Development of student worksheet with class and laboratory activity based on guided inquiry in electrolyte and non-electrolyte solution materials

F. H. Yani*, Mawardi, and F. Azra
Chemistry Department, Universitas Negeri Padang, Indonesia

*ifit.handa@gmail.com

Abstract. This research aims to produce student worksheet with class and laboratory activity based on guided inquiry in electrolyte and non-electrolyte solution materials and then express its validity and practicality. This research used the type of research and Development (R & D) research with the Plomp development model. The instrument used is a validity and practicality questionnaires their data were processed by using the kappa cohen (k) formula. Based on the validity of the questionnaire, it showed that the developed LKPD has a substantial validity with k = 0.80. The data showed that the developed student worksheet has been valid. Based on the practicality questionnaire data in the small group evaluation obtained an almost perfect level of practicality with k = 0.83. Based on the practicality questionnaire in the field test obtained an almost perfect level of practicality with k = 0.87 based on the teachers’ responses and k = 0.85 based on the student’s responses.

1. Introduction
Chemistry is the study of structure, change, and processes in a material. In studying chemistry most of the topics of discussion are abstract. Abstraction means that not all topics of the discussion can be observed directly by the macroscopic and symbolic only, but it is necessary to understand the structure and processes at the particle (atom/molecule) level of the observed macroscopic phenomena (submicroscopic). In fact, someone’s understanding of chemistry is determined by its ability to transfer macroscopic phenomena, to submicroscopic, or symbolic. In addition, chemistry is a laboratory knowledge, whose learning will not be effective without laboratory activities. One of the chemistry material for SMA/MA class X which is abstract and will not be effective without laboratory activity is electrolyte and non-electrolyte solution materials.

Studying the materials of electrolyte and non-electrolyte solutions at the level of senior secondary education must be appropriate with the demands of the 2013 Curriculum. In the 2013 Curriculum the learning must be activity-based with interactive and inspirational characteristics, contextual and collaborative, give motivation to students to participate, and appropriate with the talents, abilities, capabilities and physical or psychological development of students. Based on these demands, the government made changes in learning methods, namely scientific approach-based learning. Scientific learning will be effective if it is supported by a teaching material that guides students to be active in gaining knowledge independently.

Some fundamental problems for students, including being lazy, easily discouraged, indifferent in the learning process. This is appropriate with the result of the interviews that the author has done with
several chemistry teachers and high school students in SMA 10 Padang, SMAN 8 Padang, and SMAN 13 Padang about learning chemistry, especially in learning the materials of electrolyte and non-electrolyte solutions. Based on the interviews obtained information about teaching materials used. The teaching material used has not the needs of the 2013 Curriculum or has not guided students to be active in learning. On other issues it was known that teaching materials were easy to find in bookstores and agents of teaching materials to schools, especially related to the materials of electrolyte and non-electrolyte solutions only use the macroscopic and symbolic representation. In addition, the practical guide on the teaching material has not been aimed at finding concepts but to verify the concepts that have been learned. This is also appropriate with the interviews that the author has done that the practical guide on teaching materials in the school in general still aims to verify the concepts that have been learned in the classroom not to guide students to find concepts.

Recognizing some of these problems, its very need to develop a teaching material that can guide students to be active in gaining. The developed student worksheet is one that contains classroom activities as well as laboratory activities and presents multiple representative materials ;macroscopic, submicroscopic, and symbolic. Based on the characteristics of the required student worksheet, the student worksheet is prepared based on the learning model relevant to the 2013 Curriculum demands. The learning model is an inquiry learning.

Learning in inquiry focus on the students’ independence to search and to find. This learning model is divided into four levels and one of the most effective models of inquiry learning is guided inquiry. Learning in guided inquiry is student-centered learning. In the guided inquiry learning model, students are required to learn in gaining knowledge by finding themselves. The guided inquiry learning process consists of five stages: orientation, exploration, concept formation, application, and closing. Through the five stages of the guided inquiry learning process, it will direct students to acquire knowledge by finding themselves. Previous research on the development of student worksheet based on guided inquiry on chemical equilibrium material, colligative properties solution, and rate of chemical reaction produced valid, practical and effective. Thus, the researcher conducted a research with the title of the development of student worksheets for guided inquiry-based classroom and laboratory activities on electrolyte and non-electrolyte solution materials.

2. Research Methods

2.1. Research Subject
Subjects in this study were four chemistry lecturers at FMIPA UNP, two chemistry teachers at SMAN 13 Padang and 9 students from chemistry class grade XI IPA 1 and 27 students from X MIA 4 SMAN 13 Padang.

2.2. Research Design
This research used the type of Research and Development (R & D) research with the Plomp development model. The Plomp development model includes three stages: preliminary research, prototyping phase and assessment phase. Preliminary research aims to bring up the problems in the field. In the preliminary research phase needs analysis and context analysis (situation), literature study and concept analysis were carried out. The need analysis and context analysis include curriculum analysis, syllabus analysis, situation analysis in the field and analysis of students.

The prototype formation stage is the design stage and realization of the design results using a prototype approach. The prototype formation stage is a micro cycle of research with formative evaluation based on Figure 1.
Prototype I, II, III and IV was produced in this stage. Prototype I was the result of the realization of the design process. Prototype I was evaluated through self-evaluation by using self evaluation’s instrument to see the equipness of the components making up the prototype and the real errors of the prototype. The evaluation results of prototype I will be revised to produce prototype II. On prototype II one to one evaluation and expert review was carried out. This evaluation was done to get the level of validity of prototype II. Based on the results obtained from the expert assessment and one to one evaluation, a prototype II was revised to produce prototype III. The resulting prototype III was evaluated through small group evaluation to get a temporary level of practicality from the prototype. Small group evaluations were conducted on 6 students of class XI high school who had different levels of ability. Revisions were also made to prototype IV appropriate with the students’ suggestions and discussions with the mentors.

2.3. Data Collection
Data collection in this research used validation and practicality questionnaires. The validation questionnaires serves to rate the prototypes produced about the content, construct, linguistic and graphic components. Practical questionnaire serves to rate the prototype about ease of use, time efficiency and benefits. Cohen's kappa formula is using for analyzed he data of validation and practicality questionnaires. The values can be obtained from:

\[ k = \frac{P_o - P_e}{1 - P_e} \]  

\( k \) = kappa moment value  
\( P_o \) = proportion realized  
\( P_e \) = proportion that is not realized

| Interval        | Kategori         |
|-----------------|------------------|
| 0,81 – 1,00     | Almost Perfect   |
| 0,61 – 0,80     | Substantial      |
| 0,41 – 0,60     | Moderate         |
| 0,21 – 0,40     | Fair             |
| 0,01 – 0,20     | Slight           |
| <0,00           | Poor             |
3. Results and Discussion

3.1. Preliminary research

Learning in 2013 Curriculum must activity-based with interactive and inspirational characteristics, contextual and collaborative, give motivation to students to participate, and appropriate with the talents, abilities, capabilities, and also appropriate with the physical or psychological development of students. A learning model that was relevant to these demands was a guided inquiry learning model.

Based on the syllabus about electrolyte and non-electrolyte solutions, it was known that there were two basic competencies that students must master after learning the materials of electrolyte and non-electrolyte solutions: 3.8. Analyzing the properties of electrolyte solutions and non-electrolyte solutions based on their electrical conductivity. 4.8. Design, conduct, and conclude and present the experiments result to determine the nature of the electrolyte solution and non-electrolyte solution

The context analysis was carried out through interviews with the three chemistry teachers and the distribution of needs analysis questionnaires to 15 high school students in Padang. Based on the interviews, concluded that the problems that occurred is about the teaching materials used so far was the students did not involve actively in the learning process in electrolyte and non-electrolyte solution materials. The teaching materials used generally only used the macroscopic and symbolic representations; and the practical guide used was not intended to find concepts. Based on the analysis student that has been done, it was concluded that the students who will be used as the subject of the study were high school students of grade X IPA aged in 15-17 years. Based on Piaget's cognitive theory, at this stage students can think abstractly. At this age, students can already think of something that will or might happen. In addition, student have also can to think systematically and are able to think of all the possibilities systematically to solve through experimentation activities. Based on the needs analysis and the analysis of the context that has been done, it is necessary to develop teaching materials appropriate with the demands of the 2013 Curriculum; it facilitate students to active in the learning process containing multi chemical representations, and equipped with laboratory activities.

3.2. Prototyping phase

3.2.1. Prototype I. Prototype I is the result of the preliminary research stage. The student worksheet cover section contains the student worksheet identity which includes the name of the student worksheet, the title of the material and the name of the author. The name of the student worksheet and the title of the material are loaded to provide information about the learning model used in the student worksheet known as guided inquiry, and the title of the material available in LKPD is the materials of electrolyte and non-electrolyte solutions. The author's name is published to provide information on the name of the author so that the reader knows the author of this student worksheet. The name of the supervisor is loaded to provide information on the name of the advisor so that the reader knows the supervisor of this student worksheet.

The cover is designed with attractive colors to attract students to read and study it. student worksheet cover is dominated by light blue. Light blue is one of the brightest colors. The bright colors can stimulate positive emotions such as feelings of pleasure, happiness, calmness, etc. Student worksheet cover is also equipped with a representation of strong electrolyte solution as an illustration that will be studied in this student worksheet.

3.2.2. Prototype II. Results of self-evaluation is the prototype produced requires a change in the use of words in the key questions and the addition of the application questions and submicroscopic activity results in the experiment.

3.2.3. Prototype III. Prototype III, one-to-one evaluation and expert review was carried out. The results of the one to one evaluation was concluded about cover and color design of the prototype II could make students attracted in learning. In terms of presenting prototype II material, it has been
systematic and about language in prototype II students easily understood. In addition, models and key questions in the prototype II help the students to find the concepts to be learned. The assessment of experts aims to obtain a scientifically validity prototype. The assessment was carried out by 6 experts consisting of four chemistry lecturers from state university of Padang and two chemistry teachers from public senior high school 13 Padang. The answer distribution validation sheet contains 25 aspects of assessment. Based on the validation sheet, the six validators gave an assessment of student worksheet for guided inquiry-based classroom and laboratory activities on the materials of electrolyte and non-electrolyte solutions produced in terms of content components, construction components (presentation components), linguistic components, and graphic components. Validity data of prototype II presented in Table 2.

| Rated Aspect                  | k  | Validity Category |
|-------------------------------|----|-------------------|
| Content components            | 0.80 | Substantial       |
| Construction components       | 0.87 | Almost Perfect    |
| Linguistic components         | 0.75 | Substantial       |
| Graphic components            | 0.81 | Almost Perfect    |
| **Average**                   | **0.80** | **Substantial**   |

Validation sheets of assessment data of the student worksheet based guided inquiry were analyzed using the Kappa Cohen formula. Based on the data processing, the developed Cohen had a substantial validity category with a kappa moment value of 0.80. In terms of content components such as the developed student worksheet had a substantial validity category with a kappa cohen value 0.80. In terms of the presentation component of the developed student worksheet, it had an almost perfect validity category with a kappa cohen value 0.87. In terms of language, it had a substantial validity category with a kappa cohen value 0.75. In terms of the student worksheet graphic component, it had an almost perfect validity category with a kappa cohen value 0.81. Thus, in general the results of the student worksheet assessment developed were valid.

3.2.4. Prototype IV. Prototype IV a formative evaluation of prototype III was carried out a small group evaluation. A small group evaluation aims to obtain practicality prototype. A teaching material is practical if the teaching material is easy to use in learning. Student worksheet practicality was carried out using practicality questionnaire. An assessment of the practicality of a teaching material can be seen in four aspect as in Table 3.

| Rated Aspect                  | k  | Validity Category |
|-------------------------------|----|-------------------|
| Ease of use                   | 0.83 | Almost Perfect    |
| Learning time efficiency      | 0.82 | Almost Perfect    |
| Benefit                       | 0.83 | Almost Perfect    |
| **Average**                   | **0.826** | **Almost Perfect** |

Based on Table 3, it was known that the prototype III was practical with an almost perfect practicality category with 0.826 values. However, even though the practicality of prototype III has been almost perfect, there were still parts that must be improved, such as: refinement of the instructions for using student worksheet and improving the writing format. Based on the suggestions given by the students, a prototype III was revised to produce a valid and practical prototype IV.

3.3. Assessment test

Field test was conducted on two chemistry teachers at SMAN 13 Padang and 27 students from class X MIA 4 at SMAN 13 Padang. The practicality data of prototype IV presented in Table 4 and 5.
Table 4. Data of prototype III practicality results based on the teachers’ responses

| Rated Aspect           | k  | Validity Category     |
|------------------------|----|-----------------------|
| Ease of use            | 0.85 | Almost Perfect        |
| Learning time efficiency | 0.93 | Almost Perfect        |
| Benefit                | 0.89 | Almost Perfect        |
| **Average**            | **0.87** | **Almost Perfect**    |

Table 5. Data of prototype III practicality results based on the students’ responses

| Rated Aspect           | k  | Validity Category     |
|------------------------|----|-----------------------|
| Ease of use            | 0.86 | Almost Perfect        |
| Learning time efficiency | 0.84 | Almost Perfect        |
| Benefit                | 0.86 | Almost Perfect        |
| **Average**            | **0.85** | **Almost Perfect**    |

Based on the average Kappa Cohen obtained from the teacher and student response questionnaires, it was showed that the student worksheet developed had a almost perfect with a moment value of kappa moment 0.87 from the result of the teacher response questionnaire, and 0.85 from the result of the student response questionnaire. This showed that the student worksheet developed by the author had been practical by fulfilling the criteria that were appropriate with the assessment tools both in terms of the ease of its use, the efficiency of the learning time and in terms of student worksheet utilization.

4. Conclusions

Development of student worksheet with classroom and laboratory activities based on guided inquiry in electrolyte and non-electrolyte solution materials can be developed by using a Ploom development model. The worksheet student has a substantial validity and an almost perfect practicality from questionnaire teachers and students.

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