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# Development of an Electronic Module (E-Module) Chemistry Based on POE (Predict, Observe, Explain) on Reaction Rate Study Materials

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**Abstract.**
The social restrictions that were implemented due to the COVID-19 pandemic had a profound impact on the field of education. There was an adaptation of changes from conventional to distance learning processes. This study aimed to develop a Chemistry Electronic Module (e-Module) based on the POE (Predict, Observe, Explain) approach to the study material of Reaction Rates for 11th grade science students. This module used videos as a stimulus for the student's learning process in three learning stages: predict, observe, and explain. This Research and Development research inspired by Borg and Gall used descriptive methods for analysis. The instrument used for this study was a questionnaire. The results from the validation test by three material and language experts, as well as media experts, showed that this e-module was classified as well to be very good for a percentage range of 80-90%. The results of the e-module feasibility test for seven high school chemistry teachers, 18 high-school students of class XI IPA, and 40 undergraduate students of Chemistry Education at the State University of Jakarta on the aspects of the developed electronic module were obtained with scores ranging from *well* to *excellent* with a percentage range of 81-94%. It can be concluded that the developed electronic module is suitable for use as independent teaching material for students on the material of reaction rates.

**Keywords:** chemistry electronic module, POE, reaction rates

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## 1. INTRODUCTION

Chemistry can be described in three levels of chemical representation, namely macroscopic, microscopic, and symbolic levels [1]. Chemistry learning is basically a learning that most of the topics discussed are abstract and need understanding at the submicroscopic level. The key to problem solving is when presenting chemical phenomena at the sub-microscopic level. A correct understanding of the three levels of chemical representation will result in a correct conception of chemistry [2]. Chemistry is also

laboratory knowledge, meaning that chemistry learning will not be effective without laboratory activities.

If these three levels are understood, they will result in a correct conception of chemistry. However, most of what happens to chemistry learning today, students do not understand the concept of chemistry that it has learned. According to Dalziel, if students are only asked to disclose the facts of a situation, for example the results of an experiment, it is possible that the students does not understand the results of the experiment. The result will be different if before the experiment is done, students are asked to predict the results first and then they observe by themselves how the experimental process. In that way, students can analyze the results of the experiment which they have observed with their initial predictions, so the students can understand their mistakes are and the learning activities will be more meaningful [3].

Cakmaci's research showed that reaction rate is a difficult topic to be studied and found a concept error in it [4]. This is because students consider reaction rate topic needs to be memorized. This statement is supported by the results of preliminary analysis questionnaires and needs related to the learning of reaction rates which disseminated at SMAN 31 Jakarta and SMAN 68 Jakarta stated that the main obstacle in learning reaction rates is that the topic needs to be memorized.

In the learning process, of course, it needs teaching materials. Teaching materials are all forms of materials that can be used to assist teachers in carrying out teaching and learning activities in the classroom. It can be either written or unwritten. Teaching materials are one of the learning resources, namely everything that makes it easier for students to obtain a certain amount of knowledge information, experiences, and skills in the teaching and learning process [5]. Based on the preliminary questionnaire results and needs, the source of information used by teachers and students at SMAN 31 Jakarta and SMAN 68 Jakarta is still dominated by text books. Module is one of the teaching materials that can help students and teachers in the learning process, because by using the module, students can teach themselves and control themselves to the intensity of their learning [6]. According to Russel, module learning will make learning more efficient, effective, and relevant [7].

Rapid development in the field of technology, especially information and communication technology has brought great changes in various fields, including in the education field. In the education field, the development of technology can be utilized to support the development of distance self-learning, especially by promoting ease, flexibility, and interactivity between users. One of the advantages of electronic module is that it is easily to be accessed by a smartphone or laptop anytime, considering that in today's

modern era, it is certain that all high-school students in particular must have one or both of them. This is evidenced by preliminary analysis data and needs, that the tools has been owned by more than 93% of students.

One of the solutions that can be done to solve these problems is to use the right learning models and media. One of the media and learning models that are in accordance with the scientific approach is the POE learning model (Predict, Observe, Explain) which is applied in teaching materials in the form of electronic modules (e-Modules). The development of electronic modules in reaction rate topic is intended as self-taught material by students that are useful for use in distance learning during the COVID-19 pandemic.

POE-based electronic modules are perfect for elusive topics because in this module contained some examples and implementations in daily life. So the students can understand and build a knowledge in advance of all existing phenomena and then observe the phenomenon in the laboratory by themselves, and finally they can associate their knowledge with new knowledge so that meaningful learning occurs [8].

## 2. RESEARCH METHOD

The type of research used is research and development of Borg and Gall models with quantitative descriptive method through questionnaires. The stages of research conducted are (1) Research and information collection, (2) Planning, (3) Development of initial e-Module, (4) e-Module validation test by experts, (5) Revision, (6) Small-scale trial test, (7) Revision, (8) Large-scale trial test, (9) Final revision. The topic, language, and media validators are lecturers in chemistry and chemistry education of FMIPA UNJ. The subject of this study consisted of seven high-school chemistry teachers, eighteen 11th grade science students, and forty undergraduate chemistry education students of Universitas Negeri Jakarta. The development of modules at the validation stage by experts until the trial stage by teachers and students is carried out during the COVID-19 pandemic, because of that the data retrieval process is taken online.

The instruments used in this study are preliminary and need analysis questionnaires, module validation questionnaires, and module test questionnaires. Questionnaires used in validation instruments by experts use a ten-point scales; scale 1 to 2 is Less Once, scale 3 to 5 is Less, scale 6 to 8 is Good, and scale 9 to 10 is Very Good. The questionnaire used in the electronic module trial instrument is a four-scale adapted from the Likert Scale. The interpretation of the assessment of the four scales are scale

1 for Strongly Disagree, scale 2 for Disagree, scale 3 for Agree, and scale 4 for Strongly Agree.

Assessment obtained from validation tests by topic, language, and media experts, as well as small and large-scale trials by teachers and students are analyzed through the calculation of score percentages [9]:

$$score\ percentage = \frac{\Sigma\ score\ obtained}{\Sigma\ score\ maximum} \times 100\% \quad (1)$$

The result is interpreted to the rating scale score in table 1 below:

TABLE 1: Interpretation of rating scales.

| No. | Percentage | Interpretation |
|---|---|---|
| 1 | 0% - 29% | Less Once |
| 2 | 30% - 59% | less |
| 3 | 60% - 89% | good |
| 4 | 90% - 100% | Very Good |

Furthermore, the reliability of the data from the assessment results from the experts is calculated. The goal is to know the level of consistency between raters in giving a score by using the Hoyt Formula [10]:

$$r = \frac{RJK_r - RJK_e}{RJK_r} \quad (2)$$

Information:

r = reliability of conformity between experts

RJKr = average number of squares rows

RJKe = average number of squares errors

Reliability score obtained from the calculation result can be known criteria based on data in table 2.

TABLE 2: Reliability criteria.

| No. | Percentage | Interpretation |
|---|---|---|
| 1 | - 0.20 | bad |
| 2 | 0.21 - 0.40 | Less than average |
| 3 | 0.41 – 0.60 | Average |
| 4 | 0.61 – 0.80 | Good |
| 5 | 0.81 – 1.00 | Excellent |

# 3. RESULTS AND DISCUSSION

Research on the Development of Electronic Module (e-Module) Chemistry-Based on POE (Predict, Observe, Explain) on Reaction Rate Topic was conducted from December 2019 to July 2020. This electronic was developed in hope to attracting student in studying chemistry, especially in reaction rate topic independently in distance learning.

## 3.1. Preliminary Analysis and Needs

The preliminary analysis and needs were conducted at SMAN 31 Jakarta and SMAN 68 Jakarta with sixty respondents from $11^{th}$ grade science students and three chemistry teachers on December $6^{th}$ and $18^{th}$, 2019. The results of preliminary analysis questionnaires and teacher needs related to reaction rate learning are limited learning time, the use of text books as a learning resource, and the irrelevant text books with the current development. While the results of the preliminary analysis questionnaire and the needs of students related to the learning of reaction rates is about 44% of students stated the most difficulty in learning reaction rate is because there are too much topics to learn. Another factor is because the topic is boring and needs to be memorized. Teachers and students expect for modern, interactive, easy-to-understand, short and clear learning resource, contains summary, practical guidance, animations, and videos. Therefore, a POE-based Electronic Module on Reaction Rate Topic was developed.

## 3.2. Planning

This phase is to develop the initial product of POE-based Electronic Module on Reaction Rate Topic, begins with syllabus analysis, storyboarding, instrument preparation, and application selection. The applications used to create this module are Corel Draw X8, Canva, and Flip PDF Professional.

## 3.3. Development

POE-based Electronic Module on Reaction Rate Topic was developed by designing the draft of each module page using Corel Draw X8, then all drafts are converted and put together into a pdf file. After that the module pdf file is converted into a flipbook using Flip PDF Professional. Finally, POE-based Electronic Module on Reaction Rate Topic in html format produced, and can be accessed online using any type of browser.

## 3.4. Validation Test by Experts

This stage aims to test the feasibility of electronic module before trials are conducted to teachers and students. The module validated in two aspects, namely topic and language aspects, and media aspect. The result of the interpretation of the assessment by topic and language experts can be seen in table 3.

TABLE 3: Results of module assessments by topic and language experts.

| Indicators | Rating Percentage (%) | | | Interpretation |
|---|---|---|---|---|
| | Expert 1 | Expert 2 | Expert 3 | |
| Content Components | | | | |
| Material coverage | 90 | 80 | 83,3 | Good – Very good |
| Accuracy of materials | 90 | 80 | 83,3 | Good – Very good |
| Skills | 90 | 80 | 85 | Good – Very good |
| Language Components | | | | |
| Conformity with student development | 90 | 80 | 80 | Good – Very good |
| Communicative | 85 | 80 | 85 | good |
| Motivating Ability | 85 | 80 | 80 | good |
| Simplicity | 90 | 80 | 80 | Good – Very good |
| Coherence and The Tangle of Thought Flows | 80 | 80 | 90 | Good – Very good |
| Conformity with Indonesian Language Rules | 80 | 80 | 80 | good |
| Use of Chemical Terms and Symbols or Symbols | 80 | 80 | 85 | good |

Based on the results of the assessment by topic and language experts in table 3, obtained a reliability value of 0.86 with very good criteria. Furthermore, module to be validated on presentation and graphic aspects. The result of the interpretation of the assessment by media experts can be seen in table 4.

Based on the results of reliability calculation between raters, obtained a reliability value of 0.96 with very good criteria. The feedbacks that are given by experts on e-Module depicts 'good to very good' with percentage range 80-90%. The results of the assessment by experts stated that the developed module are worth to be tested to teachers and students.

Table 4: Results of module assessments by topic and language experts.

| Indicators | Rating Percentage (%) | | | Interpretation |
|---|---|---|---|---|
| | Expert 1 | Expert 2 | Expert 3 | |
| E-Module Cover Design | | | | |
| Cover layout | 82,5 | 80 | 80 | Good |
| Cover typography | 85 | 80 | 85 | Good |
| Cover illustration | 87 | 87 | 87 | Good |
| E-Module Content Design | | | | |
| Content layout | 82 | 80 | 80 | Good |
| Content typography | 84 | 81 | 83 | Good |
| Content illustration | 86 | 80 | 86 | Good |

## 3.5. Small-Scale Trial

This stage is the initial stage of the feasibility trial of modules in the field on a small scale that aim to obtain comments and suggestions from respondents. POE-based Electronic Module on Reaction Rate Topic on a small scale trial was conducted by three high school chemistry teachers in Jakarta and by eighteen students of 11th grade at SMAN 31 Jakarta. The results of the interpretation of teacher and student assessments in small-scale trial can be observed in table 5 and table 6.

Table 5: Results of teacher assessment in small-scale trial.

| No. | Aspects | Percentage (%) | Indicators |
|---|---|---|---|
| 1 | Conformity of content substance with competencies that must be achieved by students | 90 | Very Good |
| 2 | Clarity of information in electronic modules | 92 | Very Good |
| 3 | Language | 78 | Good |
| 4 | Audio and visual display | 88 | Good |
| 5 | Benefits | 94 | Very Good |
| 6 | *POE* Approach | 81 | Good |

Based on the data in table 5 and table 6, the feedbacks of assessment interpretation by teachers and students in small-scale trial showed that the POE-based Electronic Module on Reaction Rate Topic depicts “good to very good” with percentage range 76-94% on its aspects. The module was revised based on the suggestions and comments of teachers and students, for further large-scale trial.

Table 6: Results of students assessment in small-scale trial.

| No. | Aspects | Percentage (%) | Indicators |
|---|---|---|---|
| 1 | Topics, experiment, and question quality | 81 | Good |
| 2 | Language | 79 | Good |
| 3 | Audio and visual display | 77 | Good |
| 4 | Implementation and software engineering | 82 | Good |
| 5 | Benefits | 87 | Good |
| 6 | *POE* Approach | 76 | Good |

## 3.6. Large-Scale Trial

This stage is the final stage of module feasibility testing in the field on a large scale. The goal is to get comments and suggestions from respondents. Suggestions from respondents are used as a reference in improving the developed module. The large-scale trial was conducted by four high school chemistry teachers and forty undergraduate chemistry education students of Universitas Negeri Jakarta. The results of the interpretation of teacher and student assessments in small-scale trial can be observed in table 7 and table 8.

Table 7: Results of teacher assessment in large-scale trial.

| No. | Aspects | Percentage (%) | Indicators |
|---|---|---|---|
| 1 | Conformity of content substance with competencies that must be achieved by students | 93 | Very Good |
| 2 | Clarity of information in electronic modules | 92 | Very Good |
| 3 | Language | 82 | Good |
| 4 | Audio and visual display | 91 | Very Good |
| 5 | Benefits | 94 | Very Good |
| 6 | *POE* Approach | 84 | Good |

Table 8: Results of students assessment in large-scale trial.

| No. | Aspects | Percentage (%) | Indicators |
|---|---|---|---|
| 1 | Topics, experiment, and question quality | 83 | Good |
| 2 | Language | 84 | Good |
| 3 | Audio and visual display | 85 | Good |
| 4 | Implementation and software engineering | 87 | Good |
| 5 | Benefits | 87 | Good |
| 6 | *POE* Approach | 81 | Good |

Based on the data in table 7 and table 8, the feedbacks of assessment interpretation by teachers and students in large-scale trial showed that the POE-based Electronic Module on Reaction Rate Topic depicts “good to very good” with percentage range 81-94% on its aspects. These results showed a percentage increased in some aspects compared to the results of small-scale trial. Based on the outcome, it can be concluded that the developed electronic module has sanctioned to utilize as an independent learning material for student.

## 4. CONCLUSION

Based on the results of the study, it can be concluded that the POE-Based Electronic Module on Reaction Rate Topic has been developed based on preliminary analysis and needs has sanctioned to utilize as an independent learning material for student. It is validated by three experts in chemistry content, language, and media, the feedbacks that are given by experts on e-Module depicts ‘good to very good’ with percentage range 80-90%. The subjects in this study are seven high school chemistry teachers, eighteen 11th grade science students and forty undergraduate chemistry students of State University of Jakarta. The feedbacks that are given by teachers and students on e-Module depicts ‘good to very good’ with percentage range 81-94% on its aspects. Suggestions that can be submitted based on the study is, the need to implement the module that has been developed to test the effectiveness of the learning modules to student learning outcomes.

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