory (Subamia et al., 2019; Wang & Ren, 2020). An effective practical guide is necessary to carry out the practical lab work. The practical guide is a content plan for lab work to facilitate the implementation procedures starting from the planning, implementation, data analysis, and writing report (Darmaji et al., 2019; Kepmendiknas, 2001). The practical guide is utilized as the medium to aid the student in learning and working sustainably. In accordance with previous study who state that a practical guide is needed as a guide for lab work so that it can be carried out smoothly (Arini & Darmayanti, 2022; Wahab et al., 2021). The students must participate actively in their lab work through the lab work guide by the practical guide to develop process skills (Prayitno, 2017; Tafa, 2012). Through the practical guide, the students will acquire an overview of the goals, benefits, and procedures of the lab work to prepare the students in order to carry out the lab work (Syamsu, 2017). In addition, the practical guide is expected to aid the students in enhancing their creativity and scientific attitude in conducting experiments. Practical guides must be able to adapt the development of 21st-century learning skills not only on the knowledge aspect but also to rely on the role of learning skills through the process. The 21st-century learning skills focus on the 4C skills (Communication, Collaboration, Critical Thinking and Problem Solving, Creativity, and Innovation) (Kurniawan, 2020). The development of science and technology in the 21st century requires the Indonesian people to prepare a competent human resource capable of advancing the nation's progress (Hairida et al., 2021). Not only the teachers but also students have to be able to face the development of 21st century. The students are required to collect information from various sources, formulate a problem, think analytically, collaborate, and work together to solve a problem. To keep up with the development of 21st century skills, lab work can be carried out by applying a guided inquiry model to practice the content and apply the theory in real life. Guided inquiry model is an inquiry-based learning model that involves the student actively participating and exploring, and taking a role as a scientist who seeks or solves a problem (Ain & Mitarlis, 2020; Yasin et al., 2019). The guided inquiry learning model helps the students to be actively involved in formulating the problem as well as solving it (Nurlaila & Lufri, 2021; Ulfa et al., 2018). The guide was given to the student in lab work, starting from asking a question to the discussion to the point where the students were able to draw a conclusion (Arantika et al., 2018; Trianto, 2010). The implementation of guided inquiry models can improve scientific attitudes and critical thinking skills (Parwati et al., 2020; Saekawati & Nasrudin, 2021). Thus, the guided inquiry model is expected to be able to provide a positive impact in developing the practical guide. The use of the *colorimeter*® application can be one alternative to overcome the problem of implementing chemistry lab work during distance learning. The *colorimeter*® application version 5.51 was developed by Research Lab Tools, São Paulo, Brazil, and it can be purchased through Google Play Store. The application can facilitate the practice of science experiments through smartphones. The *colorimeter*® application work by utilizing the photodetector where the light can be measured based on its composition of three primary color intensity, namely, red(R), green (G), and blue

(B). The *colorimeter*® application provides accurate measurement in the form of light transmittance of red(R), green (G), and blue (B), which can easily calculate the absorbance (Quartarolli et al., 2021). This is in line with the study which report that a mobile phone camera can be used for the analysis of a spectrophotometer, colorimetric, and fluorescence (Scheeline, 2010).

A study utilizes the use of RGB analyzer application on a smartphone to measure the absorbance of substances (Kuntzleman & Jacobson, 2016). A similar study was conducted and the researcher utilized the *colorimeter*® application to analyze lithium ions based on the formation of $[Fe(phen)_3]^{2+}$ complex and a study that aims to determine the kinetics of the bleaching reaction of allura red-colored food dye by measuring the transmittance in red(R), green (G), and blue (B). These studies prove that *colorimeter*® application can be used as an alternative to *colorimeter*® tools or spectrophotometers to calculate the absorbance at certain wavelengths of light. In this study, the *colorimeter*® application was used in the Developing the Practical Guide for Determination of the Rate and Order of Reactions. The *colorimeter*® application plays a role in determining the rate and the order of reaction of a reactant according to the analysis of the Smartphone based *colorimeter*®. The aim of this study is to develop a product that is a practical guide to aid the students in carrying out lab work during online learning as well as blended learning. Furthermore, this study aims to find out the feasibility of practical guides for determination of the rate and order of reactions based on the *colorimeter*® application; anf to find out the perception of Chemistry education study program students, Faculty of Teacher Training and Education, the University of Tanjungpura on the practical guides for determination of the rate and order of reactions based on the *colorimeter*® application.

2. METHOD

The method used in this research is Research and Development (R&D), which refers to the 4D development model (Thiagarajan et al., 1974), which consists of four stages. These stages consist of define, design, develop and disseminate. However, this research is limited to the develop stage due to the limited time and ability of the researcher. The third stage carried out in this study can be seen in Table 1.

Table 1. Research procedures performed

No.	Step 3D	Activities
1.	Define	- Front-End Analysis - Student Analysis - Concept Analysis - Task Analysis - Specifying Practical Objectives
2.	Design	- Designing Practical Guide - Designing instrument questionnaire validation expert and students' Response
3.	Develop	- Instrument Validation - Validation of Practical Guide - Data Analysis - Revision of practical guide based on expert input - Initial trial to students accompanied by revision - Main trial to students

The subjects of this research are a practical guide for determining the reaction rate and order of reaction based on the *colorimeter*® application which were tested on class 2019 students at the chemistry education study program Universitas Tanjungpura who have taken chemical kinetics courses. A total of 6 students as the initial trial and 20 students as the main trial. In this research, the sampling technique used the practical guide validation sheet instrument, and the students' response questionnaire sheet. The product developed was validated by two experts (in the same expertise) on each aspect, namely content, graphics and language aspects using the *Gregory* test (Gregory, 2015) with validation criteria refer to (Amir et al., 2015). The data obtained were analyzed using a qualitative approach. The students' responses were assessed using a questionnaire. Researchers used a questionnaire consisting of various questions to determine the response of students to the designed practical guide. Analysis of questionnaire data on students' responses to the practical guide developed using the Likert scale (Sugiono, 2015), with four options: strongly agree (SS), agree (S), disagree (TS), and strongly disagree (STS). The use of research instruments aims to obtain information and collect data. The statement on the students' response

questuionnaire involved negative and positive messages. Thus, the researcher used the following rubric in Table 2.

Table 2. Students' Response Questionnaire Conversion Result (Riduwan, 2016)

Positive Statement		Negative Statement	
Answer	**Score**	**Answer**	**Score**
Strongly agree	4	Strongly agree	1
Agree	3	Agree	2
Disagree	2	Disagree	3
Strongly disagree	1	Strongly disagree	4

The quantitative data obtained based on the above assessment then analyzed by using the following formula (Sugiono, 2015) :

$$P = \frac{\sum A}{\sum B} \times 100\% \quad (1)$$

Information:
P = percentage of score earned
∑X = total score of each item
∑Xi = idea number of score

With category score interpretation of numbers presented in Table 3.

Table 3. Score Interpretation Criteria (Riduwan, 2016)

No.	Interval Score (%)	Category
1	81 - 100	Very good
2	61 – 80	Good
3	41 – 60	Enough
4	21 – 40	Less
5	0 - 20	Very Less

3. RESULT AND DISCUSSION

Result

The first stage is the define stage, conducted pre-research to determine and reveal the problems encountered in the Department of chemistry education FKIP Untan especially learning in the laboratory. This stage consists of 5 main steps, namely: (1) Front-End analysis, the problems faced in learning chemical kinetics in the Department of Chemical Education FKIP Untan, among others, the unavailability of compatible practical guides to support the implementation of practical activities that can be used by students in blended learning by involving students' independently in carrying out experiments. In addition, the practical guide used also has not trained students to have 4C (Communication, Collaboration, Critical Thinking and Problem Solving, Creativity and Innovation) skills according to the demands of 21st century competencies, (2) student analysis, the results of this analysis, students have taken chemical kinetics courses and the average students has the age of 19-21 years. At that age stage the child is able to develop his formal mind, can utilize logic and abstraction of the information obtained so that the necessary practical guide who can guide students' to do lab activities independently, train students' to have 4C skills and things that are suitable hypothesis to be given to the student. (3) concept analysis, determine the concepts to be taught. The concept of chemical kinetics obtained is about determining the reaction rate and reaction order. (4) task analysis, the result of the task analysis is a discussion task to determine the reaction rate and reaction order on the absorption of cotton yarn to natural dyes with variations in soaking time, (5) specifying practical objectives, at this stage the formulation of practical objectives and indicators of achievement in the practical guide for determining the reaction rate and reaction order based on the *colorimeter*® application.

The second stage is the design stage. This stage is continued with the development of the initial draft of the practical guide. The developed practical guide consists of several main components including (1) practical title, (2) achievement indicators, (3) Information, (4) orientation, (5) tools and materials, (6) hypotheses, (7) Information Collection, (8) work Procedures, (9) observation results, (10) analysis of observation results, and (11) conclusions. In addition, the practical guide is also equipped with supporting

components including (1) cover, (2) the identity of the practical guide, (3) preface, (4) first aid in accidents (P3K), (5) table of contents, (6) info on the operation of the *colorimeter*® application, (7) Bibliography, and (8) author profile. At this stage, the initial draft is produced in the form of a practical guide for determining the reaction rate and reaction order based on the *colorimeter*® application. In addition, the expert validation questionnaire and students' response questionnaire were also designed as data retrieval instruments. The validation questionnaire consists of 5 items of statement on the language aspect, 12 items of statement on the content aspect, and 6 items of statement on the graphic aspect. The students' response questionnaire consists of 12 items of statements on construction, content, and language aspect.

The development of practical guide continued with the develop stage. A total of 6 experts involved in providing an assessment of the product that consists of two experts on each aspect of the language, content (presentation and convenience), and graphics aspect. Validation in this study aims to minimize errors in several ways, including the concept of content, language, appearance, and determine the feasibility of the product designed. To determine the results of the feasibility assessment by experts, the expert assessment tabulation is carried out to calculate the validity of the practical guide, namely using the gregory test. The validation process was also followed by several revisions until finally a practical guide was suitable for use. The results of validation assessment by each expert are presented in Table 4.

Table 4. Results of Validation Assessment of Two Experts

Aspect	No.	Indicator	Validator		Validity	Description
			1	2		
Language	1.	Readability	4	4		
	2.	Feasibility of Indonesian linguistic	3	3		
	3.	Clarity of information	4	4	1,00	Very High
	4.	Level of language usage	4	4		
	5.	Suitability of students' performances	4	4		
Content	1.	Suitability of content with learning outcomes	4	4		
	2.	Suitability of level of education	4	4		
	3.	Suitability of guided inquiry procedure with the content of guided inquiry-based practical guides	4	4		
	4.	Suitability of the content of guided inquiry-based practical guides with the concept of rate of reaction	3	3	1,00	Very High
	5.	Clarity of practical objectives	3	4		
	6.	Clarity of work procedure	3	3		
	7.	Table order	3	3		
	8.	Students' involvement	4	4		
	9.	Insightful	4	4		
	10.	Ease of practical guides usage	4	3		
	11.	Availability of tools	3	3		
	12.	Availability of substances	3	3		
Graphics	1.	Compatibility of font styles	4	4		
	2.	Compatibility of font size	4	3		
	3.	Display	4	3	1,00	Very High
	4.	Illustration and image	4	4		
	5.	Color variation	4	4		
	6.	Layout	4	3		
Average					**1,00**	**Very High**

Based on Table 4 validation result of the practical guide for determining reaction rate and reaction order based on the *colorimeter*® application on language, content and graphic aspects according to gregory test is 1.00, which is categorized as a very high level. If the coefficient of content validity exceeds 0.8, then it belongs to the high category, so that the practical guide for determining reaction rate and reaction order based on the *colorimeter*® application is valid and usable in essence (Amir et al., 2015). Changes to the practical guide based on suggestions from language validators can be seen in Table 5. Validators language provide suggestions that improve the use of the right words, improve sentences in

accordance with Indonesian grammar rules, and set the correct numbering sequence. Validation of practical guide on content aspects there are several improvements according to the suggestions given by experts. The results of the repair according to the expert advice of the content are presented in Table 6.

Table 5. The results before and after improvements to the Practical Guide on language validation

No.	Before Improvements	After Improvements
1.	KATA PENGANTAR Puji syukur atas kehadirat Allah SWT atas segala limpahan rahmat dan hidayah-Nya sehingga *Penuntun Praktikum Penentuan Laju Reaksi dan Orde Reaksi Berbasis Aplikasi Colorimeter* ini dapat terselesaikan.	KATA PENGANTAR Puji syukur ke hadirat Allah SWT atas segala limpahan rahmat dan hidayah-Nya sehingga *Penuntun Praktikum Penentuan Laju Reaksi dan Orde Reaksi Berbasis Aplikasi Colorimeter* ini dapat terselesaikan.
2.	D. Hipotesis Buatlah hipotesis tentang hubungan waktu kontak dengan adsorpsi, konsentrasi terhadap waktu pada masing masing orde reaksi dan pengaruh konsentrasi terhadap laju reaksi pada proses pewarnaan benang katun !	D. Hipotesis Buatlah hipotesis tentang hubungan waktu kontak dengan adsorpsi, konsentrasi terhadap waktu pada tiap-tiap orde reaksi dan pengaruh konsentrasi terhadap laju reaksi pada proses pewarnaan benang katun !
3.	4. Luka-luka akibat reagen yang dapat dibedakan sebagai berikut. a. Reagen pada mata a) Segera basuh mata dengan banyak air selama minimal 15 menit dengan menggunakan air dingin atau hangat b) Jangan menyentuh mata c) Dapatkan perawatan medis dengan segera apabila masih merasa sakit b. Reagen pada kulit a) Segera cuci dengan banyak air selama minimal 15 menit, celupkan bagian kulit yang terkena reagen kedalam air paling sedikit 3 kali b) Olesi dengan salep levetran dan tutup dengan kasa pembalut c) Jika terjdi iritasi, maka segera dapatkan perawatan medis	4. Luka-luka akibat reagen yang dapat dibedakan sebagai berikut. a. Reagen pada mata 1) Segera basuh mata dengan banyak air selama minimal 15 menit dengan menggunakan air dingin atau hangat 2) Jangan menyentuh mata 3) Dapatkan perawatan medis dengan segera apabila masih merasa sakit b. Reagen pada kulit 1) Segera cuci dengan banyak air selama minimal 15 menit, celupkan bagian kulit yang terkena reagen kedalam air paling sedikit 3 kali 2) Olesi dengan salep levetran dan tutup dengan kasa pembalut 3) Jika terjadi iritasi, maka segera dapatkan perawatan medis

Table 6. The results before and after improvements to the Practical Guide on content validation

No.	Before Improvements	After Improvements
1.	Detailing queries E. Pengumpulan Informasi Temukan sumber bacaan yang dapat membantu anda untuk menemukan informasi berkenaan dengan pertanyaan dibawah ini. Pertanyaan ini disusun berdasarkan rumusan masalah dan dapat digunakan untuk merumuskan hipotesis. 1. Tuliskan apa saja yang kamu ketahui tentang laju reaksi !	E. Pengumpulan Informasi Temukan sumber bacaan yang dapat membantu anda untuk menemukan informasi berkenaan dengan pertanyaan dibawah ini. Pertanyaan ini disusun berdasarkan rumusan masalah dan dapat digunakan untuk merumuskan hipotesis. 1. Tuliskan apa saja yang kamu ketahui tentang : a. Pengertian laju reaksi b. Persamaan laju reaksi c. Perbandingan laju reaksi pengurangan reaktan dan penambahan produk
2.	Clarify the concept of RGB and its use in color measurement Aplikasi *colorimeter* memanfaatkan kamera *smartphone* sebagai fotodetektor dimana cahaya dapat diukur berdasarkan komposisinya dalam hal intensitas warna primer yaitu *red* (R), *green* (G) dan *blue* (B). Zat berwarna umumnya menyerap sebagian dari radiasi tampak yang berasal dari spektrum elektromagnetik (Gambar 1A). Dengan menggunakan roda warna yang ditunjukkan pada gambar 1B, warna larutan yang akan dipelajari ditempatkan (warna pantul) dan intensitas warna komplementer (warna yang diserap) diambil sebagai dasar pengu	Aplikasi *colorimeter* memanfaatkan kamera *smartphone* sebagai fotodetektor dimana cahaya dapat diukur berdasarkan komposisinya dalam hal intensitas warna primer yaitu *red* (R), *green* (G) dan *blue* (B). RGB merupakan suatu metode penggambaran warna dimana dari ketiga komposisi warna tersebut dapat dibuat beragam spektrum warna lainnya. Penganalisis RGB mampu menentukan nilai RGB rata - rata gambar dalam tampilan kamera sebagai pendeteksi cahaya. Za
3.	Add an equation of the order reaction Grafik Hubungan konsentrasi vs waktu | Regresi Linier (Pers. Garis, koefisien korelasi (R^2)) | Tetapan Laju Reaksi (k) Orde 0	Grafik Hubungan konsentrasi (y) vs waktu (x) | Regresi Linier (Pers. Garis, koefisien korelasi (R^2)) | Tetapan Laju Reaksi (k) Orde 0 $[A]_t = [A]_0 - k\,t$ y = x

Based on Table 6, the content expert validators provide suggestions that detail the questions in the Information Collection section to make it easier for students to understand the question, clarify the concept of RGB and its use in color measurement in the Information section, and add an equation of order reaction in the observation section table to make it easier for students to make graphs. There are several improvements suggested by graphic experts in varying the appearance of the practical guide. The results of the repair can be seen in Table 7.

Suggestions for improvement submitted by graphic experts in Table 7 are to adjust the use of images to the topic of discussion on the cover of the practical guide and increase the size of the image to be proportional. The input aims to make the appearance of the practical guide more interesting so that it can motivate students in learning. After practical guide for determining reaction rates and reaction orders based on the *colorimeter*® application, it was stated that it was feasible to use it and make improvements according to the advice of experts. Continued with students' response test to practical guide. Practical

guide was tested on chemistry education students of FKIP Untan who had taken chemical kinetics courses by being given an instrument in the form of a 4-scale likert response questionnaire that had previously been validated. The instrument was distributed to 6 students of chemistry education FKIP untan as the initial trial and 20 students as the main trial. The response questionnaire consists of three aspects, namely construction, content, and language. The initial trial process was followed by revisions until finally a more perfect practical guide was obtained to conduct the main trial. The results of the initial response test can be seen in Figure 1.

Table 7. Results before and after improvements to the Practical guide on graphs validation

No.	Before Improvements	After Improvements
1.	Adjusting the use of images with the topic of discussion on the cover of the practical guide	
		
2.	Increase the size of the image to be proportional	
		

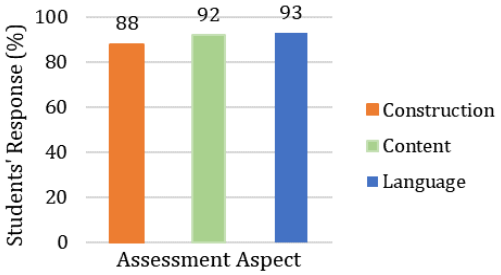

Figure 1. Percentage of Students' Response Test Results in The Initial Trial

Based on the results of students' response data on the initial trial porridges to guide the practical of determining the reaction rate and reaction order based on *colorimeter*® applications, percentage obtained on the aspects of construction, contents, and language were 88%, 92%, and 93% and overall percentage obtained 91%. The figure of 81% - 100% is a very high response interpretation criterion. The input submitted by the students in the initial trial is to improve some sentences in accordance with the rules of the Indonesian grammar rules, add a mark on the image presented so as to clarify the information referred to in the section how to operate the *colorimeter*® application, flatten the first aid section in accidents (p3k), and the bibliography and enlarge the answer column. After the revision, followed by the main trial porridge on 20 students of chemistry education FKIP Untan. The results of students' responses to the main try porridge can be seen in Figure 2.

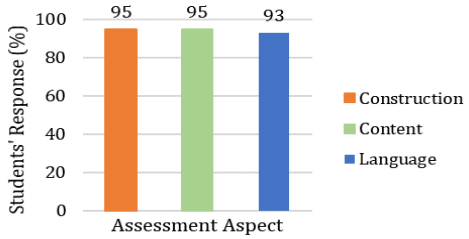

Figure 2. Percentage of Student Response Test Results in The Main Trial

Based on the results of students' response data in the main trial to the practical guide for determination of reaction rate and reaction order based on *colorimeter*® on aspects of construction, contents, and language get a very good response with a percentage of 95%, 95%, and 93% respectively with an overall percentage of 94%. The figure of 81% - 100% is a very high response interpretation criterion. Thus, it can be concluded that the practical guide for determining the reaction rate and reaction order based on the *colorimeter*® application received a positive response from the students of Chemistry Education FKIP Untan so that the practical guide developed can help students in doing practical both online and blended learning, and facilitate students in understanding the concept of reaction rate, especially the determination of reaction rate and reaction order.

Discussion

The primary purpose of this study is to produce a valid and feasible practical guide for determining the reaction rate and reaction order based on the *colorimeter*® application. In the development process, this practical guide received some inputs, and suggestions from experts who were competent in their respective disciplines, particularly in terms of language, content, and graphic elements. The purpose of the validation was intended to measure the suitability of the practical guide draft in terms of the language, content concepts, and visual displays (graphics) used in the practical guide based on the assessment given by the competent expert in their field. The use of the guided inquiry model in this practical guide is to improve students' activity in conducting chemical kinetics practical activities. It is consistent with previous study who stated that the guided inquiry model could engage students in actively seeking and placing them as the scientists who can find or solve a problem (Ain & Mitarlis, 2020; Simatupang et al., 2017). This viewpoint is supported by research who argue that the students can be actively involved in proposing problems to solve them using guided inquiry models (Gunawan et al., 2019; Ulfa et al., 2018). By finding solutions to their problems, students become more motivated to learn (Haryadi & Pujiastuti, 2020; Ledi et al., 2021). The use of the inquiry module is an effective way to improve students' inquiry, and critical thinking skills (Arantika et al., 2018; Hairida, 2016).

The practical guide in determining the reaction rate and reaction order applied the *colorimeter*® application to determine the absorbance of a sample through RGB analysis by a smartphone camera. The design of the practical guide acquired suggestions and input from experts during its development. The feasibility test was conducted to assess the validity of the practical guide in the form of its language, content, and graphics aspects. The objective of language validation is to evaluate the validity of the practical guide draft in terms of readability, the feasibility of Indonesian linguistics, clarity of information, and conformity with students' performances. The feasibility test results show that the practical guide for determining reaction rate and reaction order based on the *colorimeter*® application is valid and usable in essence. Furthermore, it indicates that the language used in the practical guide is applicable, simple, communicative, consistent with students' intellectual performance, coherent with proper Indonesian grammar rules and that it can motivate students to learn the content of the practical guide. The ideal practical guide is not complicated withinside the sentence editor (Panjaitan et al., 2021; Sari et al., 2018). This is in line with previous study who stated that multiple interpretations of a sentence could be avoided through the use of appropriate language, as well as helping readers understand and learn the information (Panjaitan et al., 2021). In the aspect of conformity with the Indonesian grammar rules, there are several corrections in terms of writing errors, such as the use of conjunctions, standardized terms, and sequential numbering. The content validation showed excellent criteria based on the aspects of content feasibility, content presentation, and usefulness. Whereas the content of the practical guides is designated as not requiring significant revision, experts' judgments and suggestions for improvement are nonetheless taken into account for the additional revisions. Learning media can effectively communicate meaning or content if it is incorporated with clear content along with graphics (Istifarida et al., 2017; Rakhman et al., 2017). Based on the results of content validation, the validator advises elaborating on the questions and trying to make the concept more explicitly clear. Students may find it simpler to comprehend the significance of

questions if they are clear and relate to the current issues (Kristiana & Muhibbin, 2019; Putri et al., 2019). Misconceptions cannot occur if intuitive thinking that appears spontaneously in problem-solving is not wrong and students' reasoning or logic is correct in drawing conclusions and is too broad in generalizing (Kusumawati et al., 2021; Sheftyawan et al., 2018). The result of validation for the graphic aspect obtained a value of 1.00, which is categorized as a very high level. In the graphic aspect, there are five indicators that consist of the selection of font style, font size, display, illustrations, and images, as well as layout. The appearance of attractive learning media created by combining various images or animations might encourage students to learn more so that it can improve their performance (Alexander et al., 2018; Antara et al., 2022). By the illustrations, it is meant to offer a variety of practical guides so that teaching contents become engaging, inspiring, and communicative, assisting students in remembering and comprehending the content. This is similar to previous study who states that the cover illustration serves as the textbook's primary display face and should be attractive, motivating, communicative, and have a positive impression (Arifin & Kusrianto, 2009).

The purpose of collecting students' responses is to analyze the responses towards the use of practical guide for determining the reaction rates and reaction orders based on the *colorimeter*® application. This response test is viewed from three aspects, namely, construction, content, and language. The overall response rate was 94% in the main test, and it is categorized as a very good criterion. The construction aspects encompass clear pictures, readable letter display, acceptable text and image layout (without any blocking), attractive color scheme, and overall attractive appearance (Kunandar, 2013). The results of students' responses to the construction aspect are 95% in the main trial which is categorized as a very good category. This demonstrates that the practical guide is interesting in terms of design, applicability, and clarity of the graphics and photos offered that can stimulate students' interest in reading and studying the reaction rate content. The existence of a coherent combination of colors, letters, and images can provide the reader with an overview of the content so that it can stimulate their interest (Muswita et al., 2020). It is similar to a study who found that students were indeed interested in studying the content if it is presented in an attractive and understandable way (Istifarida et al., 2017).

The practical guide for determining the reaction rates and reaction orders based on the *colorimeter*® application can make it easier for students to understand the content. This is proven through the students' response to the content and language aspects, with each of the overall score percentages of 95% and 93% in the main trial with very good criteria. The presence of this practical guide might help the student understand the concept of determining reaction rates and reaction orders. It can be proven from the statement in point 6, which stated that "A practical guide based on the *colorimeter*® application can assist me in understanding the concept of determining the reaction rate and reaction order," with the result of a percentage of 93%". Besides, the presentation of information related to reaction rates, application of *colorimeter*®, and the use of natural dyes can gain more knowledge to students. It is confirmed by the statement in point 5, which states that "Information in the *colorimeter*® application practical guide can add more knowledge," which obtained a percentage of 98% with a very good category. The use of *colorimeter*® program to determine absorbance is considered a great step for students in implementing technology for practical purposes. By utilizing technological developments, it can improve the pedagogic competence of Chemistry Education students as competent teachers in the future. Integrating technology into the teaching and learning process can increase teachers' pedagogical competence in terms of knowledge development and educational quality (Purnasari & Sadewo, 2020). Additionally, information concerning environmental issues might stimulate pupils' interest in learning (Istifarida et al., 2017). The results of the language aspect of the students' response test prove that the language in the practical guide for determining reaction rates and reaction orders based on the *colorimeter*® application is used properly and clearly, which makes it easier for students to understand the content for determining reaction rates and reaction orders. If language is utilized correctly to avoid double interpretation, readers will more readily understand the intent and meaning of each word employed (Panjaitan et al., 2021). Readers will more easily understand the intent and meaning of each word used if language is used properly so that multiple interpretations can be avoided (Panjaitan et al., 2021).

4. CONCLUSION

This research produces a product in the form of a practical guide for determining the reaction rate and reaction order based on the *colorimeter*® application. Based on the results of expert validation of the practical guide for determining the reaction rate and reaction order based on the *colorimeter*® application, it revealed that the product is very valid in terms of language, content, and graphic aspects so that it can be used in carrying out practical activities, especially determining reaction rates and reaction

orders. In addition, the results of the Chemistry Education students' response test showed a positive response to the developed practical guide. Hence, it can be concluded that the practical guide for determining reaction rates and reaction orders based on the *colorimeter*® application has an attractive appearance and can be used by students in carrying out practical activities in order to help them understand the concept of reaction rate.

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