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Development of a Chemistry E-Module Based on a Problem Based Learning Model on Reaction Rate Material

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Abstract: Development of a Chemistry E-Module Based on a Problem Based Learning Model on Reaction Rate Material. This research aims to develop and determine the validity and practicality of e-modules based on problem based learning on reaction rate material and to see student responses. This research uses the 4-D Research and Development (R&D) model starting with the definition, design, development and deployment stages. This research is restricted to the development stage. The instruments used were validation questionnaires and teacher and student response questionnaires. The validation assessment involved five expert validators including two media expert validators and three material expert validators. The practicality test was given to a chemistry teacher at SMAN 1 Percut Sei Tuan and a small-scale trial was given to 32 class XI Matlansos students. The media expert assessment was 87.8% which met the very valid criteria and the material expert assessment was 80.5% with the very valid criteria. Therefore, the problem based learning model chemistry e-module is valid for utilize within the classroom learning prepare.. The teacher practicality test was carried out and a result of 98% was obtained which met the very practical criteria. The results of student responses to the e-module were 82.9% with the criteria of strongly agree. It was concluded that the Chemistry E-Module based on the Problem Based Learning Model on Reaction Rate Material is valid, practical and can be used as teaching material in schools.

Keywords: E-Module; Reaction rate; Problem Based Learning.

Abstrak: Pengembangan E-Modul Kimia Berbasis Model Pembelajaran Problem Based Learning pada Materi Laju Reaksi. *Penelitian ini bertujuan untuk mengembangkan dan mengetahui kevalidan dan kepraktisan e-modul berbasis problem based learning pada materi laju reaksi serta melihat respon siswa. Penelitian ini menggunakan metode Research and Development (R&D) model 4-D dimulai dengan tahap define, design, development dan deployment. Penelitian ini dibatasi sampai tahap development. Instrumen yang digunakan berupa angket validasi serta angket respon guru dan siswa. Penilaian validasi melibatkan lima validator ahli meliputi dua validator ahli media dan tiga validator ahli materi. Uji praktikalitas diberikan kepada satu guru kimia SMAN 1 Percut Sei Tuan serta* uji coba skala kecil diberikan kepada 32 siswa kelas XI Matlansos. *Penilaian ahli media sebesar 87,8% yang memenuhi kriteria sangat valid serta penilaian ahli materi sebesar 80,5% dengan kriteria sangat valid. Oleh karena itu, e-modul kimia model problem based learning valid digunakan dalam proses pembelajaran di kelas. Uji praktikalitas guru dilakukan dan didapatkan hasil sebesar 98% yang memenuhi kriteria sangat praktis. Hasil dari respon siswa terhadap e-modul sebesar 82,9% dengan kriteria sangat setuju. Didapatkan kesimpulan bahwa E-Modul Kimia Berbasis Model Pembelajaran Problem*

Based Learning pada Materi Laju Reaksi sudah valid, praktis dan dapat dijadikan bahan ajar di sekolah.

Kata kunci: *E-Modul; Laju Reaksi; Problem Based Learning*

▪ INTRODUCTION

Education is the key to the development of a nation. Education can improve the quality of human resources.. In implementing quality level assessment, it is necessary to have a system or what is called an education quality assurance system (Riowati & H., 2022). The education quality assurance system can be realized by implementing an appropriate curriculum. The curriculum that applies in Indonesia has reached the development of the Independent Curriculum. The principle of this new curriculum is learning that is completely centered on students by proclaiming the term Merdeka Belajar. This term is defined as a method that allows students to choose lessons that are interesting to them. Schools have the right and responsibility to develop a curriculum according to their individual needs and characteristics (Cholilah et al., 2023). Teachers have the right to choose teaching media that suits students' needs so that the learning process can run smoothly.. Awarded projects by the government based on specific subject matter. This project is not tied to certain achievements, but provides freedom for independent learning so that students are not stressed and are more motivated to continue exploring (Kemendikbud, 2022).

Current technological developments have a huge impact on all human activities, including student learning, because they have been influenced by information technology since childhood. This allows the younger generation to have better access to information technology and digital media than previous generations. Among developing technologies, the internet plays a very important role, especially in education, thus providing great opportunities for the application of e-learning in schools. E-learning can be used to provide a variety of learning resources and learning tools so that students have an enjoyable learning experience (Asmiyunda et al., 2018).

Based on observations with one of the chemistry teachers at SMA Negeri 1 Percut Sei Tuan, it is known that SMAN 1 Percut implements an independent curriculum. The curriculum has the characteristics of project-based learning and flexibility in learning. Teachers teach according to students' abilities and try to make students interested and motivated in learning. Data was obtained that 90% of students use smartphones in learning activities. However, the teaching materials used are only textbooks as well as power point media and learning videos. Teachers consider that the textbooks used by schools have not been able to implement the demands of teaching materials. The demands for teaching materials in question are in the form of curriculum demands, student characteristics, and demands for solving learning problems. The teaching materials provided do not cover complete material concepts and the teaching materials seem less interesting and monotonous so that high school students are not motivated to learn. The lack of teaching materials that can be used in schools is a limitation in achieving learning goals. In learning activities appropriate teaching materials are needed. Teaching materials are a really imperative learning asset to bolster the accomplishment of competencies that are learning targets.

The implementation of e-learning in schools is accompanied by the need for additional teaching materials that can motivate students to increase independent learning

activities in finding appropriate concepts. One of them is teaching materials in the form of modules. This is proven by research conducted by (Sijabat, 2023) who stated that E-modules can increase students' motivation to learn so that they are reasonable for application within the learning prepare. E-modules are also very effective in learning chemistry.

Learning chemistry is a very important science to be taught to students. However, in reality, numerous understudies discover it troublesome to study about chemistry. This is because chemistry learning is considered to have abstract and complex concepts so students are required to have a deep understanding to learn it (Sariati et al., 2020). One of the materials studied in class XI is reaction rates. Reaction rate is material that is closely related to events in everyday life and has concrete benefits in life so it is important to study. According to research by Marthaferra et al. (2018), information was obtained that the reaction rate material was not well understood by students. The lack of understanding of this concept is caused by students' reluctance to learn or explore on their own. On the other hand, students' lack of understanding is also due to the fact that during the learning process they tend to apply a memorization system rather than understanding concepts (Wulansari, 2012). The role of educators is needed in providing direction regarding correct and effective ways of learning by providing problems or problems and requiring students to be able to provide solutions to these problems. One suitable learning model is the problem-based learning (PBL) model.

Problem-based learning (PBL) is defined as a variety of situational learning based on constructivist theory. The main goal of constructive learning is to support student motivation and independent learning in studying subject matter. To achieve a learning situation, teachers must provide students with multimedia to explore and design knowledge to suit the learning environment (Nainggolan et al., 2020). Based on the problem has been explained previously, it is necessary conducted research with develop learning modules chemistry based on problem based learning, especially in reaction rate material which can motivate students in studying chemistry.

▪ METHOD

Development research (Research and Development) is research directed at producing products, designs and processes (Setyosari, 2016). The products developed can be in the form of teaching materials, learning media, questions, and classroom learning management systems. Products produced through R&D research in the education sector are expected to increase educational productivity. These products are made in various forms such as objects or hardware, such as LKPD, learning modules, books and learning media in the classroom or laboratory (Andi et.al., 2018).

This development research uses Research and Development (R&D) research, where the product developed is E-Module teaching materials using the FlipHTML5 application based on the problem based learning model at SMAN 1 Percut Sei Tuan for class XI students. The comes about gotten from this investigation is the creation of an E-Module teaching material that is valid and practical in learning chemistry on reaction rate material. The development was carried out using the 4-D model by (Thiagarajan, 1974) but the implementation of this research was limited to the 3-D stage, namely the define, design and development stages.

At this definition stage, the aim is to find out how the E-Module teaching materials will be developed later. This analysis focuses on the actual situation that occurs at school by making observations at SMA Negeri 1 Percut Sei Tuan. Next, the design stage aims

to get an initial overview or initial draft of the e-module being developed. Where the e-module being developed will use the help of the FlipHTML5 application based on the PBL model. This stage is divided into three stages, namely media selection, format selection and initial design. And at the development stage, validation of the e-module is carried out, revision then practicality testing and seeing responses from students.

The data obtained in the validation stage was clarified into two, namely qualitative data and quantitative data. Analysis of qualitative data contains input and suggestions put forward by material experts and media experts to improve this e-module product. Meanwhile, quantitative data is in the form of assessment from media and material experts regarding product development that has been carried out made. Quantitative data was also obtained from teacher practicality assessments and responses student.

To determine quantitative data from the e-module, a scale is used rating scale measurements. Rating scale is a recording of objects or symptoms research according to levels. This tool is for getting an overview regarding the state of objects according to their respective levels (Hardani et al, 2022). The questionnaire scale table is:

Table 1. Likert scale description

Instrument item answers	Score
Very Good	4
Good	3
Not Good	2
Very Not Good	1

According to Riduwan (2007) to analyze the validity of the module developed using a rating scale and obtained by:

1. Determine the ideal maximum score
2. Add up the scores obtained from each validator
3. Find the ideal percentage

$$\text{Ideal percentage} = \frac{total\ score}{score\ maximum} \times 100\%$$

(Arikunto, 2010)

The results of the murdian regionality research were interpreted in a qualitative sense based on the following table:

Table 2. Validity Percentage

Intervals	Qualification
76%-100%	Very Valid
51%-75%	Valid
26%-50%	Valid Enough
0%-25%	Invalid

Table 3. Practical Percentage

Intervals	Qualification
76%-100%	Very Practical
51%-75%	Practical

26%-50%	Practical enough
0%-25%	Impractical

Table 4. Percentage of student responses

Intervals	Qualification
76%-100%	Very Agree
51%-75%	Agree
26%-50%	Agree Enough
0%-25%	Disagree

▪ RESULTS AND DISCUSSION

In the process, this research has 3 stages, namely as follows::

Define

This definition stage aims to find out what it will be like. This E-Module teaching material will be developed. This analysis focuses on circumstances actually what happened at school by conducting observations at SMA Negeri 1 Percut Sei Tuan. The activities carried out at this stage are doing interviews with teachers to analyze the problems faced in learning process at school. After conducting interviews, information was obtained that SMAN 1 Percut Sei Tuan school has implemented the curriculum independence in the learning process. The method used by the teacher in the process Learning uses lecture and discussion methods and is interspersed with presentation of learning videos and powerpoints. As for materials The teaching or learning resources used are only handbooks obtained at school. The school does not have other learning resources in the form of modules or LKS. This causes some students to be less motivated in studying chemistry because the only teaching materials are textbooks. The textbook used also do not cover complete chemistry concepts seems less interesting and monotonous. At the concept analysis stage, it is carried out to find out the curriculum used in schools, knowing the basic competencies and aspects of the independent curriculum as well as knowing the material in the reaction rate lesson that can be done used as material for making chemistry E-Module teaching materials assisted by the FlipHTML5 application.

Design

The second stage used in this research is design. At this stage the aim is to get an initial overview or initial draft of developed e-module. Where the e-module being developed will be using the help of the FlipHTML5 application based on the PBL learning model. This stage is divided into three stages, namely media selection, format selection and Preliminary design.

On media selection in the process of developing this e-module using Microsoft Word, Canva and FlipHTML5 applications. Three media were chosen because they are interconnected in producing the final product in the form of an e-module. Apart from that, the application is considered easy to use and can create e-modules according to the desired format such as text, picture illustrations and animations that support the application of multiple representations.

Electronic module design (e-module) is carried out in product design assisted by the Microsoft Word 2010 application. Selection of format, layout (margins), text shape and size, space, and accuracy are taken into consideration from the quality of the module. Apart from that, the graphic feasibility component refers to the description of the items on the assessment instrument for SMA/MA textbooks by the Agency National Education Standards (BSNP,2006).

Development

At this stage the e-module begins to be created based on the manufacturing design in design stage. This activity is carried out in several stages, namely:

1. Writing module drafts

At the module draft writing stage, an outline of the module content is developed into teaching materials in the form of Problem Based Learning (PBL). Writing Modul draft must comply by problem based learning syntax. According to (Arends, 2008), Problem based learning consists of 5 phases and behaviors, namely providing orientation about problems to students, organizing students to research, helping with independent/group solutions, develop and present work results, and analyze and evaluate the learning process.

2. E-Module Validation

The electronic modules developed are subjected to a validation test process for validate the product, so that the product developed is valid and can be used in classroom learning..

a) Media Validation

Media expert validation was given to two validators, namely two chemistry lecturers Medan State University with codes V1 (Validator 1) and V2 (Validator 2). The assessments from media expert validators are presented in the table as following.

Table 5. Media Validation Results

Assessment Aspect	Average Percentage (%)		Average (%)
	V1	V2	
Graphic Feasibility	87,5%	93,8%	**90,6%**
PBL Aspect	75%%	95%	**85%**
Average (%)			**87,8%**
Percentage Analysis Validation Criteria			**Very Valid**

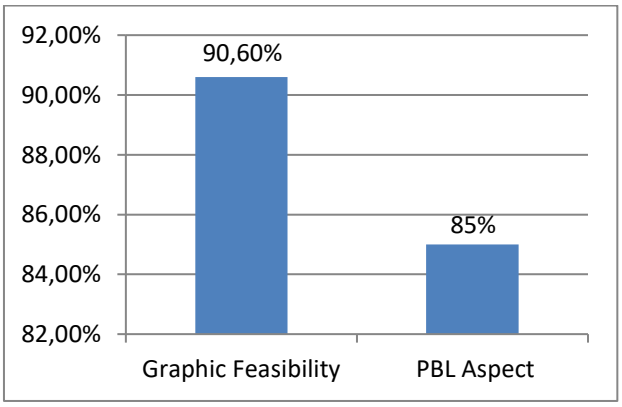


Figure 1. Media Validation Diagram

Based on Table 5, it can be seen the results of validation by media experts the average percentage obtained was 87.8%. This shows that the material in the chemistry e-module is based on the Problem Based learning model Learning on this reaction rate material is "Very Valid" based on BSNP criteria.

b) Material Validation

Material expert validation was given to three validators, namely three chemistry lecturers Medan State University with codes V1 (Validator 1), V2 (Validator 2) and V3 (Validator 3). The assessment from the expert validator of the material presented in the table 6 as follows.

Table 6. Material Validation Results

Assessment Aspect	Persentase Rata-rata (%)			Average (%)
	V1	V2	V3	
Appropriateness of content	60%	95%	90%	**81,7%**
Suitability of Presentation	61,1%	91,7%	77,8%	**76,9%**
Language Suitability	75%	93,8%	75%	**81,3%**
PBL aspect	69,4%	91,7%	86,1%	**82,4%**
Average (%)				**80,5%**
Percentage Analysis Validation Criteria				**Very Valid**

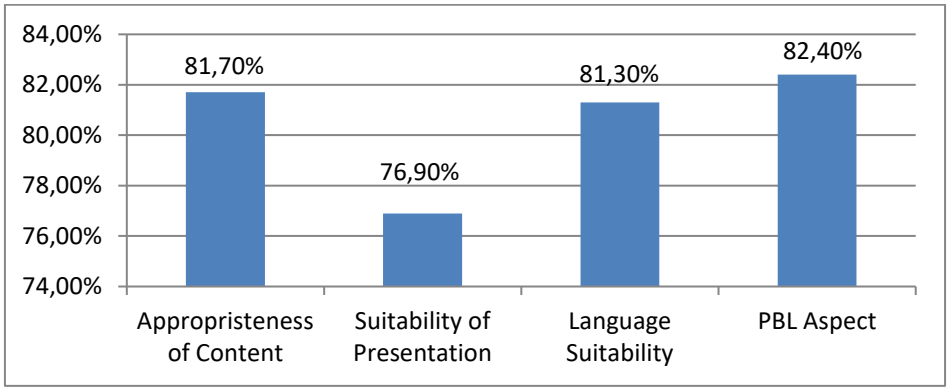


Figure 2. Material Validation Diagram

Based on Table 6, it can be seen the results of material expert validation with the average percentage obtained was 80.5%. This shows that material in the chemistry e-module based on the Problem Based learning model Learning on this reaction rate material is "Very Valid" based on BSNP criteria.

3. Revision of Validation Results

The validation results are then followed up with revisions. Revision of the E Module teaching materials in terms of media and materials was carried out taking into account the suggestions validator. The results of the revisions carried out by researchers are presented as follows.

Table 7. Revision results in terms of media

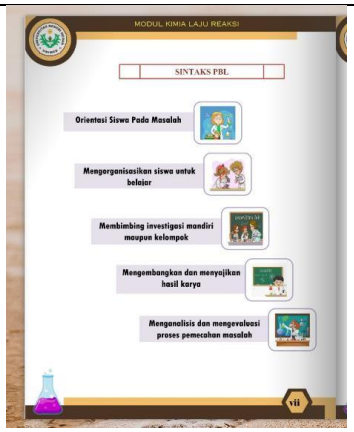
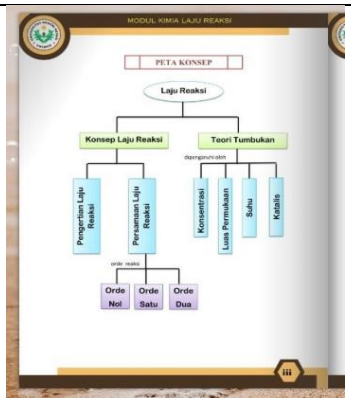
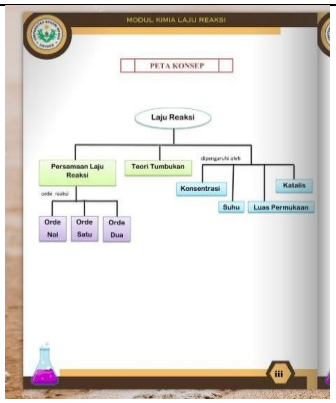
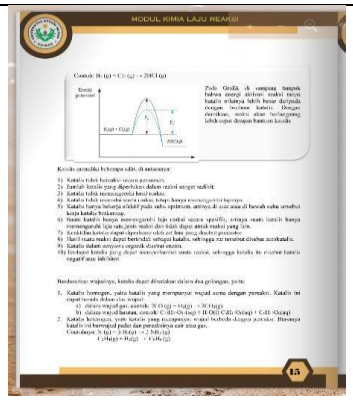
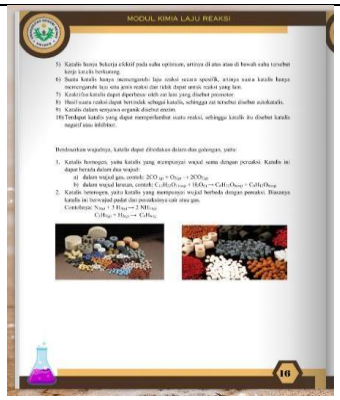
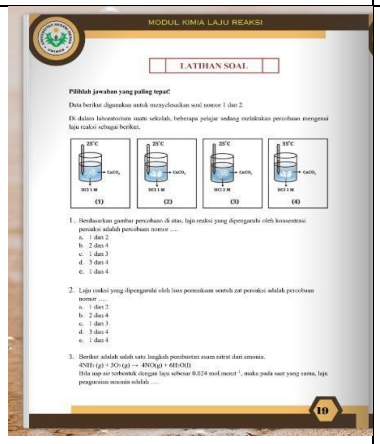
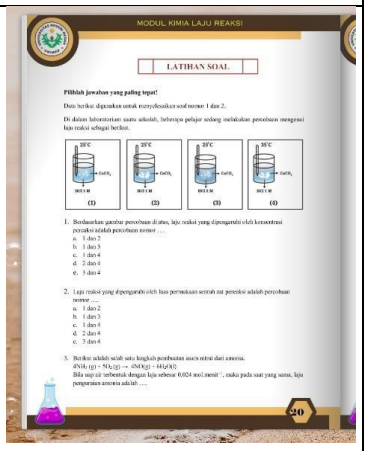
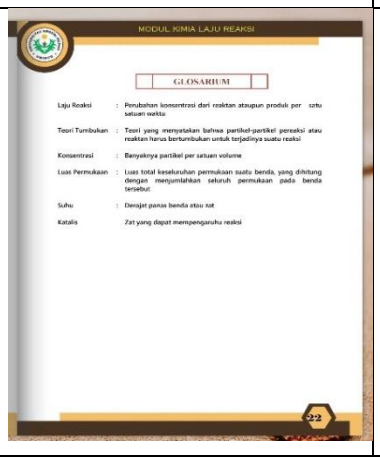
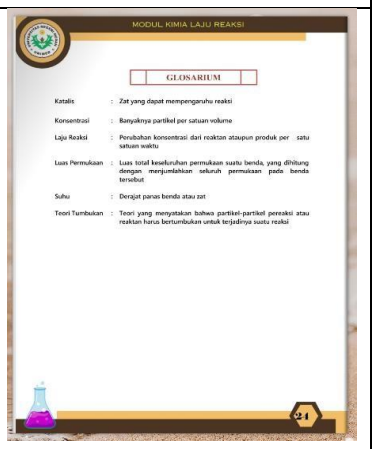
Corrected Category	Before Revision	After Revision
Add an image to the cover that is related to the module title		
Adding learning model syntax from the beginning of the lesson in the module.	There is no PBL Syntax	

Table 8. Revision results in terms of material

Corrected Category	Before Revision	After Revision
Fixed the layout of the concept map		

Improved writing of substance phases.		
The answer choices in the Practice Questions are made sequentially and an answer key is also added.		
The glossary is written alphabetically		

4. Practicality and Module Testing

a) Teacher Practicality Test

The practicality test of a teaching material can be seen from the teacher's response after using the teaching material.. The Practicality Questionnaire was given to one chemistry teacher at SMAN 1 Percut Sei. The results of the teacher response practicality questionnaire consist of four indicators, namely usable, easy to use, attractive, and efficient (Kurniawan & Syafriani, 2021). Results of students' practicality regarding e-modules can be seen in Table 9.

Table 9. Practicality test results

Feasibility Aspect	Average Percentage (%)
Usable	100
Easy To Use	100
Appealing	100
Effective	91,6
Average (%)	**98**
Criteria	**Very Practical**

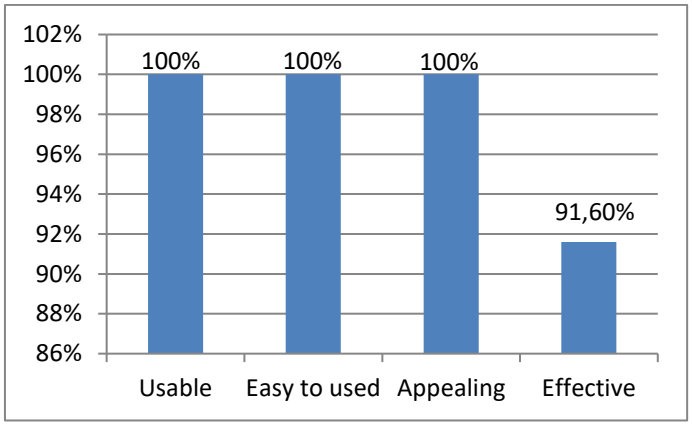


Figure 3. Practicality Test Diagram

Table 9 shows that the practicality of the e-module based on teacher responses was 98% with the criterion "Very Practical". PBL-based e-Modules can be used well, are easy to use, interesting and efficient..

b) Small Scale Trial

The trial stage is carried out by producing products from the previous stage namely in the form of an e-module on reaction rate material based on the Problem learning model Based Learning. The initial step is to carry out validation with experts consisting of 5 chemistry lecturers at Medan State University (2 media experts and 3 media experts material).

Product trials were carried out on a small scale with 32 students recommended by the chemistry teacher at SMAN 1 Pecut Sei Tuan. Testing aims to determine students' responses in using e-modules in the learning process. This test is carried out by distributing student response surveys to the electronic modules developed. As for analysis of the calculation of student response questionnaire results to e-module material Problem based learning based reaction rates on each indicator can be seen in Table 10.

Table 10. The result of students' responses

Feasibility Aspect	Average Percentage (%)
Material	82,2
Apperance	86,8
Benefit	79,8
Average	**82,9**
Criteria	**Very Agree**

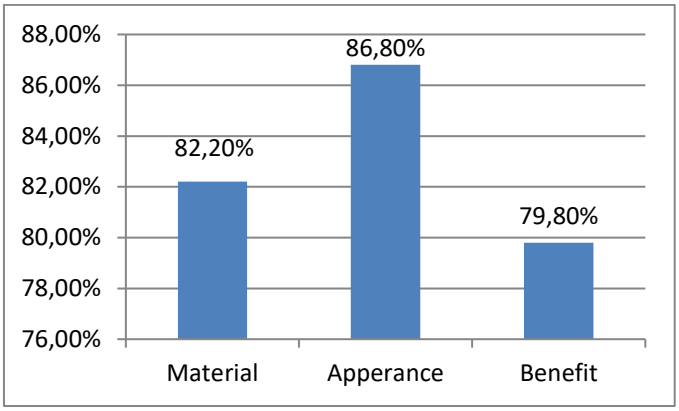


Figure 4. Student response diagram

Based on the experiments carried out, it can be seen that average percentage of student responses to model-based E-Modules Problem based learning on material reaction rate of 82.9% and is included in the 'Very agree' criteria so it can be used in chemistry learning. Students strongly agree that the E-Module is model Problem based learning on reaction rate material can motivation in studying chemistry.

▪ CONCLUSION

The validation results given to 2 media expert validators were 87.8% with very valid criteria and 3 material expert validators were 80.5% with very valid criteria. Therefore, the e-module developed is valid for use in learning. In the teacher practicality test, a result of 98% was obtained which met the very practical criteria so that the e-module developed could be used as teaching material in schools. Based on a small-scale test of the e-module being developed, an average result of 82.9% was obtained with the Very Agree criteria. Student responses stated that the E-module developed could motivate students to learn.

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