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# The development of guided inquiry worksheet on acid and base experiment for grade XI

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**Abstract.** This research aims to generate the development of guided inquiry worksheet on acid and base experiment for grade XI valid and practical. This development research using stages of 4-D model *i.e* define, design, develop, and disseminate. Instruments of data collection used is validation sheet and practicality questionnaire. The developed experiment worksheets based on guided inquiry was validated by five expert and practicality test by 26 students eleven-grade. The data obtained were analyzed using Kappa Cohen Formula. The data obtained were analyzed by using Cohen Kappa Formula. The validity test of the developed experiment worksheets based on guided inquiry is in high validity categories. The practicality test of students about developed experiment worksheets based on guided inquiry indicated a very high category. While the teacher practicality about developed student worksheet obtain a very high practicality category. This finding also suggests that the developed experiment worksheets based on guided inquiry can help students to learn find the concepts of chemistry. In conclusion, the worksheet can be used in chemistry learning process in laboratory (acid and base experiment).

## 1. Introduction

Science learning process, including chemistry is often only aimed at the achievement to the cognitive domain of students, whereas the purpose of education is not only the cognitive domain, but also includes affective and psychomotoric. This could be one of the causes of the low quality of science education in Indonesia. It needs a change in the education system of Indonesia that emphasizes on the learning process so that students can think critically that students can solve various problems encountered and understand complex information by using existing analysis and can conduct investigation with critical thinking so as to improve learning outcomes in learning process. One of the government's efforts to revise the KTSP Curriculum into the 2013 Curriculum. Chemistry is an experimental science. Laboratory experiences are essential for learning science like chemistry [1]. The learning process in the Laboratory (Experiment) can help students to learners in understanding the chemical concepts, prove various concepts and doing simple research. Learning by experiment is more challenging for students, because students are directly faced with objects and events that occur during the experiment. Many skills are used when conducting experiments, including thinking, observing, using tools and techniques,



working closely, doing some calculations and writing experimental results [2]. Acid and Base is one of the topics of chemistry that require experiment in the learning process. The Types of student worksheet available has not yet guide students to find concepts. This research aims to generate experiment worksheets based on guided inquiry on the topic of acid and base valid and practical to find the concepts of chemistry.

The developed experiment worksheets based on guided inquiry designed using approach in the stages of guided inquiry process. In this worksheet students are given the opportunity to analyze the results and draw the conclusions independently after being presented an orientation / phenomenon and the teacher only acts as a facilitator [3]. A learning activity that implements guided inquiry using a learning cycle consisting of 5 stages of Orientation, Exploration, Concept Formation, Application, and Closure [4]. Guided inquiry learning can enhance activity, an effective learning atmosphere, opportunities for students to draw conclusions and understand the material provided better, improve relationships among students in the classroom and increase the ability of individuals [5]. This guided inquiry learning process is a student-centered strategy, students work in small groups with individual roles to ensure that all students are fully engaged in the learning process.

Based on research related to the use of guided inquiry strategy, students who learn by using guided inquiry strategy more easily understand the concept in their learning [6]. The guided inquiry chemical learning module on the topic of electrolyte and nonelectrolyte solutions is very valid, practical and effective to used in the chemistry learning process. The developed experiment worksheets based on guided inquiry can be one of the alternatives for students to find their own concept through experimental activities. The advantages of this experiment worksheets based on guided inquiry on the topic of acid and base are supplemented with prerequisite and information materials so that students can connect new knowledge with prior knowledge and motivate students to learn the concept. There are critical thinking questions to guide students to find the concepts being studied. other than that, this experiment worksheets based on guided inquiry using attractive colors and there are microscopic images to motivate and attract students attention to learn. Research on the development of worksheets based on guided inquiry experiments was also conducted by Yonata [6]. Research on inquiry based experiment was conducted by Saksri Suparsorn [7], Zhou Qing [8], and Sarantos Psycharis [9].

## 2. Methods

This type of research is Research and Development (R & D). R&D is the research used to produce or refine a product and test the effectiveness of the product [10]. Sukmadinata states that research and development is a process or steps to develop or refine a new or existing product [11]. This research was conducted at Senior High School 9 of Padang. The subjects of this research were 4 lecturers of chemistry department, faculty of mathematics and natural science, Universitas Negeri Padang, 1 chemistry teacher Senior High School 9 of Padang, 1 chemistry teacher Senior High School 15 of Padang and 26 students eleven- grade Senior High School 9 of Padang. The object of this research is experiment worksheets based on guided inquiry on the topic of acid-base used in chemistry grade XI to find concepts. This development research using stages of 4-D models *i.e* define, design, develop, and disseminate [12].

The define stage include front end analysis, student analysis, task analysis, concept analysis and objective learning analysis. Analysis of the front end to reveal and highlight the problems that teachers and students in chemistry learning. Based on the results of interviews and observations found that the experimental activities only aim to confirm the concept that has been studied. The available experiment worksheets generally do not support students in the process of finding their own concept that is still in the form of sheets containing work procedures such as a recipe book. Student analysis aims to identify the target of learning ie students. Identification to know the characteristics of students, one of them cognitive development. High school XI students have an age range of 16-17 years. According to Jean Piaget's developmental theory, students aged 16-17 years can already think abstractly, understand symbolically, solve problems through the use of systematic experimentation.

Analysis of tasks in the form of analysis of core competence (CC), basic competence (BC), and indicators to be developed into experiment worksheets. In this research analyzed were CC and BC on the topic acid and base in the eleven class according to syllabus of 2013 curriculum. The conceptual analysis is to identify the main concepts to be studied and to arrange them systematically and to link one

concept with another relevant concept. The main concepts on the topic acid and base are acid-base indicator and acid-base titration. Analysis of learning objectives is formulated as follows:

- (1) Students can experiment to identify various solutions based on the nature of acid or base solutions using litmus paper
- (2) Students can determine the pH of a solution using universal indicator
- (3) Student can perform acid-base titration based on work procedure given
- (4) Students can create a titration graph based on data from experiments performed.

The design stage is the stage of designing experiment worksheets based on guided inquiry on the topic acid and base. The format of writing this experiment worksheets in the guidebook of teaching materials development from the ministry of national education in 2008. The developed experiment worksheets adapted to the guided inquiry stage *i.e* Orientation, Exploration, Concept Formation, Application, and Closure.

At the development stage modification of the resulting product (experiment worksheets based on guided inquiry) after getting input and refinement of the validators. This stage consists of three steps *i.e* validity test, revision, and trial (practicality test). Validity is the level of accuracy testing in measuring material and behavior to be measured. Validity is an assessment of a product. Validity comes from the word "valid", etymologically meaning appropriate, true, valid and legitimate [13]. The validator provides an assessment of the Student Worksheets of the experiment by considering 4 aspects, component content, components of presentation (construction), linguistic components and components of graffiti. Product validation can be done by some experienced experts or experts to assess the advantages and disadvantages of new products produced. This product is validated by five expert. The election of five experts is based on the opinion of Sugiyono who stated that to test the validity of the construct of the instrument can be used the opinion of experts (judgment experts) which amounted to at least three people. A product is said to be valid if the product can indicate a condition that is in accordance with the contents and constructs. After the validity test, and then the developed experiment worksheets revised in accordance with the input of the validator. Followed by practicality test by teacher and student. For this product, practicality test is tested to 2 chemistry teachers and 26 students of 11th class in Senior High School 9 of Padang. The data obtained were analyzed using Kappa Cohen Formula [14].

$$\text{moment kappa } (k) = \frac{P - P_e}{1 - P_e} \quad (1)$$

Information:

k = moment kappa

P = The realized proportion, calculated by the number of values given by the validator divided by the sum of the maximum values.

Pe = The unrealized proportion, calculated by the sum of the maximum value minus the number of values given by the validator divided by the sum of the maximum values.

**Table 1.** Category by moment kappa.

| 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   |

Disseminate stage is the dissemination stage of teaching materials through distribution to teachers and students to get responses to the teaching materials that have been produced.

### 3. Results and Discussion

The validator provides an assessment to experiment worksheets from considering 4 aspects i.e component of content, components of presentation (construction), component of linguistic and component of graffiti. Results of data analysis validity test of experiment worksheets by validator can be found in Table 2.

**Table 2.** Validity test by validator.

| Aspects of the Assessment | k (I)               | k (II)              | k (III)        | k (IV)         | k (V)               |
|---------------------------|---------------------|---------------------|----------------|----------------|---------------------|
| Component of Content      | 0.88<br>(Very High) | 0.67<br>(High)      | 0.71<br>(High) | 0.79<br>(High) | 0.67<br>(High)      |
| Construction              | 1<br>(Very High)    | 0.67<br>(High)      | 0.74<br>(High) | 0.67<br>(High) | 0.736<br>(High)     |
| Linguistic Components     | 0,92<br>(Very High) | 0,84<br>(Very High) | 0,67<br>(High) | 0,67<br>(High) | 0,84<br>(Very High) |
| Components of Graffiti.   | 0,92<br>(Very High) | 0,84<br>(Very High) | 0,67<br>(High) | 0,67<br>(High) | 0,92<br>(Very High) |

Information:

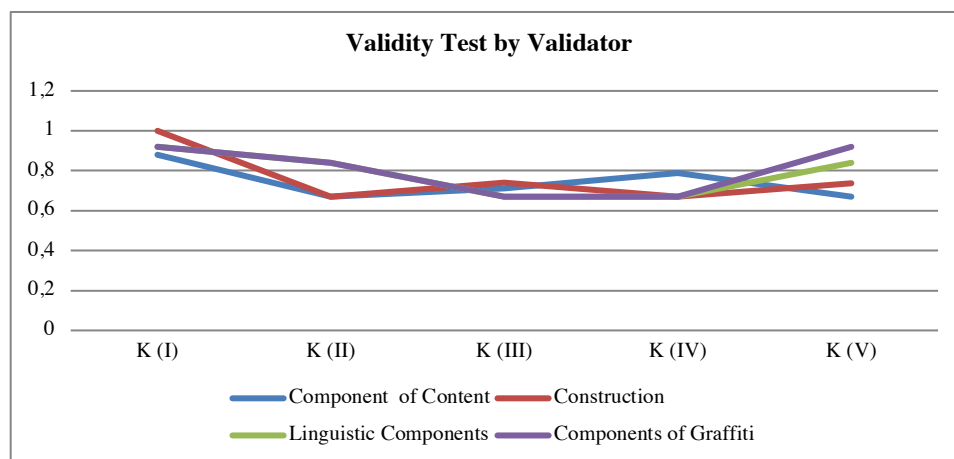
k (I) = moment kappa by validator I

k (II) = moment kappa by validator II

k (III) = moment kappa by validator III

k (IV) = moment kappa by validator IV

k (V) = moment kappa by validator V



**Figure 1.** Validity test by validator.

The result of data processing validity test using kappa cohen formula in Table 2 was found that the validity of the experiment worksheets based on guided inquiry on the topic acid and base from validator I has a very high category with the acquisition value of moment kappa 0.89, while the validators II, III, IV and V have high category with the acquisition value of moment kappa 0.73, 0.73, 0.78 and 0.71. the average result of the kappa moment is 0.77 which means that the developed experiment worksheets assessment is valid with the high category. A product is said to be valid if the product can indicate a condition that is in accordance with the contents and constructs.

Table 3. Practicality test.

| No. | Practical Data   | The average value of kappa moment (k) | The category of practicality |
|-----|------------------|---------------------------------------|------------------------------|
| 1   | Teacher Response | 0,88                                  | Very High                    |
| 2   | Student Response | 0,88                                  | Very High                    |

The results of data processing practicality test experiment worksheets by teacher and student in table 3 both obtained 0.88 with the category of very high practicality. practicality is shown at the level of ease of use and implementation that includes the cost and time in implementation, as well as the management and interpretation of the results. Sukardi said, a practical teaching material that is easy to use. According to the teachers, this acid base experiment worksheets can be used in chemistry learning. So, this experiment worksheets on the acid-base topic can be used in experimental activities in school laboratory. According to the students, this acid and base experiment worksheets easy to understand, interesting, increasing student motivation to learn. This finding also suggests that the developed experiment worksheets can used chemistry learning process in laboratory (acid and base experiment).

This is the display of developed experiment worksheets based on guided inquiry on the topic acid and base in Figure 2. We can see that the experiment worksheets was colourful. This experiment worksheets equipped with introduction of laboratory equipment and laboratory rules, introduction of laboratory equipment, teacher instructions and student instructions.



Figure 2. Display of developed guided inquiry experiment student worksheet.

#### 4. Conclusions

The results of validity test obtained the average value of kappa moment of 0.77 with high Validity category. Practicality test by students obtained average value 0.88 with very high practicality category and Practicality test by teachers obtained average value 0.88 with very high practicality category. The research concluded that the experiment worksheets based on guided inquiry on the topic acid-base valid and very practically, so it can be used in chemistry learning process in laboratory (acid and base experiment).

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