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Development of Structured Assignment Sheets on Factors Affecting Reaction Rates to Train Concept Building Skills

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ABSTRACT: The objective of this study is to develop a Structured Assignment Sheet for Concept Building Ability, abbreviated as LPT-KMK, that is feasible for use as a learning tool on the topic of factors influencing reaction rates. This research adopts a research and development (R&D) methodology to design and refine the LPT-KMK. The feasibility of the developed LPT-KMK is assessed based on three criteria: validity, practicality, and effectiveness. The LPT-KMK, which was developed and validated by expert reviewers, was trialed in June 2024 with a group of 25 eleventh-grade students from SMAS Muhammadiyah 10 Sugio, located in the Lamongan district. The instruments employed in this study included review sheets, validity assessment sheets, student response questionnaires, and concept-building ability tests. The findings indicate that the LPT-KMK achieved a mode score of 4 for both construct and content validity, classifying it as valid. Additionally, the practicality of the LPT-KMK was confirmed, with student response percentages ranging from 84% to 100%. The effectiveness of the LPT-KMK was validated through statistical analysis of student test results using the statistical application. The implementation of the LPT-KMK material on the topic of factors affecting reaction rates resulted in significant improvements in student performance. Therefore, the developed LPT-KMK is considered valid, practical, effective, and suitable for use as a learning device in chemistry education, specifically in teaching factors influencing reaction rates.

Keywords: concept building ability, factors affecting reaction rate, structured assignment sheet

INTRODUCTION

In the modern era, students learning more integrates knowledge and skills [1]. This day, the demands on students have become increasingly complex. Due to these responsibilities, students require support in order to develop their knowledge and abilities on their own. Therefore, it needs to be integrated into learning that has been supported by the merdeka curriculum. The merdeka curriculum serves as a support for students with the aim of improving the understanding material of the nation's generation [2]. The merdeka curriculum optimizes intracurricular learning and gives students enough time to understand the concepts of the material and strengthen their abilities in understanding the material [3].

According to Kusdiningsih [4], students do not have the ability to construct knowledge independently, it causes students to master concepts at a low level. Whereas in chemistry learning, students are required to master various concepts. The fact that students are rarely given activities that can train them to build the correct concepts. The concept of factors affecting the reaction rate is one of the chemistry concepts related to reaction rates that students still find difficult to understand [5]. In addition, the interview results also show that many students lack understanding of the concept of factors affecting the reaction rate. This is also supported by research conducted by Wulansari [5] and Andromeda [6], which states that many students lack understanding of the concept of factors affecting the reaction rate. This is also in line with the research conducted by Istiqamah [7], which claims that because students prefer to memorize information rather than develop and comprehend concepts, they still have a limited comprehension of the concept of factors affecting reaction rates.

Students' comprehension of the concept of factors affecting the reaction rate is influenced by both social and external factors. External factors that influence students' mastery of concepts in 2024 include the teaching methods employed by teachers, the lack of conducive learning time, the learning materials provided by teachers, and inadequate teaching resources [8]. Social factors related to the learning activities conducted by teachers, such as the chosen teaching methods or models, and the teaching materials used by teachers, additionally impact students' low comprehension of the concept of factors affecting reaction rate [9]. These social and external factors make it evident that the teacher's role and the learning resources are crucial to students' comprehension of the concept of factors affecting reaction rate. Therefore, follow-up actions are needed to improve students' conceptual understanding by developing their ability to construct concepts, especially in chemistry lessons on the factors affecting reaction rates.

One alternative that teachers can use to develop students' conceptual building skills is by implementing structured assignments for students [10]. Structured assignments can be optimally carried out with the presence of structured assignment sheets. The level of students' conceptual knowledge is positively influenced by the use of structured assignment sheets [11]. Learning using structured assignment sheets is also known to be valid, practical, and effective in chemistry education [12].

Based on that description, to train students' ability to build concepts, the researcher developed a structured assignment sheet on the factors affecting reaction rates. The structured assignment sheet that was developed was then given the acronym LPT-KMK. In this research, a learning device was produced, namely the LPT-KMK on the topic of factors affecting reaction rates, whose feasibility has not yet been determined. Thus, this research has the main objective of producing a valid and practical LPT-KMK that can be used as a learning device for the topic of factors affecting reaction rates. Valid, practical, and effective are the three standard development criteria that must be met for it to be considered as a suitable learning device [13, 14].

The developed LPT-KMK is expected to help improve students' ability to build concepts in understanding chemistry concepts. In addition, In order to maximize the amount of time allotted for students' individual activities and scheduled tasks, LPT-KMK can also be used as a guide while creating chemistry learning device.

RESEARCH METHODS

Research and development in the area of chemistry education is the kind of study that is being carried out. The research and development method, also known as (R&D), was used in this study. The process of creating a product and evaluating its effectiveness is known as research and development method [15]. The even semester of the 2023/2024 school year was when this study carried out. In June 2024, data for this research was gathered at SMAS Muhammadiyah 10 Sugio, which is located in the Lamongan Regency.

The steps of the Research and Development (R&D) approach serve as a base for the research procedure(1) Problem and potential analysis; (2) data collection; (3) product design; (4) design validation; (5) design revision; (6) product testing; (7) product revision; (8) field implementation testing; (9) final product refinement; (10) dimensioning and implementation are the steps that comprise the Research and Development (R&D) method [15]. The Research and Development (R&D) research method's steps are modified in this research project based on the needs of the investigation. Therefore, the following are the specific steps of the Research and Development (R&D) approach in this research: (1) analysis of the issue and its possibilities; (2) gathering of information; (3) design of the product; (4) validation of the design; (5) modification of the design; (6) testing of the product; (7) product. This aligns with the research needs, which is to produce a viable product in the form of LPT-KMK material on factors affecting the reaction rate.

To determine the feasibility of LPT-KMK in this study, it is necessary to conduct a validity test consisting of content and construct validity, practicality test, and effectiveness test. The instruments used in this study consist of review sheets and validity sheets, student response questionnaires, and concept-building ability test sheets. The review and validity sheets are used to obtain validity data, which is then processed to determine the validity of the LPT-KMK. The LPT-KMK's practicality is assessed by processing the student response data that is obtained from the student response questionnaire. To ensure the effectiveness of the developed LPT-KMK, a concept-building ability test sheet was used,

namely pre-test and post-test sheets for students to collect information about the scores obtained from completing the pre-test and post-test sheets. The students response questionnaire and the pre-test and post-test have been previously validated before use.

The LPT-KMK validity data, student response data, and the outcomes of the students' pre- and post-test scores are among the quantitative data generated by this research. Validation of the LPT-KMK design, the fourth step of the research and development (R&D) method, produces validity data. The sixth step of the research and development (R&D) method is product testing, conducted after revising the design based on previous validation results. Data that shows practicality and effectiveness are the results of the pre-test and post-test questionnaire scores.

The Likert scale in Table 1 was used in a quantitative descriptive analysis of the validity data [16].

TABLE 1. Likert Scale

Assessment	Scale Value
Very invalid	1
Less valid	2
Quite valid	3
Valid	4
Very valid	5

The content and construct validity of the LPT-KMK are declared valid and suitable for use if the validity score reaches a minimum of 4 with a valid category.

The practicality of LPT-KMK is obtained through a descriptive quantitative analysis with percentages from the Guttman scale. The percentage of student responses to the questionnaire with a firm "Yes" statement gives a value of 1 and a "No" statement gives a value of 0 using the Guttman scale [15]. To obtain the percentage from the Guttman scale, the following formula is used [17]:

$$\text{Percentage (\%)}: \frac{\sum \text{total score}}{\sum \text{criteria score}} \text{ x } 100\%$$

The percentage obtained is then interpreted within 5 response score criteria. The criteria for interpreting response scores are showed in Table 2 [16].

TABLE 2. Response Score Interpretation Criteria

Percentage (%)	Criteria
0-20	Very impractical
21-40	Not practical
41-60	Quite practical
61-80	Practical
81-100	Very practical

Table 2 shows that if the percentage of results with practical criteria is greater than or equal to 61%, LPT-KMK is deemed straightforward to use for learning.

Students' pre-test and post-test data are analyzed to determine the effectiveness of LPT-KMK. Before students are given LPT-KMK, a pre-test is given to ascertain their starting skill levels. Additionally, after using LPT-KMK, a post-test is administered to ascertain student proficiency. The statistical application program is then used to examine the collected data in order to ascertain whether the pre-test and post-test data are normally distributed using Kolmogorov-smirnov test. If the p-value is greater than 0.05, the pre-test and post-test data are regarded as normally distributed. The statistical application program then uses a one-tailed t-test to test the pre-test and post-test data after determining that the data is normally distributed.

This one-tailed t-test assumes that:

- H_0: The post-test scores after using LPT-KMK do not differ from the average pre-test scores before using LPT-KMK.
- H_1: The post-test scores after using LPT-KMK differ from the average pre-test scores before using LPT-KMK.

A one-tailed t-test can be used to determine that if the t-test value is larger than or equal to the t-table = t(α,db), then H_0 is rejected and H_1 is accepted. This indicates that the post-test scores after the use of LPT-KMK different from the average pre-test scores before the use of LPT-KMK. The post-test score after the application of LPT-KMK does not different from the average pre-test score before the application of LPT-KMK if the t-test value is less than t-table = t(α,db). In this case, H_0 is accepted and H_1 is refused. If students' concept-building skills significantly improve after using LPT-KMK, it is considered effective. This is shown by the results of a one-tailed t-test, which show a significant difference in the conceptual building skills of the students, with H_0 being refused and H_1 being accepted.

Valid, practical, and effective are three standard development criteria that must be met for a learning device to be considered suitable for use [13]. Thus, LPT-KMK can be concluded to be suitable for use if it meets three criteria: valid, practical, and effective.

RESULT AND DISCUSSION

The research conducted under the title "Development of Structured Assignment Sheets on Factors Affecting Reaction Rates to Train Concept Building Skills" resulted in structured assignment sheets to train conceptual building skills which is acronym as LPT-KMK. Structured Assignment Sheet (LPT) is a learning device to guide students' learning activities outside of face-to-face hours to achieve specific learning objectives [18]. The developed LPT-KMK is used as a structured assignment for students outside of face-to-face hours to train their ability to independently construct concepts.

The developed LPT-KMK must be tested for its feasibility before being used as a learning device. In this research, an LPT-KMK was produced whose feasibility is yet to be determined. Three requirements must be met for the LPT-KMK to be considered suitable for use: it must be valid, effective, and practical [13]. The developed LPT-KMK was then reviewed and validated by chemistry lecturers as an expert, resulting in suggestions and feedback for the development of LPT-KMK, so that improvements could be made and it would be ready for effectiveness and practicality testing.

Feasibility Test Based on the Validated LPT-KMK

Two aspects of validity criteria are construct validity and content validity [15]. The validity test for the developed LPT-KMK was conducted by three chemistry lecturers by filling out the provided validity sheets. The validity data were obtained from the completion of the validity sheets by three validators who are chemistry lecturers. Table 3 below presents the following content validity data.

TABLE 3. Data Results of Content Validity

No.	Score			Modus	Category
	V1	V2	V3		
1	4	5	5	5	Very Valid
2	4	4	5	4	Valid
3	4	4	4	4	Valid
4	4	4	4	4	Valid
5	4	4	5	4	Valid
6	4	4	5	4	Valid
7	4	4	5	4	Valid
8	4	4	5	4	Valid
9	5	4	5	5	Very Valid

Table 3 shows that the mode score from three validators for the numbers 1 and 9 is five, which falls into the very valid category. With the valid category, the mode score for the numbers 2, 3, 4, 5, 6, 7, and 8 is four.Thus, it can be stated that the LPT-KMK is declared valid in terms of content validity.

The assessment of construct validity was also conducted by three validators. The data on construct validity results are presented in Table 4.

As can be shown from Table 4, the three validators' mode score is 4, which is classified as valid. As a result, the LPT-KMK has been deemed valid in terms of construct validity. According to the results of

the validity data analysis, LPT-KMK is considered valid in terms of both construct validity and content validity. Therefore, it can be said that the LPT-KMK is considered valid and suitable for use.

TABLE 4. Data Results of Construct Validity

No.	Score			Modus	Category
	V_1	V_2	V_3		
1	4	4	5	4	Valid
2	4	4	5	4	Valid
3	4	4	5	4	Valid
4	4	4	5	4	Valid
5	4	4	5	4	Valid
6	4	4	5	4	Valid

Feasibility Test Based on Practicality of LPT-KMK

LPT-KMK's practicality is determined by the results of processing the data collected from the students' answered questionnaire which the questionnaire sheet has been previously validated. LPT-KMK can be considered practical if it can be used and operated easily by students. Students complete the student response questionnaire after their application of the LPT-KMK and post-test. The Guttman scale is used to measure students' positive perception of the LPT-KMK based on fifteen statements, with a score of 1 for the "Yes" answer option and a score of 0 for the "No" answer option. After processing the students' responses to the questionnaire, the percentages of each response were calculated. Table 5 presents the data from the students' questionnaire answers.

TABLE 5. Data Results of Student Respondent Questionnaire

Statement Item	Number of Positive Perceptions (Response "Yes")	Percentage (%)
1	25	100
2	25	100
3	25	100
4	25	100
5	25	100
6	25	100
7	25	100
8	25	100
9	25	100
10	25	100
11	25	100
12	21	84
13	25	100
14	25	100
15	25	100

After the data had been processed and analyzed, all participants (100%) agreed that (1) the LPT-KMK's language is easy to understand; (2) LPT-KMK uses sentences that do not cause multiple interpretations; (3) the activity instructions in LPT-KMK are clear, making it easier for students to carry out the activities; (4) the choice of font type, size, and spacing used makes it easier to read LPT-KMK; (5) LPT-KMK has an engaging presentation style; (6) the variety of activities, assignments, questions, and illustrations help students develop their chemistry skills; (7) students can acquire knowledge independently with the help of LPT-KMK; (8) LPT-KMK is able to make students think about various aspects of the material on factors affecting the reaction rate; (9) the content of LPT-KMK is considered

beneficial for students; (10) students find it easy to build concepts; (11) students can apply the concepts they have acquired to existing problems; (12) students can conclude and build concepts; (13) students gain knowledge that is not obtained in the classroom regarding factors that influence the reaction rate; (14) students enjoy studying chemistry, specifically the material on factors affecting the reaction rate. There is one statement in the statement item 12, there are 84% of students who stated that they understood a lot of the material in LPT-KMK. According to Table 5, with a very practical category the percentage of student response scores ranges from 84% to 100%, referring to Table 2 for the response score interpretation category. Thus, it can be concluded that LPT-KMK falls into the very practical category and meets the requirements in terms of practicality.

Feasibility Test Based on Effectiveness of LPT-KMK

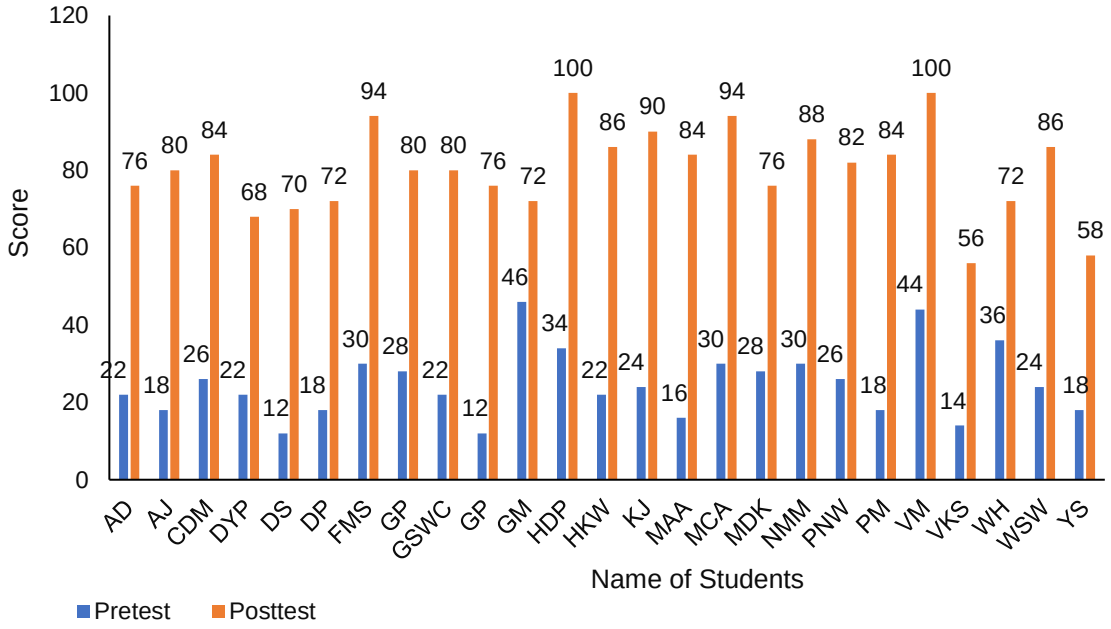

FIGURE 1. Results of the Student's Pre-test-Post-test

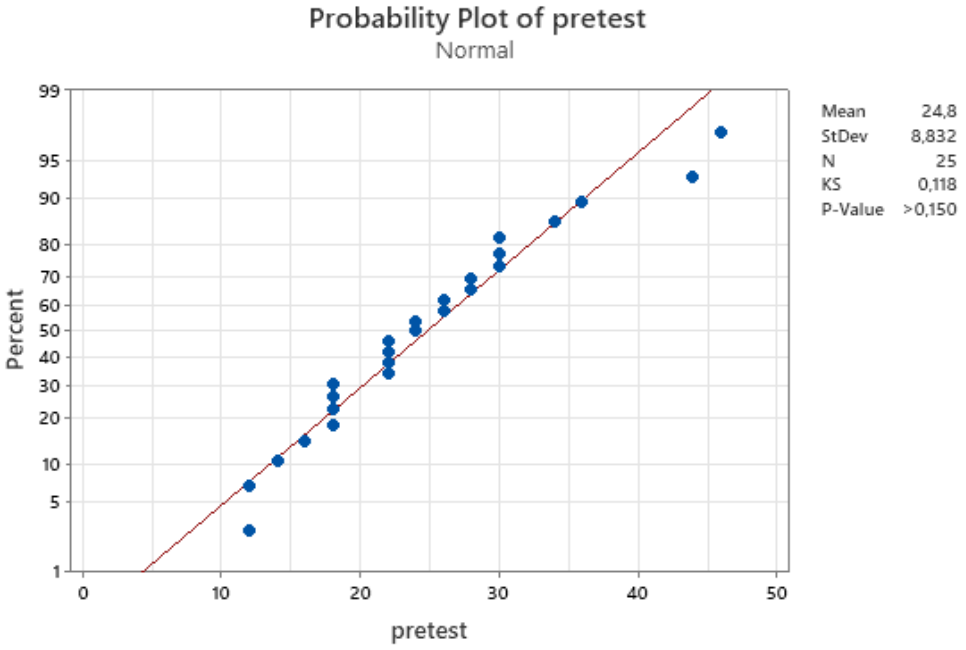

FIGURE 2. Results of the Pre-test Normality Test

In this research, the pre-test and post-test methods were employed as the test method to determine students' conceptual knowledge. To find out the students' starting skill levels before to administering the LPT-KMK, a pre-test was held. The pre-test and post-test questions sheet have been validated before. After the pre-test is conducted, the students are then given the LPT-KMK. To figure out the students' ability after the application of the LPT-KMK, a post-test was held. Figure 1 show the test sheet results that the students submitted.

The students test results showed that the pre-test score ranged from 12 to 46, with 12 being the lowest score. As for the post-test scores, the lowest is 56 and the highest is 100. Using the statistical application with the Kolmogorov-Smirnov test, a normality test was then carried out on the collected pre-test and post-test data.

According to Figures 2 and 3, the results of the pre-test and post-test have a p-value of 0.150 > 0.05, which suggests that the data are normally distributed. A one-tailed t-test was then carried out using the statistical application program after completion of the normality test and confirmed that the pre-test and post-test data are normally distributed using Kolmogorov-smirnov test. Table 6 presents the findings of the one-tailed t-test for the pre-test scores.

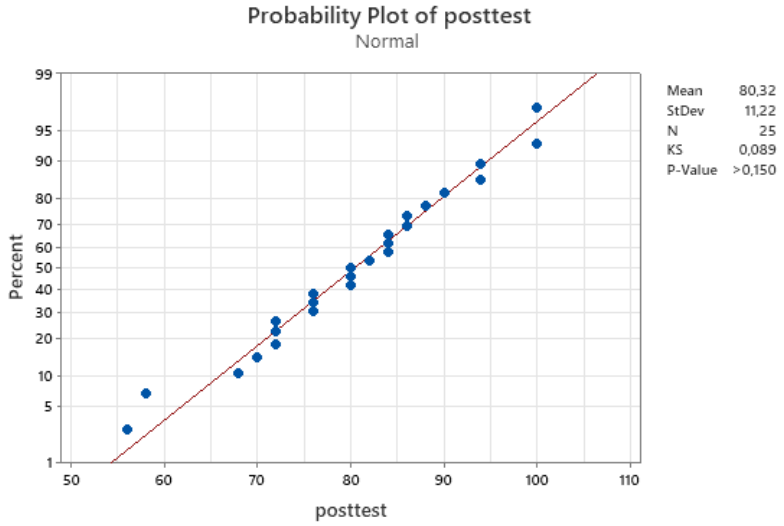

FIGURE 3. Results of the Post-test Normality Test

TABLE 6. Results of the One-tail t-test Pre-test LPT-KMK

N	Mean	StDev	SE Mean	95% Lower Bond for μ
25	24.80	8.83	1.77	21.78

μ: population mean of pre-test

Pre-test scores are known to average 24.80, which can be rounded to 25. The students' average pre-test score was 25, indicating that they still do not have strong concept-building abilities. The LPT-KMK pre-test sheet's questions have addressed every element of the concept-building ability indicators.

A one-tailed t-test was used on the students' post-test score data after a one-tailed t-test was used on the pre-test score data. Table 7 displays the results of the one-tailed t-test on the post-test scores of the students.

Based on the data processing results (Table 7) using the statistical application with a one-tailed t-test, the determination of t-table can be conducted. t-table can be determined using the data N, which is 25, resulting in df = 24, and the significance value of 0.05 is known to be 1.71. A t-test value of 24.65 and a p-value of 0.000 were the results of the statistical computation. The hypothesis leads to the conclusion that H_0 is rejected and H_1 is accepted since the t-test of 24.65 ≥ the t-table of 1.71. Therefore, it can be concluded that there is a difference between the average pre-test scores before using LPT-KMK and the post-test scores after using it. LPT-KMK is declared effective with a significant difference in pre-test and post-test scores, indicating the level of understanding of concepts among the students.

TABLE 7. Results of the One-tail t-test Post-test LPT-KMK

N	Mean	StDev	SE Mean	95% Lower Bound for μ
25	80.32	11.22	2.24	76.48
μ: population mean of post-test				
			Null hypothesis	H_0: μ = 25
			Alternative hypothesis	H_1: μ > 25
			T-Value	24.65
			P-Value	0.000

The pre-test and post-test sheets employ three components as indicators: defining a concept, restating a concept, and applying a concept. The test results indicate that (1) all students were able to accurately define the concept in the first component, which is define the concepts; (2) in the second component, which is restating the concept, all students were also able to restate the concept correctly; (3) in the third component, which is applying the concept, there are 7 out of 25 students who still have difficulty applying the concept after using LPT-KMK. This may occur because LPT-KMK is still unfamiliar among the 11th-grade students of SMAS Muhammadiyah 10 Sugio. It is well known that students barely apply concepts to difficulties they encounter during learning activities, according to the outcomes of an interview conducted with a chemistry instructor at SMAS Muhammadiyah 10 Sugio. During the pre-test, the students only answered a few questions on the concept-building ability indicator. This also happens because the students are not yet accustomed to being encouraged to build concepts independently. Chemistry teachers and students at SMAS Muhammadiyah 10 Sugio also confirmed that they have never been trained in concept-building skills in the subject of chemistry. The use of LPT-KMK implemented gradually can enhance students' ability to construct concepts, thereby improving their understanding of the concepts taught in the subject matter.

This research has similarities with previous research in that using structured assignment sheets to teach chemistry is likewise known to be a valid, practical, effective method of instruction [12]. Since the LPT-KMK created by the researchers in this research is comparable to earlier research, it can be said that it is appropriate for student usage as well because it satisfies the requirements of validity, practicality, and effectiveness.

CONCLUSION

Based on the analysis of data and discussion, it can be concluded that: (1) the developed LPT-KMK is feasible for use in terms of content and construct validity; (2) the developed LPT-KMK demonstrates high practicality; and (3) the developed LPT-KMK is effective, as indicated by the acceptance of hypothesis H_1, showing significant improvements. Therefore, the LPT-KMK constitutes an appropriate instructional tool for teaching chemistry, particularly in the topic of factors influencing reaction rates.This study specifically resulted in the development of a structured assignment sheet focused on the topic of factors affecting reaction rates. The findings confirmed that the structured assignment sheet is valid, practical, and effective in facilitating students' conceptual understanding. Consequently, it is recommended that future research explore the development of structured assignment sheets for other chemistry concepts to further enhance the quality of learning in this discipline.

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