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Development of Website-Based Learning Media on Reaction Rate Material to Improve Student Learning Outcomes

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Abstract
This development research aims to describe the feasibility of website-based learning media for reaction-rate material. The feasibility of learning media is reviewed in terms of validity, practicality, and effectiveness. Media validity is measured by content validity and construct validity. The practicality of the media is measured by student responses and activities. Effectiveness is measured by the percentage of classical completeness and the improvement of students' learning outcomes. The research method used in this research is Borg and Gall's Research and Development (R&D) method, which has been modified by Sukmadinata. Media trials were conducted at SMA Negeri 20 Surabaya on 33 students of class XI MIPA 2 who had previously received reaction rate material. This website-based learning medium is declared feasible. The results of content and construct validity show valid results in each aspect with a mode between 4 and 5. Practicality results show that web-based learning media is practical with 98,10% of relevant student activities at the first meeting and 99,05% at the second meeting, while the percentage acquisition of each aspect in the student response gets a percentage of 90%. The results of the effectiveness of learning media obtained classical completeness results of 87.9% and an N-Gain score of 0.78. This is supported by the results of the Paired sample t-test of 0.000, which means there is a significant average difference in learning outcomes.

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INTRODUCTION

The world of education has undergone a major upheaval in the 21st century. Developing the talents and potential of learners in the era of globalization requires teachers to show that, although things have changed, they are not difficult. Education is at the core of a nation's progress. With such great demands on human resources in this century, teachers must innovate in the learning process. (Hasibuan & Prastowo, 2019). Kustandi dan Sutjipto (2011) said the learning media used by teachers is very important for learning because it helps improve the learning process and helps clarify the meaning of the message, so that it can achieve learning objectives better and perfectly.

Learning media has recently applied technology in its manufacture. The media used by teachers at first was still in the form of media that could only be used offline. The media still has some shortcomings such as ineffective distribution. Based on the results of pre-research conducted at SMAN 20 Surabaya, it proves that 71.4% of the use of learning media in the classroom uses blackboard media and 23.8% uses book media. According to Nurchaili's research (2010) showed that the average value of conventional chemistry learning outcomes

was 62.05 with a standard deviation of 13.133, while the average value of IT-based chemistry learning outcomes was 89.06 with a standard deviation of 4.748.

Chemistry is one of the materials taught in high school. Some of the materials in chemistry are in the form of concepts with abstract examples, such as the reaction rate material. Based on preliminary research at SMAN 20 Surabaya, it can be seen that 52.4% of students find the reaction rate material difficult to understand. According to Cakmakci, Donnelly & Leach (2003), this difficulty stems from the fact that the concepts in reaction rate material tend to be abstract and involve challenging chemical calculations, and learners also need to understand other fundamental concepts such as stoichiometry and concentration. Representative learning media that can be viewed anytime and anywhere is needed because this material requires in-depth understanding.

One of the learning media that can support student learning outcomes and facilitate understanding of chemistry material is using website-based learning media. Utilizing the website is one of the ICT applications used in education. The website is an innovation that has made a considerable contribution to changes in the learning process. Students can actively participate in the learning process by reading, observing, asking questions, collecting data, associating, and communicating in addition to listening to the teacher explain the subject matter. teaching materials can be visualized in various forms that are more dynamic and interactive, to encourage students to be more involved in the learning process (Harmoko et al., 2017). According to Rahman (2014), The use of websites allows learners to access and obtain information from text, graphics, images, photos, animations, audio and video. The existence of audio and video features in the media can increase students' interest in learning. Web-based learning media can also be used during the learning process or independently for students to learn at home.

Based on the results of preliminary research, website-based learning media is still rarely used by teachers and 90.5% of students agree if the chemistry teaching and learning process is carried out using website-based media. This website-based learning media contains several information menus that contain instructions for using learning media, an introductory menu containing learning objectives to be achieved, concept map menu, material menu, LKPD menu, quiz menu, evaluation menu, and profile menu. When selecting the material menu, the reaction rate material will be presented briefly, concisely, and clearly. Then there is an LKPD menu that contains LKPD that can be done by students. The quiz menu contains 10 questions about the reaction rate to check the knowledge of students. At the end of the quiz, students can see the scores they get. The last menu is the evaluation menu which contains 10 questions which are used as posttest scores.

The feasibility of learning media is reviewed based on the validity, practicality, and effectiveness of the media. Media validity is a media quality criterion that is measured by the validity of the content and constructs in the learning medium. Validation was carried out by 3 experts, namely, 2 chemistry lecturers as media and material experts and 1 chemistry teacher. The media is said to be valid if each aspect of the assessment has a mode ≥ 3. The practicality of the media is reviewed based on the responses and activities of students. Learning media is declared practical if the results of the learner response questionnaire have a percentage of $\geq 61\%$ and the percentage of relevant learner activities is greater than the percentage of irrelevant learner activities. The effectiveness of the media is reviewed in terms of classical completeness and increased learning outcomes. The instruments used are pretest and posttest sheets. Learning outcomes are said to increase if they have classical completeness, namely $\geq$ 85% of the class achieving individual completeness, n-gain value ≥ 0.3, and the media is said to be effective if it obtains a significant value <0.05.

Based on the description above, the research **"Development of Website-Based Learning Media on Reaction Rate Material to Improve Student Learning Outcomes"** was conducted. This research is expected to obtain information about the feasibility of website-based learning media.

METHOD

The research method used in this study is the Borg and Gall research and development (R&D) method which has been modified by Sukmadinata (2016). Broadly speaking, the research and development steps consist of three stages, namely, 1) preliminary study, 2) development, and 3) testing. This research was used as a test of effectiveness and practicality in learning, so it was carried out until the limited trial stage. The following is the research design of this study.

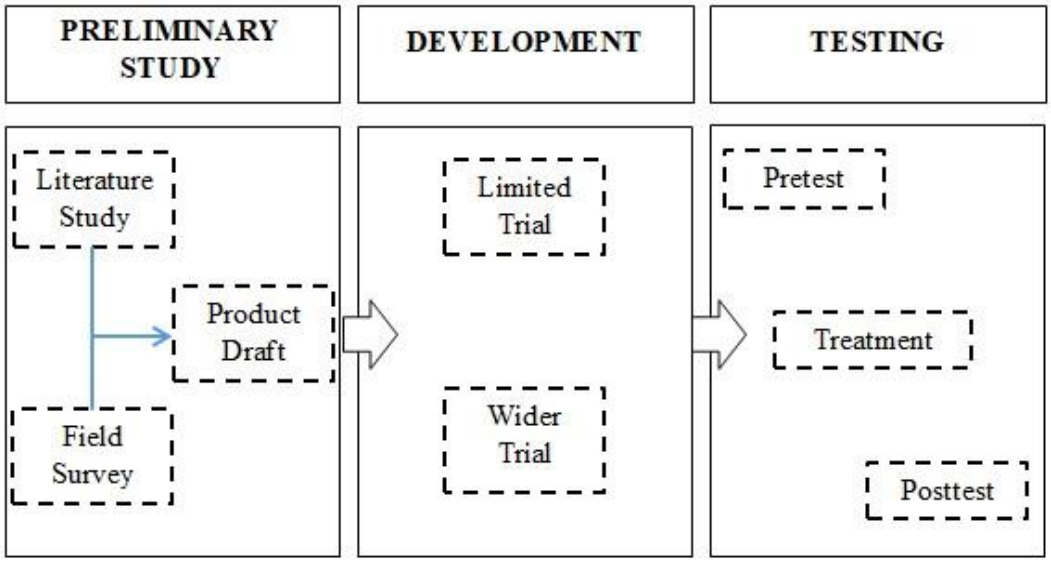

Figure 1. Modified Borg and Gall Development Steps

Preliminary Study

Literature Study

A literature study is a study to learn concepts or theories related to the product that will be designed and then developed. At this stage, the activities carried out include studying learning theories about learning using website-based media, good media criteria, learner characteristics, and the results of relevant previous research.

Field Survey

The field survey stage was carried out through interviews with chemistry teachers and questionnaires for students through pre-research activities. Field surveys are conducted to collect data related to how things are at school. Some of the things that were observed included the use of the existing curriculum at school, chemistry learning difficulties felt by students, student characteristics, student learning interests, and student needs in the classroom.

Product Draft

Data obtained from literature studies and field surveys is used as a reference in making product drafts. The draft product is formulated by formulating the title and learning objectives of the media, making storyboards, and compiling the media.

After the draft product in the form of website-based learning media is completed, the media is reviewed by chemistry lecturers as material experts and media experts to obtain criticism and suggestions. Criticism and suggestions from the reviewer will then be used as a guide to improve the website-based learning media that will be developed so that it is ready to be validated. After making media improvements based on the results of the review, validation was carried out by two chemistry lecturers and one chemistry teacher. The validation consisted of two aspects: construct validity, or the structure of the media, and content validity, or the content of the website-based learning media. After validation, the scores that have been obtained will be analyzed for deficiencies in the media. If the media does not meet the criteria, then improvements are made again to perfect the media. After that, the assessment is carried out again to find out whether the media is declared valid or not.

Development

At this stage, researchers develop products in the form of website-based learning media based on reaction rate material by conducting limited trials. Limited trials were conducted as initial trials to determine the applicability of the media. The media was tested on a limited basis, including six students who were used as the basis for preparing the implementation plan for the class trial. In this limited trial, information was obtained indicating that there were obstacles in entering the password to start opening the quiz. The media was then repaired, and after there were no obstacles, the media was ready to be tested on a larger scale, namely in one class.

Testing

Limited Trial

In the testing stage of website-based learning media, a limited trial was conducted on students of class XI MIPA 2 at SMAN 20 Surabaya. Limited trials were conducted using a one-group pretest-posttest design, which means that before students use website-based learning media, they will be given pretest questions about the reaction rate. Pretest questions are used to determine the initial understanding of students about the reaction rate material. Then students are given treatment, namely learning using website-based learning media. During learning using website-based media, students' activities will be observed. After using the media, students will be given posttest questions about the reaction rate. This posttest question is used to determine the completeness of students' learning outcomes as an influence of website-based media. After the posttest, students will be given a response questionnaire related to the media that have been used in learning chemistry reaction rate material. This can be represented mathematically as O1 X O2.

The target of this research is website-based learning media which was tested on students of XI MIPA class at SMAN 20 Surabaya totaling 33 students. This development research was conducted on students of class XI MIPA at SMAN 20 Surabaya. Then for the validity test was carried out by 2 chemistry lecturers and 1 chemistry teacher.

The data collection methods used in this research are questionnaire, observation, and test methods. Data collection instruments such as review sheets, validation sheets, student response questionnaires, student activity observation sheets, knowledge test sheets in the form of pretest and posttest questions are needed.

Validity Test

Validation of learning media includes content and construct validity conducted by 3 validators, namely 2 chemistry lecturers and 1 chemistry teacher. Validation is carried out based on a Likert scale by giving a score of 1 to 5 on the validation sheet. The validation results are said to be valid if they get a mode ≥3.

Practicality Test

The practicality of web-based learning media is reviewed from the responses and activities of students. The students' response questionnaire contains statements about how students respond after learning using learning media which are answered with the answers "Yes" or "No", which are then analyzed using the Guttman scale as follows.

Table 1. Validity Criteria of The Worksheet

Answer	Positive Statement Score	Negative Statement Score
Yes	1	0
No	0	1

The data obtained will be analyzed using the calculations below

$$P(\%) = \frac{F}{N} \times 100\%$$

Description: P = percentage of answer; F = number of scores obtained; N = total score. The percentage results obtained were interpreted into the following criteria.

Table 2. Interpretation of Response Questionnaire Score

Percentage	Criteria
0% - 20%	Very less practical
21% - 40%	Less practical
41% - 60%	Pretty practical
61% - 80%	Practical
81% - 100%	Highly practical

The learning media developed is declared practical if a percentage of ≥61% is obtained (Riduwan, 2015).

The results of the practicality test are also supported by data from the observation of students' activities during learning activities using website-based learning media. Learners' activities were observed by the observer. The observation results were calculated using the following formula.

$$\%\text{student activity} = \frac{\sum \text{activity that appears}}{\sum \text{overall activity}} \times 100\%$$

Student activities are said to be well implemented and support the practicality of the learning media developed if the percentage of relevant student activities is greater than irrelevant student activities.

Practicality Test

The effectiveness of the website-based learning media is reviewed from classical completeness and improvement of learning outcomes. According to Trianto (2009), Website-based learning media is said to be effective if the learning outcomes are classically ≥ 85% in the class achieve individual completeness. The improvement of students' pretest and posttest results can be known through the calculation of the N-Gain score. The equation for determining the N-Gain score is written as follows.

$$\text{N} - \text{gain} = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}$$

The N-Gain score is then interpreted as follows.

Table 3. Interpretation of N-Gain Score

N-Gain Score	Criteria
(N-gain) < 0,3	Low
0,7 > (N-gain) ≥ 0,3	Medium
(N-gain) ≥ 0,7	High

Learning media is said to be feasible from the aspect of effectiveness, if the learning outcomes of students experience an increase in the "Medium" and "High" categories.

To find out the significant difference between pretest and posttest scores, a paired T test must be done. Data must be tested for normality with the Shapiro Wilk test. data is said to be normally distributed if the significance value is > 0.05 (sig. >0.05).(Suardi, 2019).

If both paired data are normally distributed, hypothesis testing uses the Paired sample t-test with the following hypothesis.

H_0 : there is no average difference between pretest and posttest
H_1 : there is an average difference between pretest and posttest
If Sig. < (0.05), then H_0 is rejected, if Sig. > (0.05) then H_0 is accepted

If the paired data is not normally distributed, hypothesis testing uses the Wilcoxon Signed Rank Test with the following hypothesis.

H_0: there is no average difference between pretest and posttest
H_1: there is an average difference between pretest and posttest
If Sig. < (0.05), then H_0 is rejected, if Sig. > (0.05) then H_0 is accepted
Learning media is said to be effective if the significance <0.05

RESULTS AND DISCUSSION

Preliminary Study

The first stage is a literature study, where concepts or theories related to the product to be created and developed are studied. Things that are done at this stage are studying learning theories about learning with website-based learning media, good media criteria, learner characteristics, and the results of relevant previous research. This literature study also aims to collect theoretical foundations and concepts to improve learning media.

A total of 43,265 schools from various regions in Indonesia have registered to start using the independent curriculum in teaching and learning activities for the 2022/2023 school year. The demand for the use of educational technology cannot be separated from this independent curriculum. The purpose of educational technology in the branch of science is to create efficient and effective education by assisting the learning process through the use of various learning resources listed on the right technology. Thus, it is expected that technological advances will enable educators to use various technologies (Widiyono & Millati, 2021).

The next activity is to analyze the characteristics of students. According to Piaget's theory, grade XI high school students have entered the formal operational stage, which has the ability to think concretely. Unlike what is contained in the theory, in reality students still have difficulty understanding it, so learning media are needed to help students understand the material. The next activity is to review research relevant to the development of website-based learning media. Based on the review of previous research related to the development of

website-based learning media, the results show that students can learn and understand the material easily due to the use of easy and interesting website media. This also increases students' learning outcomes.

Field Survey

The second stage is the field survey stage, where a field survey is carried out in class XI MIPA 2 SMAN 20 Surabaya. A field survey, in this case, is pre-research conducted at school. This pre-research activity is carried out to collect data such as the learning difficulties of students and the media used in schools, especially in chemistry subjects. Pre-research was conducted by distributing questionnaires to students of class XI MIPA 2 SMAN 20 Surabaya. The instrument used in pre-research is a questionnaire sheet.

Judging from the results of the pre-research questionnaire conducted at SMA Negeri 20 Surabaya, it showed that 71.4% of teachers used blackboard media and 23.8% used book media. The interview results stated that chemistry teachers at SMAN 20 Surabaya have not utilized web-based learning media. As many as 61.9% of students felt that learning chemistry was boring. Monotonous learning media is one of the reasons why students are less interested in learning chemistry.

Drafting of Products

The preparation of the product draft starts with preparing a media design in the form of a storyboard. A storyboard is used as a reference in developing media. The storyboard contains an overview of the media to be created, starting with symbols, images, designs, animations, navigation buttons, and videos that will be used to make students interested in learning to use the media. The flow of media usage must also be designed using a flowchart. The flow is from the beginning of using the learning media to the end.

The flow of learning media starts with the initial appearance of the media in the form of an initial page to welcome users who want to enter using website-based learning media. Learners are directed to press the "Go" button to proceed to the information page. On the information page, learners are presented with information related to media descriptions and instructions for using learning media.

Figure 2. Website Home View

Figure 3. Information Page

Learners are then directed to press the "Go" button to proceed to the menu page. Learners will be presented with several menus, namely the information menu, introduction menu, concept map menu, material menu, E-LKPD menu, quiz menu, evaluation menu, and profile menu.

Figure 4. Menu Page

The introduction menu contains learning outcomes and learning objectives. The concept map menu contains a concept map of the reaction rate material.

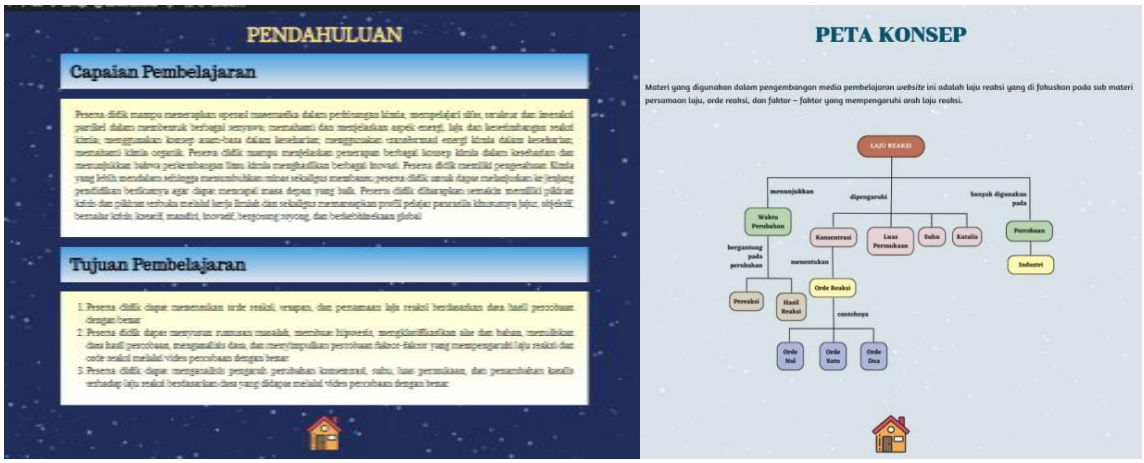

Figure 5. Introduction Page and Concept Map

The material menu consists of two topics, namely reaction order and factors. The E-LKPD menu consists of two LKPDs, namely the rate equation, reaction order, and factors that affect the reaction rate.

Figure 6. Material Page and E-LKPD

The quiz menu contains 10 multiple-choice questions on reaction rate material. The teacher will provide a password to open the quiz menu if students have gone through the learning process coherently according to the instructions for use that have been displayed at the beginning.

Figure 7. Quiz Page

The evaluation menu contains 10 questions, including 4 multiple-choice questions with one answer, 3 multiple-choice questions with more than one answer, and 3 true and false questions. The profile menu contains the developer profile and the profile of the thesis supervisor.

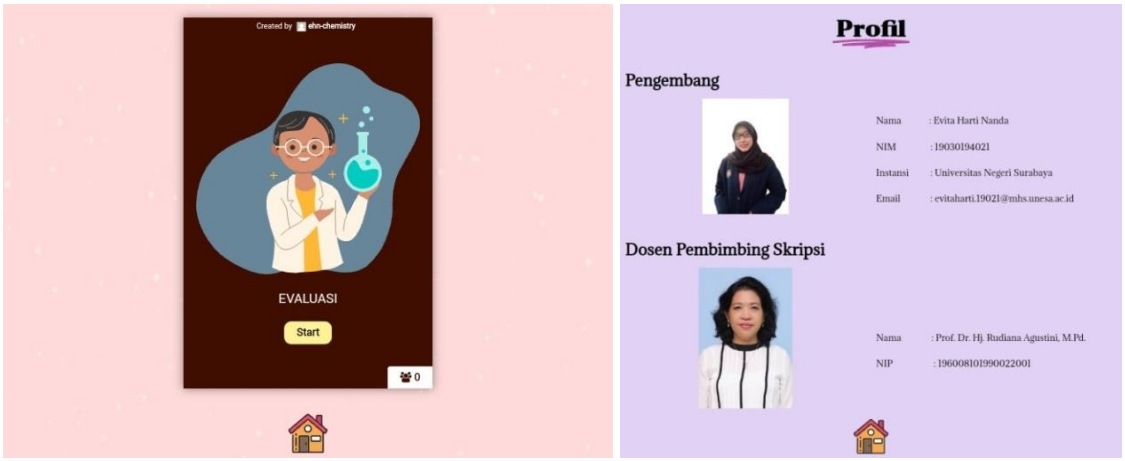

Figure 8. Evaluation and Profile Page

Validity Test

Validation of learning media includes content and construct validity conducted by 3 validators, namely 2 chemistry lecturers as media experts and material experts and 1 chemistry teacher of SMAN 20 Surabaya.

Content Validity

Table 4. Content validation results

No.	Aspect of Validity	Mode	Category
1.	Correctness of concept	5	Highly valid
2.	Have a purpose	4	Valid

The first aspect, namely "the truth of the concept" means that the reaction rate material and questions on the website are in accordance with existing concepts in chemistry. In this aspect, a mode score of 5 was obtained with a very valid category. According to Supriyah (2019), The suitability of learning media to support learning in the nature of facts, concepts, principles, or generalizations must be one of the criteria that must be considered The statement states that the selection of material on learning media must be considered so as not to get the wrong concept.

The second aspect, namely "having a purpose" means that the material, LKPD, questions on the website are in accordance with the learning objectives to be achieved, so it is valid to be used as learning media. This aspect obtained a mode score of 4 with a valid category.

Construct Validity

Table 5. Construct validation results

No.	Aspect of Validity	Mode	Category
1.	Chemical characteristics	5	Highly valid
2.	Adaptability to learner characteristics	4	Valid
3.	Has a rule	4	Valid
4.	Giving feedback	4	Valid
5.	Has a decision-making element	5	Highly valid
6.	Appearance	5	Highly valid
7.	Media operation	5	Highly valid

The first aspect, namely "chemical characteristics" obtained a mode of 5 with a very valid category. The developed learning media has an experiment or investigation activity where on the LKPD there are experimental observation activities regarding factors that affect the reaction rate. Learners can collect data, analyze data, and draw conclusions. The media also has a connection with everyday life where there is a material menu in the factor section where there are phenomena around that are related to factors that affect the reaction rate.

The second aspect, namely "suitability with the characteristics of students" obtained a mode of 4 with a valid category. This aspect means that the learning media is in accordance with the learning style and age of students.

The third aspect, namely "having rules" obtained a mode of 4 with a valid category. The website-based learning media developed already has rules of use contained in the information menu and has been displayed at the beginning of the media before entering the menu page. The existence of instructions for using the media can facilitate students in using learning media.

The fourth aspect, namely "providing feedback", obtained a mode of 4 with a valid category. The website-based learning media developed has feedback, which is at the end of the quiz and evaluation in the form of encouraging words.

The fifth aspect, namely "having an element of decision making" obtained a mode of 5 with a very valid category. The website-based learning media developed provides options in answering when choosing answers to quiz questions and evaluation questions. Learners must choose the right answer in order to get a good score and exceed the KKM. Learners are also given the option of using the website when on the menu page. Learners can open the menu or return to the previous page.

The sixth aspect, namely "Appearance" obtained a mode of 5 with a very valid category. This aspect means that the color, font size, and images on the media are harmonious and clear for users to see.

The seventh aspect, namely "media operation" obtained a mode of 5 with a very valid category. This aspect means that the learning media developed is easy to access and easy to use.

Practicality Test

The practicality of learning media is reviewed from the results of student observations during learning and the results of student response questionnaires after using learning media.

Results of the Student Response Questionnaire

Table 6. Results of student response questionnaire

No.	Aspect	Percentage (%)	Category
1.	Interest in learning media	93,2	Highly practical
2.	Usefulness of learning media	89,9	Highly practical
3.	Ease of using the media	84,8	Highly practical
4.	Language in learning media	87,9	Highly practical
Total		**90**	Highly practical

Based on Table 6, the response of students to the website-based learning media developed is very positive, this can be seen from the acquisition of the percentage of each aspect of positive statements and negative statements getting an average percentage of 90%. It can be concluded that the learning media developed is practical to use in learning.

Student Activity during Learning

Table 7. Results of observation of student activity

No.	Observed aspect	Persentage each trials	
		1	2
1.	Students listen to the teacher's explanation	6,67	6,67
2.	Students ask questions related to the use of the website	11,90	8,10
3.	Students ask questions related to the material	6,67	7,14
4.	Students respond to questions from the teacher	11,90	9,52
5.	Students read the material on the website media	13,33	16,67
6.	Students discuss with friends in working on LKPD and quizzes	32,86	42,38
7.	Students express opinions	9,05	4,76
8.	Students respond to other students ' opinions	6,19	4,76
9.	Students do irrelevant activities	1,90	0,95
Relevant Activity		**98,10**	**99,05**
Total		**100**	**100**

Based on the results of observations of learner activities in Table 7, the results of relevant activities were 98.10% at the first meeting and 99.05% at the second meeting, while irrelevant learner activities were 1.90% at the first meeting and 0.95% at the second meeting. Learner activities are said to be well implemented and support the practicality of the learning media developed because the percentage of relevant learner activities is greater than irrelevant learner activities. So it can be stated that website-based learning media on reaction rate material is practical in learning.

Illustrations of the abstractness of chemistry can be seen in the material presented on the website, which contains images of the phenomenon of the reaction rate and animations of particle collisions that occur at the reaction rate according to the factors that influence it.

Effectiveness Test

The effectiveness of the website-based learning media is based on the classical completeness and improvement of students' cognitive learning outcomes. Students' learning outcomes are obtained from the results of students' pretests and posttests. In the pretest learning results, all students in class XI MIPA 2 were not complete. When the treatment was carried out using website-based learning media during chemistry learning, there were 29 students who were complete and 4 students were not complete. Based on classical completeness, no students achieved individual completeness during the pretest, while in the posttest there were 87.9% of students who were individually complete because they had reached the KKM. Thus, from the pretest and posttest data, students can be declared classically complete because ≥ 85% of students have reached individual completeness. It can be said that website-based learning media is effective in learning chemistry reaction rate material.

27.27% of students obtained an N-Gain score in the medium category and 72.73% of students obtained a high N-Gain score. This shows that 100% of learners experienced an increase in scores from pretest to posttest. The average N-Gain was 0.78 with a high category. Based on this, website-based learning media on reaction rate material is said to be effective to use because the N-Gain score > 0.3.

The effectiveness of learning media can be analyzed using t-test. The t-test is used to determine whether there is a difference in the average pretest and posttest scores. The following are the results of the normality test of the pretest and posttest scores. Based on the normality test on the pretest and posttest results, the significance value on the pretest score was 0.148 and on the posttest score was 0.206. From these results it can be concluded that the

pretest and posttest score data are normally distributed because the significance value> 0.05. The hypothesis test used is the Paired sample t-test because the pretest and posttest data are nomally distributed. Paired sample t-test results are presented as follows.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	*Pretest - Posttest*	-53.788	12.639	2.200	-58.269	-49.306	-24.448	32	.000

Table 8. Paired sample t-test

Based on Table 8, a significance value of 0.000 was obtained in the Paired sample t-test. It can be said that there is a difference in the average pretest and posttest scores because the significance value obtained is <0.05. It can be concluded that the learning media developed is effectively used in learning activities.

CONCLUSION

The conclusion of this research is that the web-based learning media developed meets the criteria of valid, practical, and effective. The results of content and construct validity show valid results in each aspect with a mode between 4 and 5. The practicality results show that the website-based learning media is practical with 98.10% of relevant student activities at the first meeting and 99.05% at the second meeting, while the percentage acquisition of each aspect in student responses gets a percentage of 90%. The results of the effectiveness of learning media obtained classical completeness results of 87.9% and N-Gain value of 0.78. This is supported by the results of the Paired sample t-test of 0.000 which means there is a significant difference in the average learning outcomes.

RECOMMENDATIONS

Based on the results of research and discussion related to the development of web-based learning media on reaction rate material, the following suggestions can be given.

1. The web-based learning media developed is only limited to the sub material of the rate equation, reaction order, rate constant, and factors affecting the reaction rate, it would be better if in further development the media is developed on the sub material of the reaction rate collision or on other chemical materials.
2. For teachers, this website-based learning media can be used as a media option that can be used in learning reaction rates because it can be accessed directly via the internet.

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