Validity and Practicality Level of Acid-Base Electronic Module Based on Structured Inquiry Containing Three Levels of Chemical Representation for Senior High School Student

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Abstract. Acid-base is prerequisite material for studying the hydrolysis of salts and buffer solutions. This material is still difficult to understand for students. This study aims to reveal the level of validity and practicality of electronic module based on structured inquiry containing three levels of chemical representation. This research was Research and Development (R&D) using Plomp’s development model. The research instrument was a validity and practicality questionnaire. The e-module was validated by 4 chemistry lectures and 2 chemistry teachers. The practicality test was carried out on 2 chemistry teachers and 65 students grade XI of Senior High School. The data were analyzed using the Kappa Cohen formula. The result of the study showed the developed e-module had a very high level of validation (k = 0.86). The results of practicalities also showed a very high level, k=0.90 response of teachers, and k= 0.88 response of students. The electronic module was valid and practically for in acid-base learning in Senior High School.

1. Introduction
Acid-base is one of the chemical material that is considered difficult by students [1],[2] because it includes abstract concepts and involves many mathematical equations [2]. Acid-base is prerequisite material for studying the hydrolysis of salts and buffer solutions [3]. Students’ difficulties in understanding this material will prevent students from understanding the next material. So that teachers need to help students to understand these difficult concepts.

The solutions to handle this case are using three levels of representation in the chemistry learning process [4]. Because can assist students to understanding abstract concepts [5]. The three levels of chemical representation are the macroscopic level, submicroscopic level, and symbolic level[5]. Based on the results of interview conducted in several high schools in Padang city, acid-base learning has not fully involve the three levels of chemical representation. The teaching materials used in learning also do not contain three levels of representation. Teachers and students expect interesting teaching materials. Electronic module (e-module) can be a solution to this problem. Because e-module can contain audio, video, and animation that are arranged in an integrated, systematic, and detailed manner so that students can learn on their own. [6],[7]. The video and animation on the e-module can contain a submicroscopic level of representation.

E-module component are arranged following the e-module preparation guidelines from MoEaC in 2017 [8]. The arrangement of the e-module is also by follows the steps of the learning model suggested...
by the Ministry of Education and Culture No 22/2016 rules, namely the inquiry learning model [9]. One part of the inquiry learning model is structured inquiry [10],[11]. In the structured inquiry learning model, students are required to investigate questions or problems to find the relationship between variables from the data obtained until it is concluded that a concept [12]. The structured inquiry has been effectively used in science learning [13], because it can build good and meaningful conceptual knowledge [14]. The structured inquiry can make students remember information longer, and direct students to continuous knowledge [15],[16]. So that the structured inquiry learning model is suitable for learning difficult material.

For this reason, an acid-base e-module based on structured inquiry containing three levels of chemical representation was developed which is valid and practical for learning acid-base material. The purpose of this study is to reveal the level of validity and practicality of acid-base electronic module based on structured inquiry with three levels of representation.

2. Research Methods

This research is using Research and Development (R&D) type. R&D is one of the research method that is usually used to produce a particular products and test the effectiveness of the products [17]. This study used the plomp development model developed by tjeerd Plomp. There are three major phase in the Plomp Development Model, namely: (1) Preliminary Research, (2) Prototyping, (3) Assessment [18].

The research instrument used was a validity and practicality questionnaires. The validity questionnaire was given to 6 validators, including 4 lecturers of chemistry and 2 chemistry teachers. The practicality questionnaire was given to 2 chemistry teachers and 65 students at SMAN 3 Padang and SMAN 8 Padang. The validation instrument aims to assess content, construct, language, and graphic components of e-module. E-module that have been validated by validator are revised according to the suggestions given. A practicality instrument are used to see the practicality of the e-module. The aspects assessed that are assessed namely, attractiveness, ease of use, time efficiency, benefits aspects, and an additional aspect for the teacher response questionnaire, namely aspect of scientific truth. The data from the questionnaires are processed using the Kappa Cohen formula. Whereat the end of the processing, a kappa moment was obtained which stated the validity or practicality of the product.

\[
\text{Kappa Moment} = \frac{(\rho - \rho^e)}{(1 - \rho^e)}
\]

Information:
\(K\) = Kappa moment that shows the level of validity and practicality of the product.
\(\rho\) = The realized portion is calculated from the number of values given by the validator divided by the maximum value.
\(\rho^e\) = The unrealized portion is calculated from the result of reducing the maximum value by the total value given by the validator divided by the maximum value.

After calculating the kappa moment \(k\), the result of this calculation are a description of the level of validity and practicality of the developed e-module. Kappa moment values range from 0 to 1 with the category of decisions according to Boslaugh as presented in Table 1 [19].

| Interval   | Category   |
|------------|------------|
| 0.81 – 1.00| Very high  |
| 0.61 – 0.80| High       |
| 0.41 – 0.60| Medium     |
| 0.21 – 0.40| Low        |
| 0.01 – 0.20| Very low   |
| <0.00      | Invalid    |
3. Results and discussion

Based on research that has been done, an acid-base e-module based on structured inquiry containing three levels of chemical representation has been developed through the plomp development model. The reason for choosing acid-base materials is acid-base material including material that is difficult for students.[1],[2]. Besides that acid-base is prerequisite material for studying the hydrolysis of salts and buffer solutions [3]. The result of the development of this e-module are described as follows:

3.1. Preliminary Research Phase

Preliminary research is carried out to develop an acid-base e-module based inquiry structured containing three levels of chemical representation. preliminary research begins with a needs analysis, analysis of curriculum, and analysis of concept. The result of this phase are served as the basis of the initial design of the e-module. The result of the analysis is described as follow:

1. There are still many students who consider acid-base material as difficult material.
2. Based on used teaching materials, students are still hard to understand the whole concepts.
3. The teaching materials provided do not fully contain three levels of representation that can make it easier for students to understand the acid-base concept.
4. Teachers and students hope that instructional materials that are easy to understand and interesting.

3.2. Prototyping Phase

Based on the result of the previous phase, an e-module was designed according to that results. The first designed of this e-module is named Prototype I. The e-module design consists of several components, namely cover of e-module, foreword, table of content, list of table, list of figures, instructions for using e-modules, glossary, competence, maps of concept, sheets of activity, worksheets, evaluation, answer keys and references [8]. The prototype I conducted by self evaluation that focuses on mismatch typing letters, the use of images, the completeness e-module as the required elements that should exist in the e-module, and also the completeness stage of the structured inquiry learning mode. Following are some views of the e-module components, see figures 1 and 2.

![Figure 1. Cover e-module](image)

![Figure 2. stages of data collection and organization of the e-module activity sheet](image)
Base on self evaluation results, it gained Prototype II. Furthermore, expert validation and one to one evaluation is carried out. There are 6 validators who have validated this e-module developed. The level of validity of the e-module developed was very high (k=0.86). The results of the e-module validity analysis are summarized in Table 2.

| No | Rated Components          | The average of Moment Kappa | Validation category |
|----|----------------------------|-----------------------------|---------------------|
| 1  | Content Component          | 0.86                        | Very High           |
| 2  | Construct Component        | 0.82                        | Very High           |
| 3  | Language Component         | 0.88                        | Very High           |
| 4  | Graphic Component          | 0.91                        | Very High           |
|    | Average                    | 0.86                        | Very High           |

Based on the table 2 can be noticed that the results of the level validity of contents components show very high validity categories (k= 0.86). This indicated that the e-module is by following with competencie to be achieved. The contents of the e-module also contain three levels representation has spread scientifically. The product content is said to be valid if it is in accordance with the curriculum [20],[4] and according to science [21]. Furthermore, the level of validity of the e-module construct component was also very high (k= 0.82). this case shows that e-modules developed by following the components of the e-modules and syntax of structured inquiry. The product can be said valid in terms of the construct if all of the components are consistently interconnected [22],[23].

In the language component, the level of validity is very high (k=0.88). These results show that the language used by following with the rules of Indonesian properly and correctly so that it can be understood properly by the users. One of a good category of e-module is user friendly, that is the e-module is easy to understand and communicative[24]. The value of the e-module validity of the graphic component is very high (k=0.91). This indicated that the e-module has an attractive designs. Attractiveness is one part of a quality e-module [25]. High attractiveness can increase student’s enthusiasm for learning. One of the improvements suggested by the validator can be seen in Figures 3 and 4. From the figure it can be seen that the validator suggested adding a submicroscopic and symbolic level to the existing image.

Next stage one to one evaluation was carried out by interviewing three students grade XI IPA at SMAN 3 Padang, the students with low ability, moderate ability, and high ability. Three aspects that will be assessed at this stage, that are the clarity, obvious errors. In this stage, typing errors still exists such as questions in evaluation questions.

The result of improvement from Prototype II are called Prototype III. Furthermore, conducted a small group evaluation on prototype III. Small group evaluation was carried out to see the practice of the developed e-module before tested in a field test. In this evaluation, there were 6 students with low ability, moderate ability and high ability who were used as the subjects of e-module testing. This evaluation is carried out in one learning process and at the end of the lesson they were given a practicality questionnaire. Overall, the results of this stage showed that the practicality of this e-module was very high (k=0.86). Then a prototype IV has been obtained which will be used for field test.
3.3. Assessment Phase
At this stage consists of practicality and effectiveness stage. After testing Prototype IV to the field group a practicality questionnaire was given to teachers and students. Broadly, the practicality value of the teachers and students response questionnaires show a very high category, k=0.90 for teachers’ responses and k=0.88 for students’ responses. The Practical of the developed e-module can be observed in the Table 3.

| No  | Rated aspects        | Average of teacher’s kappa moment | Average of student’s kappa moment |
|-----|----------------------|-----------------------------------|-----------------------------------|
| 1   | Attractiveness       | 1                                 | 0.89                              |
| 2   | Ease of use          | 0.91                              | 0.88                              |
| 3   | Times efficiency     | 0.85                              | 0.89                              |
| 4   | Benefits             | 0.89                              | 0.88                              |
| 5   | Scientific truth     | 0.88                              | -                                 |
|     | Average              | 0.90                              | 0.88                              |

The aspects that are assessed practicality of the e-module developed can be seen in the table, including attractiveness aspect, ease of use, time efficiency, [26] benefits and additional aspect for the teacher response questionnaire, namely scientific truth aspect. Can be seen, the attractiveness aspect of the developed e-module results in a kappa moment of 1 from the teachers’ response and 0.89 from students’ response with a very high of practicality level. This result shows that the developed e-module is interested the students. The use of videos, pictures and attractive design can increase students interest motivations [27], [28]. From the ease of use aspect, the developed e-module has a k=0.91 from teachers’
response and k= 0.88 from students’ response, its mean the of ease of use aspect getting a very high level of practicality. The results show the developed e-module is easy to use, this is the same as the feature of an e-module, namely user friendliness is one of the characteristics of a good e-module. This indicates that the developed e-module is easy to understand and communicative [6]. Every instruction contained the easiness ways and users are easy to respond and interact [29].

The benefit aspect, the developed e-module gets a very high level of practicality with k= 0.89 response of teacher and k= 0.88 response of students. This indicated that the developed e-module is beneficial for readers. The e-module consists of exercise worksheet and questions on evaluation can help the students to measure their own abilities of understanding the concept of e-module. [27], [30]. From the time efficiency aspect, the developed e-module also get a very high level of practicality, the result shows that developed e-module can save their learning time. Learning with an e-module can make the learning process more efficient [31]. And the scientific aspect shows that the developed e-module has kappa moments 0.88, it means that the developed e-module is scientifically correct. The e-module must scientifically correct [32].

4. Conclusion
Acid-base e-module had a very high level of validity and practicality.

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