Validity and practicality of salt hydrolysis module based on discovery learning with scientific approach to increase the critical thinking ability of 11th grade high school students

Sowel Ilhami*, Ellizar, Ananda Putra and Hardeli

Departement of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Jl. Prof Hamka, Padang 25131, Indonesia

*sowelaja@gmail.com

Abstract. The critical thinking ability and students’ learning outcomes could be improved by using module based on discovery learning. This study aimed to develop a salt hydrolysis module based on discovery learning with scientific approach and revealed its validity and practicality. The Research and Development (R & D) has been used in this research. Plomp model which consists of 3 stages, namely preliminary research, prototyping phase, and assessment phase has been applied. The research instrument used is a questionnaire in the form of validity and practicality sheet. The module is validated by lecturers and chemistry teachers and tested at two schools with medium and low student skills. Teachers and students response questionnaire has been used as practicality test. Data were analysed by Kappa Cohen formula. The validity test results showed that the module has a very high category of validity. The result of practice test by teacher and student showed that module has high and very high practicality category. Based on the results of this study, it can be concluded that the module developed was valid and practical

1. Introduction
Chemistry in the 2013 national curriculum is one of the subjects of mathematics and natural sciences’ subject. Chemistry is the study of matter and the changes that accompany it [1]. Chemistry has an important role in the advancement of science and technology. Therefore, mastery of chemistry needs to be improved in the learning process. Some student considers learning chemistry as difficult to understand. The difficulties of students in understanding chemistry are due to the characteristics of abstract chemistry. Salt hydrolysis was claimed as one of them. The salt hydrolysis material is included in the subjects of grade 11 and listed in the national syllabus with Basic Competence 3.11 which analyses the ionic equilibrium in saline solution and correlates its pH, and 4.11 reports the experiment to show the acid-base properties of various saline solutions. This material discusses the reaction of a cation or anion of a salt with water. This reaction is abstract and certainly not visible to the students. Students can only observe symptoms or facts in the form of pH values performed by experiment.

Based on observation, students are expected to find the concept independently of salt hydrolysis. In addition, students are required to be able to explain; why salt solution can be acidic, alkaline or neutral, what components affect it, and how to calculate the pH of the solution based on the relationships $K_a$, $K_b$, $K_h$ and $K_w$ [2].
Based on interview, five chemistry teachers and several students conducted in three Padang High Schools showed that salt hydrolysis material is a material which considered difficult for students. Student difficulties in salt hydrolysis materials include calculating saline pH, determining the acid-base properties of salt and differentiating the total, partially hydrolyzed salt and not hydrolyzed. This is evidenced by the number of students who have not reached the Minimum Criteria of Completeness (KKM). In the academic year 2015/2016, 60% of students have scores below the KKM, and in the academic year 2016/2017 as many as 57% of students have scores below the KKM.

In addition, students' understanding of the hydrolysis material is only memorizing, because while we asked about salt hydrolysis some students was forget. This is because the concept of the material is given directly by the teacher and not found by the students themselves, so it does not last long in memory. Salt hydrolysis is a material that combines abstract concepts and calculations, requiring high thinking and analytical skills to understand the material. Teachers in the learning process is expected to facilitate students develop thinking skills to find concepts. One of the thinking skills that must be developed is the ability to think critically.

Critical thinking is a directional and clear process used in mental activities such as solving problems, making decisions, analyzing assumptions, and doing scientific research [3]. The ability to think critically has the potential to increase the critical analytical power of students relating to the improvement of students' intellectual abilities. The students' critical thinking skills increased, so student learning outcomes also increased significantly [4]. Therefore, critical thinking skills are indispensable in learning, especially chemistry learning. Based on research conducted by Ellizar and Djamis reported that the average critical thinking skills of high school students in the city of Padang is quite low at under 40% [5]. The ability to think critically is a skill that must be done through practice and requires a supportive learning tool to tackle students critical thinking skills. In the learning process should implement activities that trained students' critical thinking skills to give students the opportunity to hone their critical thinking skills [6].

Teaching material is applied to support learning tools in case to train students' critical thinking skills. Based on previous interviews teachers use more teaching materials in the form of textbooks and student's worksheet during the learning process. However, teaching materials used by teachers have not included activities that are in accordance with the 2013 national curriculum. The teaching materials have not directed students to find the concept because it is still given directly, so the process of self discovery of the concept by the students has not been done completely. Presentation of materials and concepts on existing materials also still not include the three levels of chemical representation of submicroscopic level, but this is very helpful to understand the material of abstract salt hydrolysis.

One of the teaching materials that support students to train students' critical thinking skills is the module. A module is a printed media that is structured in a systematic, operational and complete component that contains learning materials of a material to be learned and its use is directed [7]. By the module, students can not only learn in the classroom on the chemistry learning process, but also outside the classroom independently or in groups. Characteristics of the module is systemical, complete and can be used by students independently, so that the module has language, materials and other components more easily understood for self-study by students. Therefore, modules become an option that needs to be developed. Critical thinking modules can be developed by adding contextual questions that train critical thinking skills in accordance with critical thinking indicators. Module based on scientific in static fluid materials can improve students' critical thinking skills [8].

The developed module must be in accordance with the 2013 national curriculum. The learning activities are fully directed towards developing the real of knowledge through a scientific approach and by applying the learning model. One of the learning models that match the scientific syntax and can develop students' critical thinking skills is discovery learning.

Discovery learning is a model of learning to develop an active way of learning by finding, self-investigating, the results obtained will be durable in memory, it will not be easily forgotten students [9]. By discovery learning, students can also learn to think analysis and try to solve their own
problems faced. The discovery learning model that involves maximally the ability to think in discovering their own chemical concepts causes students to better understand and not easily believe in what has not been proved which is one of the traits of a person who thinks critically [10]. The choice of discovery learning model is also adapted to the salt hydrolysis properties characteristics, students can actively engage themselves to find concepts through experiment.

Discovery learning-based modules have advantages in terms of engaging students actively in the learning process that trigger students' critical thinking skills and improve learning outcomes. The results of the study by Ellizar, et al showed that student learning outcomes using discovery learning-based module significantly higher than student learning outcomes without using modules [11], and the results of research Sapitri et al. indicates that the application of discovery learning model can improve students' critical thinking skills on physics subject [12].

The objective of this research is to develop salt hydrolysis module discovery learning-based with scientific approach to improve students' critical thinking ability and to know the validity and practicality of developed module.

2. Method
Research and Development (R & D) is applied in this study. Research and Development / R & D is a process or steps to develop a new product or refine an existing product and can be accounted for [13]. The development model used is a Plomp model consisting of three phases, namely preliminary research, prototyping phase, and assessment phase.

Preliminary research stage, is the stage of data collection to identify problems that occur in the learning and get a figure of the expected product specifications. At this stage needs analysis, student analysis, curriculum analysis and concept analysis. Needs analysis is done by interviewing chemistry teacher and high school student about the problem that happened in chemistry learning. Curriculum analysis aims to determine what ability should be owned by students based on the analysis of Basic Competence so that formulated indicators and learning objectives. Analysis of the concept aims to determine the concepts that must be mastered by students by identifying, detailing, systematically arranging the concept contained in the module for easy understanding by students. Student analysis is done to know the characteristics of students who become the target users of developed products.

Phase prototyping phase is the design stage of the salt hydrolysis module with a scientific approach based on the analysis results in the preliminary research stage. Modules that have been designed are formative evaluations. Formative evaluation is done by self-evaluation using check list, experts review using validation sheet, one to one evaluation with interview sheet and small group using questionnaire of student's response practice.

Phase assessment phase is conducted field testing of developed module. The test aims to know the practicality of the module. The data were obtained from the questionnaires by 3 teachers and 57 high school students from two schools.

Data obtained from the validation and practicality sheet were analyzed using Cohen's kappa formula, so the kappa moment value (κ) was obtained. The κ values range from 0 to 1 [14]. Interpretation of the value κ can be seen in Table 1.

| Table 1. Category by Moment Kappa [14] |
|-------------------|
| Interval | Category |
|---------|----------|
| 0.81-1.00 | Very High |
| 0.61-1.80 | High |
| 0.41-0.60 | Moderate |
| 0.21-0.40 | Low |
| 0.01-0.20 | Very Low |
| ≤0.00 | Not Valid |
3. Result and Discussion

3.1. Development Result

3.1.1. Preliminary Research

Based on the results of interviews with chemistry teachers it is known that the method of learning of chemistry applied in schools has varied, such as lecture method, discussion, and practicum (experiment). Learning steps are also available using scientific approaches and learning models such as inquiry and discovery learning but the implementation not optimally reached. In practice, the lecture method still dominates, caused by the less active students in the learning process to construct their own concepts.

The teaching materials used in salt hydrolysis materials are textbooks and student's worksheets. The textbook used has not been edition of the 2013 revision curriculum 2017. The display of the teaching materials used has a colored cover, black writing, and black-and-white images that only display macroscopic and symbolic levels. The teaching materials used are complete materials, with sample questions and there is a question of evaluation at the end of the material. This teaching materials more direct students to read and understand the material given, so the students own conceptual draft is still lacking. The teaching materials used do not present the learning steps demanded by the curriculum of 2013, so that the steps of scientific approach and the stages of the 2013 curriculum learning model have not been implemented maximally in the learning process. Therefore, the teaching materials used have not led the students to construct their own concepts and train students' critical thinking skills.

Teaching materials that teachers hope is a teaching material that is able to direct students to find the concept and active in the learning process. In addition the teaching materials are easy to understand, efficient against time and has an attractive appearance, color and picture.

Student analysis is done to know the character of student which become target user of developed product. Students who were analyzed were 11 grade of high school age 15-17 years in average. According to Piaget the level of thinking of children of that age at the stage of formal operational development, where at this stage students have the ability to think logically, abstract, and can draw conclusions [15]. Based on this it can be concluded that 11 grade high school students basically have the ability to resolve the problem in accordance with the facts. This is taken into consideration in preparing the teaching materials.

Curriculum analysis aims to determine what ability should be obtained by students. The results of curriculum analysis are used for the preparation of teaching materials. The 2017 revision curriculum were analyzed from the Basic Comptension (KD) of salt hydrolysis material. The results of the analysis of KD can be known what ability should be possessed by students in studying salt hydrolysis material so that formulated indicators of achievement of competence. The results of the formulation of the indicator is then used to formulate the objectives of learning materials.

Conceptual analysis aims to identify the main concepts taught, breakdown and systematically arrange to achieve indicators of achievement of competence. Concept analysis is based on indicators that have been formulated from Basic Competencies. The main concepts on salt hydrolysis matter are salt, determine the nature of salt, determine the type of hydrolysis and its reaction and calculate the hydrolyzed salt pH.

3.1.2. Prototyping Phase

Based on the results of the analysis at preliminary research stage, it has been designed salt hydrolysis module based on discovery learning syntax. The designed module consists of cover components, introduction, table of contents, module usage instructions, learning competencies, concept maps, introductions, activity sheets, worksheets, evaluation questions, key answers and references. In the introduction, there is a prerequisite material that is useful to remind students of the previous material of acid and base. In the module there are 4 sheets of activities that also accompanied the allocation of
time and learning objectives. The key answers to the module include key sheets for activity sheets, worksheets and evaluation questions. Key answers are used by students as a tool of correction and guidance in measuring its ability. Self evaluation will be done to know the visible errors, such as punctuation error, typing, and module component completeness by using check list. The results of self evaluation indicate that the module developed there are still errors in typing words, ion charge writing errors, and errors in writing the scientific approach approach and incomplete letters. The error was then fixed and prototype I was generated.

The results of prototype I are then validated by the experts (experts review). Discovery learning-based chemistry module with scientific approach validated by 8 experts consisting of 3 lecturers of chemistry, 1 lecturer of educational technology, 1 lecturer of Indonesian language and 3 chemistry teachers. Components assessed by the validator are components of content, constructs, language, and graphics. During the validation process there are several suggestions for improving modules by validators such as fixing less attractive covers, improving submicroscopic images of saline solution, adding salt samples present in everyday life and replacing less effective words and sentences. After revising the module of the validator's suggestion, then the validator gives the module rating which is then analyzed by kappa moment. The results of the analysis can be seen in table 2.

| No. | Rated Aspects          | k   | Criteria         |
|-----|------------------------|-----|-----------------|
| 1   | Content component      | 0.88| Very High       |
| 2   | Construct component    | 0.89| Very High       |
| 3   | Language component     | 0.84| Very High       |
| 4   | Graphics component     | 0.92| Very High       |
|     | Average                | 0.88| Very High       |

Based on the result of validation sheet analysis, the average overall kappa moment is 0.88 with the category of very high prevalence. Thus, it can be concluded that the salt hydrolysis module is based on discovery learning with scientific approach are valid from aspects of content, constructs, language and graphics. The revised and validated module design module by experts is called Prototype II.

In prototype II, the modularity of practical test is validated by the expert by performing individual evaluation (one to one evaluation). One to one evaluation were conducted through interviews of three students with low, medium and high ability. Aspects evaluated at this stage are clarity, attractiveness, ease of use, and apparent error.

First the researchers asked the students to pay attention to the appearance of cover, color, drawing and asking interest. The three students said that the cover and drawing on the module are interesting as well as they are interested to learn it. On the student activity sheet the low ability is difficult to formulate the problem while the students with medium and high ability can formulate the problem. At the third data collection stage students are still unable to understand the submicroscopic images of the salt solution so that the researcher directs the students to understand the picture by answering questions related to the picture.

Based on the interviews it was found that the display of module cover from the aspect of the picture and the color has an interesting appearance so interested to learn it, the writing and instructions the use of the clear module, the language used and the learning steps contained in the module is easy to understand.

Prototype III testing conducted by doing small group evaluation. Small group evaluation is done by teaching salt hydrolysis material to nine students with low, medium and high student ability, benefit and attraction of teaching materials.

At the end of the learning process students are asked to fill out the questionnaire of practicality of using modules in the learning process. Aspects assessed are ease of use, efficiency of learning time, and the benefits and attractiveness of teaching materials. Student questionnaire results show that the ease of use, benefit and attraction aspects of teaching materials have a very high level of practicality.
while the efficiency aspect of learning time shows a high level of practicality. Overall questionnaire results of students' practicality obtained the average moment kappa of 0.82 with practicality module level is very high. The results of small group evaluation are prototype IV, which is tested in large groups. The result of student practice questionnaire analysis on small group evaluation can be seen in Table 3.

| No. | Rated Aspects             | k   | Practicality level |
|-----|---------------------------|-----|--------------------|
| 1   | Ease of use               | 0.88| Very High          |
| 2   | Efficiency                | 0.67| High               |
| 3   | Benefit and Attraction    | 0.91| Very High          |
|     | Average                   | 0.82| Very High          |

Table 3. Results of Student Response Questionnaire at Small Group Stage

In Prototype IV field test is done in high school. There are two schools tested in field test, namely SMAN 5 Padang and SMAN 7 Padang. Then proceed on the Assessment phase.

3.1.3. Assessment Phase

Assessment Phase is conducted to determine the practicality and effectiveness of the discovery learning module that has been developed. This assessment stage was piloted on a large group in two high schools. Each school has two sample classes; the experimental class and the control class. This large group trial was conducted 4 times. Module practicality data is seen and determined from the questionnaire analysis provided by students and teachers who have implemented the learning process with the module.

Questionnaire student responses were filled by 57 students after learning using modules. There are several aspects that are assessed from the questionnaire of practicality that is ease of use, the efficiency of learning time, the benefits and the appeal of teaching materials. The average acquisition of the kappa moment for the practicality of the student response questionnaire is 0.82 with a high degree of practicality. The result of students' practicality in the experimental phase can be seen in Table 4.

| No. | Rated Aspects             | k    | Practicality level |
|-----|---------------------------|------|--------------------|
| 1   | Ease of use               | 0.84 | Very High          |
| 2   | Efficiency                | 0.725| High               |
| 3   | Benefit and Attraction    | 0.825| Very High          |
|     | Average                   | 0.82 | Very High          |

Table 4. Results Practical Questionnaire Response Student Field Test

Questionnaire of teacher responses was completed by three chemistry teachers. Questionnaire teacher response contains 15 aspects of a validated statement. Aspects assessed by teachers include ease of use, efficiency of learning time, attraction of teaching materials, and benefits. The average acquisition of kappa moment for practicality is 0.79 with high practicality level. The results of this practicality data analysis show that the salt hydrolysis module of discovery learning with a scientific approach is practical. The result of questionnaires of teacher responsiveness is shown in Table 5.

| No. | Rated Aspects             | k    | Practicality level |
|-----|---------------------------|------|--------------------|
| 1   | Ease of use               | 0.82 | Very High          |
| 2   | Efficiency                | 0.67 | High               |
| 3   | Benefit and Attraction    | 0.785| Very High          |
|     | Average                   | 0.79 | Very High          |

Table 5. Results Practical Questionnaire Response by Teachers
3.2. Discussion

3.2.1. Validity

Module validation is performed by experts using validated instruments. This module is validated by three lecturers of chemistry, one lecturer of Indonesian language, one lecturer of technological education and three high school chemistry teachers. The validation of the product done by experts or who have experience to assess the weakness and strength of the resulting product [16]. Components assessed for module validity include content components, constructive components, language components and component graphics [17].

The module content component has an average kappa moment of 0.88 with a very high category. This suggests that the salt hydrolysis module discovery learning-based with the developed scientific approach is in line with the revised 2013 national curriculum, core competencies, basic competencies, indicators and learning objectives to be achieved. This result pursuant to the statement of Purwanto states that the content feasibility aspect covers the suitability of the material in the module with KI and KD, the learning objectives to be achieved, and the material given according to the student's ability [18]. If the teaching materials used in accordance with the learning objectives to be achieved then the teaching materials can teach students [19]. In addition the aspects of the content component include facts, principles, and concepts, macroscopic, submicroscopic, and symbolic levels of images are correct in science.

The construct component has an average of 0.89 kappa moments with a very high category. This suggests that the systematics of module compilation have been adapted to the module compiler component, and the syntactic compatibility of the discovery learning model with the scientific approach. Constructive validity indicates the interrelationship of each other and is connected in an internal consistency between the components of the module [20].

The linguistic component of the module has an average of 0.84 kappa moments with a very high category. This indicates that the information contained in the module is clear, in accordance with Indonesian language rules, using language that is easy to understand and use effective and efficient language. The sentences used in the module should be simple and easy to understand [21].

The graphic component has an average of 0.92 kappa moments with a very high category. This shows that the readability of writing, the use of type and size of letters, layout, drawings and designs and colors used interesting. Good layout and color can cause attraction to the interests of learners [21].

Overall the average acquisition of kappa moment for the validity of the salt hydrolysis module discovery learning-based with the developed scientific approach is 0.88 with the very high prevalence category. The result of the salt hydrolysis module validation shows the module is valid.

3.2.2. Practicality

Practicality assessed consist of components that are ease of use, efficiency of learning time, attractiveness, and module benefits [22]. The practicality of salt hydrolysis module discovery learning-based with scientific approach was assessed by chemistry teacher and 11 grade MIA students. Practicality data were analyzed using kappa moment.

Student practicality test is done at small group stage, and filed test. At the small group evaluation stage, the module was piloted to nine students with different student abilities in actual conditions. At the end of the meeting students are asked to provide a practical assessment of the module. Furthermore, in the field test phase, the module was piloted to 57 students in two schools namely SMAN 5 Padang and SMAN 7 Padang.

The result of small group evaluation and field test obtained the average of kappa moment each of 0.82 and 0.82 categorized as very high. In the aspect of ease of use result of student practice in small group and field test respectively 0.88 and 0.84 with very high practicality category. This suggests that the salt hydrolysis module discovery learning-based with scientific approach has a user-friendly clue, the questions are clear, the language used is easy to understand, the letters used are clear and readable.
and have the same size practical and easy to follow. The consideration of preconceptions can be seen in the ease of use [22].

In the aspect of the efficiency, it was obtained practicality value at small group evaluation and field test respectively 0.67 and 0.725 as high practicality. This shows that by using learning time module more efficient and in accordance with student's learning speed. Learning by using modules can make learning time more efficient and students can learn at their own pace [23].

In the module benefit aspect, practicality value in small group evaluation and field test are 0.91 and 0.825 each as very high level. This indicates that the drawings, and the readings contained in the module can motivate the students to find concepts, the questions contained in the module can help students understand the concept, the worksheet on the module can measure students' understanding of the salt hydrolysis material, the steps of the learning model discovery learning can help students to find concepts, modules help students learn independently, and increase students' interest to learn.

Module is a teaching material that has one of the characteristics of self-learning. By independent learning, students can learn anywhere, anytime without the teacher's guidance. Modules give students the opportunity to learn continuously so that their insights will continue to increase [24]. The application of the module can condition the learning activities better planned, independent, complete, and with good results [23]. The worksheets and evaluation sheets contained in the module can help students to learn skills or test an understanding of learning materials that have been learned by comparing student answers with key answers. In addition, design and color in the module can make students interested and enjoy learning with modules. Charts and color drawings make the brain more active and enhance student pleasure [25].

The result of teacher's practicality assessment obtained the average of kappa moment of 0.79 with high category. In the aspect of ease of use the average moment of kappa is 0.82 with very high category. This indicates that the usage instructions and the contents of the module are easy to understand, the material is clear and easy to understand, the suitability of the module with the curriculum, and the module size is practical and easy to carry. In the mean time efficiency aspect, the average of kappa moment is 0.67 with high practicality category. This shows that the learning time by using more efficient modules to make students learn according to the speed of learning. In the aspect of attractiveness and benefit, the average acquisition of kappa moment is 0.795 and 0.78 respectively with high practicality category. This suggests that the module can increase students’ interest in learning, the module can support the teacher's role as a facilitator, and the module can help the students in self-study.

The result of the students' and the teacher field test showed the average of kappa moments in total of 0.82 and 0.79 each with very high and high practicality category. The results of this practicality analysis show that the designed module is practical.

4. Conclusion
Based on the research conducted, the salt hydrolysis module discovery learning-based with the scientific approach has a very high of validity and it has a very high level of practicality on one to one evaluation and field test of student response questionnaire and it has high practicality level from teacher response questionnaire.

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