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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 E-Module Based on Higher Order Thinking Skills (HOTS) on Buffer Solution Material at MAN 1 MEDAN. The lack of students' high-level thinking abilities regarding the materials taught, especially the buffer solution material, is because the buffer solution material is one of the materials that is difficult for students to understand, some teachers who teach still seem monotonous, resulting in reduced interest in learning for students, and the students Students experience boredom if learning uses inadequate media. To determine the validity, practicality and effectiveness of using E-Module learning media based on Higher Order Thinking Skills (HOTS). The type of research used in this research is Research & Development (R&D) or development research. Development research that refers to the 4-D (four-D) model. The steps of the 4-D (four-D) development model consist of 4 development stages but researchers only use 3 stages, namely define, design, and develop. The subjects in this research were 1 media expert, 2 material experts, 1 practical test teacher, and 30 students tested. The media expert validation results were 93% and the material expert validation results were 83.33% in the "Very Valid" category. The results of the practicality test by the teacher obtained a percentage of 82% in the "Very Practical" category. The trial with 30 students obtained a percentage result of 86.33% in the "Very Effective" category. It can be concluded that the development of an E-Module based on Higher Order Thinking Skills (HOTS) on buffer solution material is declared to be very valid, practical and effective for use as a learning medium.

Keywords: Development Research, E-Modul, Hots, Buffer solution

Abstrak: Pengembangan E-Modul Berbasis Higher Order Thinking Skills (HOTS) Pada Materi Larutan Penyangga Di MAN 1 MEDAN. *Kurangnya kemampuan berpikir tingkat tinggi peserta didik terhadap materi- materi yang diajarkan terutama pada materi larutan penyangga dikarenakan materi larutan penyangga merupakan salah satu materi yang sulit dipahami oleh peserta didik, beberapa guru yang mengajar masih terkesan monoton sehingga mangakibatkan minat belajar peserta didik berkurang, dan peserta didik mengalami kebosanan jika pembelajaran menggunakan media yang kurang memadai. Untuk mengetahui kevalidan, kepraktisan, keefektifan dari penggunaan media pembelajaran E-Modul berbasis Higher Order Thinking Skills (HOTS). Jenis penelitian yang digunakan dalam penelitian ini adalah Research &*

Development (R&D) atau penelitian pengembangan. Penelitian pengembangan yang mengacu pada model 4-D (four-D). Langkah-langkah model pengembangan 4-D (four-D) terdiri dari 4 tahapan pengembangan tetapi peneliti hanya memakai 3 tahapan yaitu define, design, dan develop. Subjek dalam penelitian ini adalah 1 ahli media, 2 ahli materi, 1guru uji kepraktisan, dan uji coba ke 30 peserta didik. Hasil validasi ahli media sebesar 93 % dan hasil validasi ahli materi sebesar 83,33% dengan kategori "Sangat Valid". Hasil uji kepraktisan oleh guru memperoleh persentase sebesar 82% dengan kategori "Sangat Praktis". Uji coba dengan 30 orang peserta didik memperoleh hasil persentase sebesar 86,33% dengan kategori "Sangat Efektif". Dapat disimpulkan bahwa pengembangan E-Modul bebasis Higher Order Thinking Skills (HOTS) pada materi larutan penyangga dinyatakan sangat valid, praktis dan efektif untuk digunakan sebagai media pembelajaran.

Kata kunci: *Penelitian Pengembangan, E-Modul, Hots, Larutan Penyanggga*

▪ INTRODUCTION

One of the characteristics of the 2013 Curriculum is that it requires the involvement of ICT (Information and Communication Technology) in the learning process. The role of ICT is very important because it can increase efficiency and effectiveness in learning. In addition, the use of ICT in learning can increase the attraction and attention of students. In the 2013 Curriculum, student-centered learning, which means that students must be able to learn independently and get knowledge information not only obtained from teachers. Therefore, teachers must have varied learning resources such as handouts, modules, LKPD which are expected to help the learning process and facilitate the needs of students. This is also explained by Afrizon (2017) that a teacher must have extensive knowledge in developing teaching materials to increase students' insights.

Electronic module (E-module) is a teaching material in the form of a module that is displayed in an electronic format which is expected to increase students' interest and motivation to learn. The use of e-modules is as a substitute for books or printed modules (hardcopy) without reducing their essence as a source of information or a source of learning (Nadzia, 2018).

The use of teaching materials in the form of E-modules is used as a substitute for books or printed modules (hardcopy) without reducing their function as a source of information. The use of e-modules can also be used outside the classroom or in the classroom (Rofiyadi, 2020).

The advantage of e-modules is that they can make learning activities more lively because there are videos in them. This can increase students' interest when learning teaching materials because there is navigation, as well as loose concepts. In addition, chemical materials can be relearned because they can be studied independently at home via mobile phones or laptops and also one thing that cannot be missed is that e-modules can save costs because they do not need to be print-out (Astari et al., 2023).

HOTS is a thinking skill activated when an individual faces unfamiliar problems, uncertainties, questions, and dilemmas. Mental skills were initially determined based on Bloom's Taxonomy which categorized various levels of thinking, ranging from the lowest to the highest, namely knowledge (C1), understanding (C2),

application (C3), analysis (C4), synthesis (C5) and evaluation (C6). The concept of Bloom's taxonomy, namely knowledge, understanding, and application of students' measures of lower order thinking skills (HOTS), while the other three levels, namely analysis, synthesis, and evaluation Measure higher-level thinking skills or HOTS from Bloom's Taxonomy on HOTS. (Anggraini, N. P.2019).

One of the factors that causes low thinking skills is the lack of training of children in solving tests or questions that require high analysis, evaluation, and creativity. (Dewi, 2016).

Learning that does not emphasize efforts to develop higher-level thinking skills tends to condition learners in rote learning, therefore it is very important and main in learning teachers to facilitate students in applying high-level thinking skills. Tinggi (Hastuti, 2014).

The advantage of making an E-Module based on Higher Order Thinking Skills (HOTS) on buffer solution material is that the use of this media is very practical, namely that it can be accessed online on Android (smartphone), and makes it easier for students to learn anywhere and anytime. This is in accordance with the opinion of (Nurpatmawati & Bangun, 2023) explaining that Android-based interactive E-Modules are teaching materials that can be accessed practically with a Smartphone/Cellphone so that they can be used independently at home.

As a result of the author's interview with one of the chemistry teachers at MAN 1 MEDAN, it is known that MAN 1 MEDAN implements the K13 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, there are some students who don't like chemistry material because they think it's boring and just for fun.

▪ METHOD

This research uses research and development (R&D) methods, with a 4-D model is a type of research and development model used. The product to be produced is a chemistry e-module that contains a review of reaction rate material. The four stages of 4-D development are: definition, design, development, and deployment (Lestari, 2021). Research is limited to the development stage, namely determining the level of validity of the media developed and looking at the response from students.

The research uses a 4D model, namely define, design, develop and disseminate. However, this research only reached the (development) stage. The 3 stages of the 4D model are:

1. The define stage aims to identify facts or conditions in learning.
2. The design stage is the process of designing a product that has been determined. This stage aims to prepare a draft or prototype of a product being developed. The develop stage, at this stage consists of several steps, namely design validation and design revision of the product being developed.
3. Disseminate stage, this final stage disseminates the product that has been developed.

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

1. Module Validity Analysis

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. Determine the score obtained by adding up the scores from each validator
3. Determine the ideal percentage

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

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

Table 2. Validity Percentage

No	Intervals	Qualification
1	76%-100%	Very Valid
2	51%-75%	Valid
3	26%-50%	Valid Enough
4	0%-25%	Invalid

2. Module Practicality Analysis

To carry out an analysis of the level of practicality of the module being developed, a rating scale is used and obtained by:

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

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

The ideal percentage results are then interpreted in a qualitative sense based on the following table:

Table 3. Practical Percentage

No	Intervals	Qualification
1	76%-100%	Very Practical
2	51%-75%	Practical
3	26%-50%	Practical enough
4	0%-25%	Impractical

3. Test Student Response

To carry out an analysis of the level of practicality of the module being developed, a rating scale is used and obtained by:

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

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

The ideal percentage results are then interpreted in a qualitative sense based on the following table:

Table 4. Percentage of student responses

No	Intervals	Qualification
1	76%-100%	Very Agree
2	51%-75%	Agree
3	26%-50%	Agree Enough
4	0%-25%	Disagree

▪ RESULTS AND DISCUSSION

Based on the research that has been conducted, data was obtained regarding the development process of E-modules for learning chemistry based on Higher Order Thinking Skills on buffer solution materials. In this study, there are 3 stages carried out to develop modules based on Higher Order Thinking Skills.

Define

At this stage, preliminary analysis, curriculum analysis, and material analysis are carried out to find out the problems that occur in the research school.

1. Preliminary Analysis

At this initial analysis stage it is necessary to find out the main problems faced by students and teachers in the teaching and learning process at school. To identify problems and analyze problems, interviews were conducted with teachers at MAN 1 Medan. The results of the identification and analysis carried out on MAN 1 Medan teachers can be concluded that:

Students who have good learning achievements will easily solve questions with a low level of cognitive level, but if the student is given questions with a high level, then the student will not be able to solve them. Therefore, teachers must provide more examples of questions and exercises that they must answer.

2. Curriculum Analysis

Curriculum analysis aims to find out the problems faced at the research school, namely MAN 1 MEDAN. Based on an interview with one of the teachers who teaches in class XI Chemistry, learning activities still seem monotonous using lecture methods, exercises and assignments, and still using teaching media in the form of printed books provided at school.

3. Material Analysis

Material analysis is carried out to identify material that is difficult for students to understand. Material identification is carried out in accordance with Basic Competencies (KD) and Core Competencies (KI) in chemistry learning. Based on an interview with one of the mathematics teachers in class.

Design

At this stage, modules are made in accordance with the draft E-Module which has been analyzed in the analysis of curriculum and materials. There are three main parts in the manufacture of the E-Module, namely the initial part consists of the cover, preface, table of contents, concept map, and core components, the content consists of the buffer solution and its formation, the pH of the buffer solution, the effect of dilution and the addition of a little acid and base to the buffer solution, the usefulness of the buffer solution, and the cover consists of conclusions, competency tests, glossaries, reference.

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. E-Module Validation

The electronic modules developed are subjected to a validation test process for validate the product, so that the product developed is suitable for use in the learning process.

a) Media Validation

Media expert validation was given validators, namely 1 chemistry lecturers Medan State University. Validation is carried out by giving the E-Module of chemistry learning that has been developed to be viewed and submitting the validation sheet to the media expert validator. The validation sheet consists of 15 statements consisting of 2 aspects, namely graphics, there are 13 questions, where this aspect consists of module size, cover design and content design. The second aspect is language which consists of 3 questions. The assessments from media expert validators are presented in the table as following

Table 5. Media Validation Results

No	Aspect	Media Expert Validator Results	Category
1	Graphics	94%	Very Valid

No	Aspect	Media Expert Validator Results	Category
2	Language	92%	Very Valid
Average		93%	Very Valid

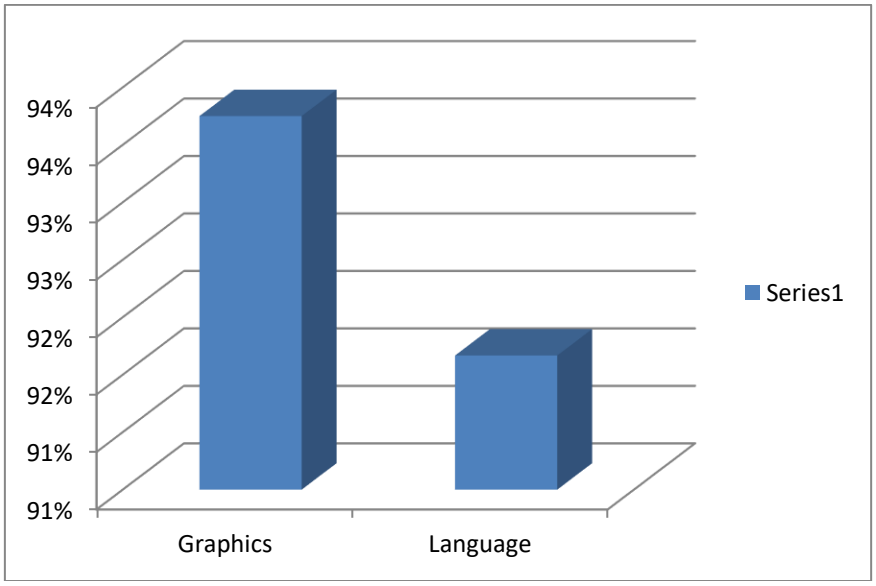

Figure 1. Media Expert Assessment Chart

Based on Table 5, above, the validation results by the validator got a percentage value of 94% with the "Very Valid" category and even got a percentage value of 92% with the "Very Valid" category, so that the average value of the percentage of media expert validators was 93% with the "Very Valid" category.

b) Material Validation

Material expert validation was given to two validators, namely three chemistry lecturers Medan State University with codes V1 (Validator 1) and V2 (Validator 2). Validation is carried out by giving the E-Module of chemistry learning that has been developed to be viewed and submitting the validation sheet to the material expert validator. The validation sheet consists of 24 statements consisting of 3 aspects, namely the validity aspect of the content, the validity aspect of the presentation, and the linguistic aspect. The assessment from the expert validator of the material presented in the table as follows.

Table 6. Material Validation Results

No	Validator	Material Expert Validation Results	Category
1	Validator 1	90,66%	Very Valid
2	Validator 2	76%	Valid
Average		83,33%	Very Valid

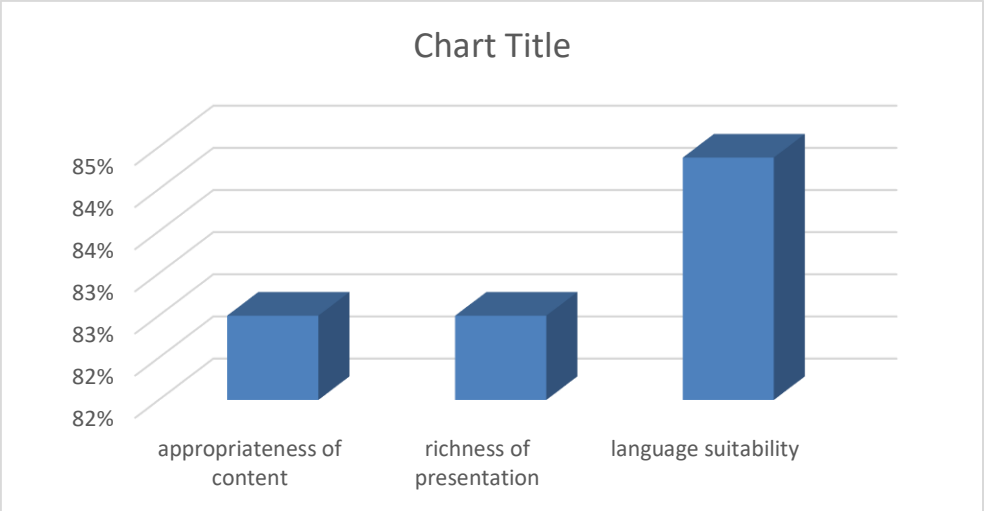

Figure 2. Material Expert Assessment Chart

Based on Table 6, above, the validation results by validator 1 got a percentage value of 90.66% with the "Very Valid" category and validator 2 got 2 got a percentage value of 76% with the "Valid" category, so that the average value of the percentage of material expert validators was 83.33% with the "Very Valid" category.

3. Practicality and Module Testing

a) Teacher Practicality Test

The practicality of the e-module can be seen from the teacher's response after using the e-module. The Practicality Questionnaire was given to one chemistry teacher at MAN 1 Medan. The results of the teacher response practicality questionnaire consist of four indicators, namely usable, easy to use, attractive, and efficient. Results of students' practicality regarding e-modules can be seen in Table 7.

Table 7. Practicality test results

Feasibility Aspect	**Average Percentage (%)**
Usable	85
Easy To Use	75
Effective	80
Average (%)	**82**
Criteria	**Very Practical**

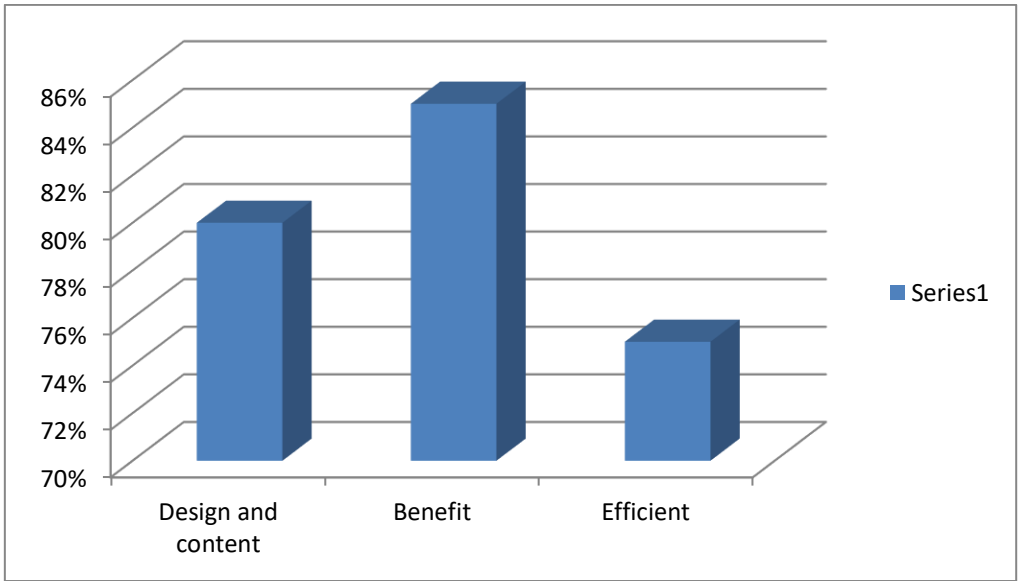

Figure 3. Teacher Practicality Test Results

Table 7, shows it is known that the results of teacher practicality were obtained by82% with the category of very practical interpretation. The results of the calculation of the practicality of the e-module are the basis that the e-module that has been developed is explained to be practically used in the implementation of chemistry learning in eleventh grade facilities and infrastructure. This is in line with research by H Nurhikmah et al., (2021) based on the results of the practicality test of the e-module being developed which is known to be practical for use in multimedia learning courses.

b) Small Scale Trial

At this dissemination stage, a test of class 1 XI was carried out consisting of 30 students of class XI MIPA 4 MAN 1 Medan. The large group trial was carried out by providing a student response questionnaire, the questionnaire was given to students to assess the practicality of the hots-based chemistry learning E-Module. From the results obtained, which is 86.33%, it is categorized as very practical, therefore the E-Module is suitable for use.

According to students, learning media in the form of E-Modules is very interesting because they have never used electronic modules (E-Modules) in their learning process. Learning using E-Modules is very fun, because the form and content presented in the learning E-Module are different from learning media in general, the learning E-Module is not fixated on the material and writings only but there are several pictures to make it easier for students to understand the buffer solution material.

Table 8. The result of students' responses

Feasibility Aspect	**Average Percentage (%)**
Material	86
Apperance	85
Benefit	87
Average	**86**
Criteria	**Very Agree**

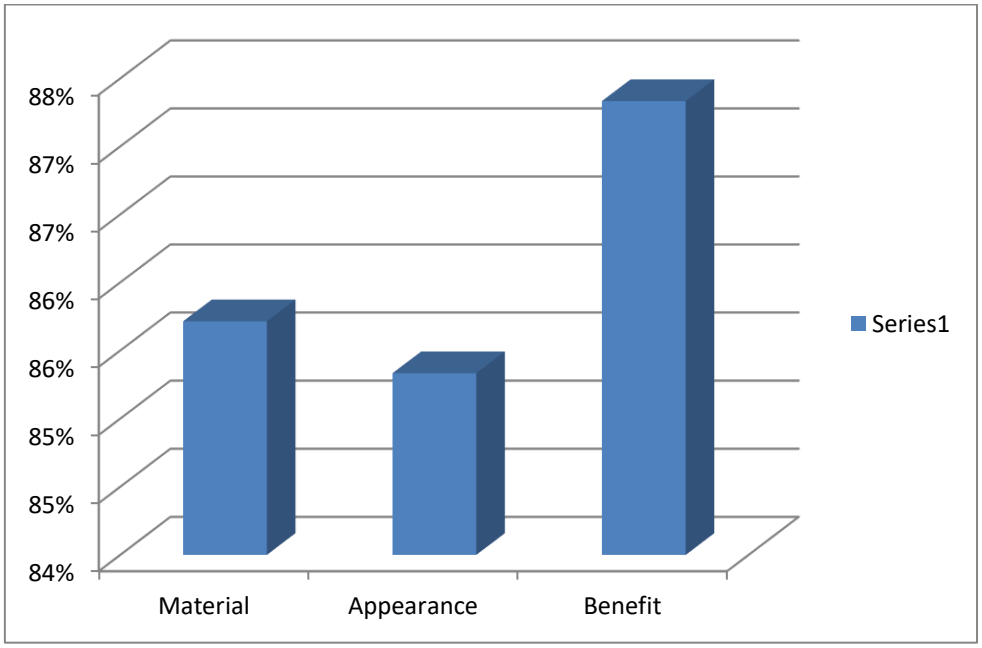

Figure 4. Student Questionnaire Results

The findings of this study are that the E-Module learning media based on Higher Order Thinking Skills (HOTS) in buffer solution materials is very suitable for use as a learning medium, this can be seen from the results of the validation assessment of media experts of 93% and material experts of 83.33% with the category of "Very Valid". Based on the results of the questionnaire of 30 students' responses to the E-Module learning media based on HOTS on the buffer solution material, the score was 86.33% with the category of "Very Practical" so that learning using the E-Module learning media based on HOTS on the buffer solution material was effectively used.

Based on research (Marthin, 2022) conducted research with the title "Development of HOTS Integrated Chemistry Module on Reaction Rate Material at SMAN 1 Sungayang". The results of the research showed that after testing the validity for the feasibility aspect, the content was included in the very valid category 94 out of a maximum score of 100%, resulting in an achievement of 94.6%. The validity test results for the feasibility aspect of presentation are included in the very valid category of 100%.

Based on research conducted by (Faizah, 2020) with the title "Development of an E-Module Containing Higher Order Thinking Skills (HOTS) on Chemical Bond Material", it was found that to measure students' high-level thinking abilities, a test of the appropriateness of ten students' responses to the module was used. containing Higher Order Thinking Skills (HOTS) on chemical bond material received a positive response by obtaining a score of 97 out of a maximum score of 100, thus obtaining a percentage of 97%. Apart from that, good results were obtained on the Hots-based question component. Questions consisting of C4, C5, and C6. The development of this Hots-based e-module was also stated by material experts to have received a score of 75 out of a maximum score of 75 with an ideal percentage of 100% and included in the very good (SB) category. The assessment results from media expert lecturers obtained a score of 27 out of a maximum score of 30 with an ideal percentage of 90% and included in the very good (SB) category. The assessment results from four SMA/MA chemistry

teachers obtained an average score of 72.50 out of a maximum score of 80 with an ideal percentage of 90.63% and included in the very good (SB) category.

Based on the findings obtained, it can be concluded that learning using E-Module learning media based on Higher Order Thinking Skills (HOTS) on buffer solution materials is very valid, very practical and very effective for use in schools. These findings help teachers or educators in delivering material and facilitate students in understanding buffer solution material.

▪ CONCLUSION.

The validation results given to media expert validators were 93% with very valid criteria and 2 material expert validators were 83.33% with very valid criteria. Therefore, the e-module developed is valid for use in learning. In the teacher practicality test, a result of 82% was obtained which met the very practical criteria so that the emodule developed could be used as teaching material in schools. Based on a small-scaletest of the e-module being developed, an average result of 86,33% was obtained with the Very Agree criteria. Student responses stated that the E-module developed could motivate students to learn.

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