International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

http://ijpsat.ijsht-journals.org
Vol. 14 No. 1 April 2019, pp. 13-19

Development of Guided Inquiry-based Worksheets on Colloidal Material for Chemistry Learning Grade XI in Senior High School

Oktiani Damaianti [1], Mawardi Mawardi [*], Budhi Oktavia [2]

[1]Student of Master Degree Program of Chemistry Education, State University of Padang
[*]Corresponding author of Chemistry Education Lecture,
[2] Chemistry Education Lecturer, State University of Padang
Jl. Prof. Dr. Hamka, Air Tawar Barat, Padang – 25131, Indonesia

Abstract - This study aims to produce guided inquiry-based worksheets that are tested for validity, practicality, and effectiveness so it can be used as teaching materials. Stages in this worksheets consist of orientation, exploration, concept formation, application, and closing. The research was conducted using the Research and Development (R & D) model. The development model used is a 4-D model (define, design, develop, and disseminate). These guided inquiry-based worksheets were validated by 5 validators and tested on 4 high school chemistry teachers and 24 students of grade XI IPA of SMA N 1 2X11 Enam Lingkung in the academic year 2017/2018. The validity analysis result showed the moment kappa of 0.81 with a very high category. The practicality analysis result test of the teacher and student response questionnaire obtained the moment kappa values of 0.79 and 0.82 with high and very high categories. In the effectiveness test, 67% of students obtained scores above the Minimum Completeness Criteria and based on gain scores students from learning outcomes before and after using worksheets were 0.44 in the moderate category and the average of activity students at each meeting was 79.29% with effective categories. Based on these results, it can be concluded that the guided inquiry-based worksheets produced have been valid, practical, and effective to use in the learning process.

Keywords - Worksheet, Guided Inquiry, Colloid.

I. INTRODUCTION

Chemistry is the study of matter and the accompanying changes (Chang. 2008: 4). Chemical learning is basically learning where most of the topics of discussion are abstract and need to be understood at the submicroscopic level.

Colloidal material is taught in grade XI of high school in the second semester. Indicators must be achieved by students are classifying mixtures into colloidal and suspensions, classifying the type of colloid based on the dispersed phase and the dispersing medium, describe the properties of colloids (Tyndall effect, Brownian motion, adsorption, electric charge, electrophoresis, emulsion and coagulation), explain the colloids of lyophobic and lyophilic and understand the process of making colloids (by means of condensation and dispersion).

In the learning process, students should be motivated to learn so they are interested in learning the material. The results of interviews with several high school chemistry teachers and high school students in Padang Pariaman district showed data that students had difficulty understanding and analyzing concepts in colloidal material, and students were still oriented towards mastering the theory by memorizing so that their learning abilities were hampered. It can be concluded that in learning on colloidal material, students still cannot maximize their ability to learn on their own and lack of student involvement in the learning process. Based on these problems, an alternative is

Corresponding Author: Mawardi Mawardi

needed in learning, one of which is to use teaching materials.

One solution that can be used by teachers to overcome the problem of the learning process that requires students to be able to observe, ask, conclude, associate, and communicate is guided inquiry-based chemical teaching materials in the form of worksheets. Guided inquiry-based teaching materials in the form of worksheets are equipped with teaching material that contains orientation (connecting new knowledge with previous knowledge) and key questions (critical thinking questions) that guide students to discover the concepts being studied. Developed student worksheet based guided inquiry that presents various illustrations of images (models) and key questions that guide students in finding concepts (Piawi, 2018). Key questions are at the essence of guided inquiry activities (Hanson.2005).

This worksheet was created using a guided inquiry cycle consisting of orientation, exploration, concept formation, application, and closing. This worksheet is also packaged by involving three levels of chemical phenomena, namely macroscopic, microscopic, and symbolic. In a study using guided inquiry-based teaching materials, the activity of the student is directed by the teacher to seek and find their own answers (facts, concepts, principles) of something that is questionable so that teachers act as facilitators and motivators of student learning (Rahmiati, 2016). In addition, this LKS is equipped with a model that students will explore with key questions.

Based on the results of previous studies conducted by Aini (2017) implements guided inquiry in student worksheet in chemical equilibrium material, Irham (2016) applies student worksheet to hydrolysis material, Repdayanti (2018) applies student worksheet to reaction rate material, and Zammiluni (2018) applies student worksheet on chemical bonding topic, the conclusion is that guided inquiry-based worksheets can improve students' understanding and ability to learn effectively.

Based on this, the authors conducted a study to develop guided inquiry-based worksheets on colloidal material for grade XI chemistry learning at the high school. The purpose of this research is to produce guided inquiry-based worksheets that were then tested the level for validity, practicality, and effectiveness.

II. RESEARCH METHODS

The type of research used is research and development (R & D), namely research used to produce certain products and test the effectiveness of these products (Sugiyono, 2006: 407). The development model used in this study is a 4-D (four D models) model such as the one developed by Thiagarajan, Semmel, and Semmel in 1974. This 4-D model consists of 4 main stages, namely: (1) define, (2) design, (3) develop and (4) disseminate (Trianto, 2010: 93). This guided inquiry-based worksheets were validated by 5 validators and tested to 4 chemistry teachers and 24 students of grade XI IPA of SMAN 1 2x11 Enam Lingkung Padang Pariaman even semester of the academic year 2017/2018.

The implementation of the research starts from the define phase. The steps in the define stage include front end analysis, student analysis, task analysis, concept analysis and analysis of learning objectives. The second stage designs. At the design stage that is done is designing guided inquiry-based worksheets on colloidal material for the chemistry learning of grade XI students at the senior high school. The third stage is the stages of develop. This stage consists of three steps, namely the validity test, revision, and practicality test. The fourth stage is the stage of disseminating. This stage consists of three steps, namely: validation testing, packaging, diffusion and adoption. In the stage of validation testing, the effectiveness test is carried out. The effectiveness of guided inquiry-based worksheets in this study is seen from the results of learning and student learning activities. The last activity of the deployment stage is to do packaging, diffusion, and adoption. This stage is done so that the products produced can be utilized by others. However, at this stage, the researcher limits only to the stage of socializing teaching materials through the distribution of a limited amount to the teacher.

The instruments used in this study were validation sheets (intended for Chemistry Education Lecturer) and questionnaires (consisting of a teacher and student response questionnaires) and effectiveness test instruments (consisting of learning outcomes tests and observation sheets of student learning activities). Validation sheets are used to assess worksheets in terms of components of content, constructs, linguistics, and graphics. The questionnaire aims to determine the practical level of use of guided inquiry-based worksheets during the learning process. Effectiveness exam instruments to find out the learning outcomes and observation sheets of student

learning activities. Technical analysis of the data used for validity analysis, practicality analysis (teacher and student response questionnaire) is by using moment kappa (k) (Bouslough and Paul, 2008: 12). .

Table 1. Decision categories based on Moment kappa (k)

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

$$moment\ kappa\ (k) = \frac{P - Pe}{1 - Pe}$$

Learning is said to be effective if the value of students after learning gets a value above the Minimum Completeness Criteria (MCC) as much as or equal to 60% (Budimah, 2014: 5). In the learning process using worksheets is said to be effective if more or equal to 60% of students get a value ≥ 80 (MCC chemistry lessons at the school where the trial is conducted). Analysis of students' understanding of student learning outcomes can be searched using the percentage approach proposed by Kunandar (2007: 97) with the following equation: $P = \frac{F}{N} x\ 100\%$.

To measure the effectiveness of teaching materials on improving cognitive abilities can also be analyzed using the N-gain formula proposed by (Hake, 2002: 3) with the following equation:

$$\langle g \rangle = \frac{\%\langle post\ test \rangle - \%\langle pre\ test \rangle}{100 - \%\langle pre\ test \rangle}$$

The magnitude of the gain average <g> is interpreted based on the criteria in Table 2

Table 2. Criteria for average gain (Hake, 2002: 2)

Limitation	Criteria
$g \geq 0{,}7$	High
$0{,}3 \leq g < 0{,}7$	Medium
$g < 0{,}3$	Low

Analysis of student activities can be searched using the percentage approach proposed by Kunandar (2007: 97) with the following equation:

$$\%A = \frac{f}{x} \times 100\%$$

Criteria for activeness of students according to Riduwan (2009: 89) can be seen in Table 3.

Table 3. Criteria for Analysis of Student Activity Observation Sheets

Percentage (%)	Category	Criteria for Effectiveness
81 – 100	Very High	Very effective
61 – 80	High	Effective
41 – 60	Medium	Enough Effective
21 – 40	Low	Less Effective
0 – 20	Very Low	Not Effective

III. Results And Discussion

A. Research Result

1. Define Stage

At the define stage, the determination and definition of learning conditions are carried out. The steps in the define stage include a) Analysis of the front end. This front end analysis aims to bring up and establish the basic problems faced by teachers and students in chemistry learning. b) Student analysis is to examine the characteristics of students as an illustration for designing worksheets. c) Analysis of the task, namely analyzing Basic Competence (KD) and the elaboration of learning indicators. d) Analysis of concepts, concept analysis is the identification of the main concepts in the colloidal matter, based on concept analysis designed teaching materials in the form of guided inquiry-based worksheets with colloidal material so that learning indicators can be achieved. e) Analysis of learning objectives. Based on task analysis and concept analysis, learning objectives can be formulated.

2. Design Stage

After the concepts are set, the indicators of learning and learning objectives are formulated, then the next step is to design guided inquiry-based worksheets. At this stage a draft of teaching material is produced in the form of guided inquiry-based worksheets whose writing format is based on the guidebook for the development of teaching materials, namely as follows: 1) Title/identity of material, 2) Instructions for learning (student instructions), 3) Core Competencies (KI), Basic Competencies (KD), Learning Indicators and Learning Objectives, 4) Supporting

Information, 5) Models and Key Questions, 6) Practice and Questions.

3. Development Stage

This development stage aims to produce guided inquiry-based worksheets that have been revised based on input from the validator so that a device can be used in research.

a. Validity Test

Guided inquiry-based worksheets that have been completed are then validated by the validator. The results of the expert validation (validator) were carried out to reveal the components of content, constructs, linguistics, and graphics of the worksheets that had been designed. The results of validation from validators I, II, III, IV, and V on guided inquiry-based worksheets had been developed as shown in Table 4.

Table 4. Average Result of Validity Test Guided Inquiry-Based Worksheets

No.	Validity Test	Average *k* Value from the Validator
1	Content Validation	0,82
2	Presentation Validation (Construct)	0,75
3	Language Validation and Graphics	0,85
Average *k* value		**0,81**
Validity Category		**Very High**

b. Practicality Test

Table 5. Data on worksheets Practical Assessment

Practicality Data	Average kappa moment value (k)	Practicality Category
Teacher Response	0,79	High
Student Response	0,82	Very High

4. Dissemination Stage

The dissemination stage is divided into three steps, namely: validation testing, packaging, diffusion and adoption. In the stage of validation testing, the effectiveness test is carried out. The effectiveness of guided inquiry-based worksheets in this study is seen from the learning outcomes which can be seen in Table 6 and student learning activities which can be seen in Table 7.

Table 6. Data on Student Learning Outcomes

Test	Completeness (%)	Complete Number of Students	Average Value
Pre Test	20,83 %	5 students	65
Post Test	66,66 %	16 students	80,6

Based on the N-gain calculation, the gain score is 0.44. Based on the criteria of Hake (2002: 3), it shows that the increase in student learning outcomes in the category of "medium".

Table 7. Recapitulation of the Value of Student Activity Observation Sheets

No	Activity	Percentage (%)		
		I	II	III
1.	Observe and analyze the model	83	83	92
2.	Discuss with groups to determine answers to key questions	80	83	90
3.	Ask the teacher	63,3	66	86,7
4.	Responding to the teacher's question/statement	76,7	80	83
5.	Doing practice	66	70	86,7
Average		**73,8**	**76,4**	**87,68**
Average and Category		**79,29 (Effective)**		

In the context of developing teaching materials, researchers at this stage of dissemination limit only to the stages of socializing teaching materials through the distribution of a limited amount to teachers. This distribution is intended to obtain a response, feedback on instructional materials developed.

B. Discussion

1. Validation

Worksheets assessments are carried out using assessment sheets validated by 5 validators. Guided inquiry-based worksheets validation data on colloidal

material was obtained from the assessment of 2 chemistry education lecturers UNP, 1 Indonesian language lecturer UNP postgraduate and 2 high school chemistry teachers. The selection of five experts is based on the opinion of Sugiyono (2008: 352) which states that to test the construct validity of the instrument, it can be used the opinion of experts (judgment experts) whose numbers are at least three people.

Based on the validation sheet, the five validators provide an assessment of guided inquiry-based worksheets that are produced in terms of content components, construction, language, and graphics. The data for assessment of guided inquiry-based worksheets validation sheet was then analyzed using the Cohen Kappa formula. From processing the data obtained the average validity score from the four different validators, as shown in Table 4. Based on the table, the results of worksheets validation from validators I, II, III, IV, and V have a very high validity category. Thus, the results of the assessment of developed worksheets are valid.

The validator gives a valid value because the guided inquiry-based worksheets developed by the author have met the criteria according to the assessment tool (validation sheet). Teaching materials developed have been prepared based on indicators of achievement of competencies developed. Van den Akker (1999: 10) states that validity refers to the level of design based on knowledge (content validity) and various kinds of components related to one another (construct validity). In other words, a product is said to be valid if the contents of the product are in accordance with the theory and the material being studied or the components of the product must be consistent and interconnected with each other.

Although the validity of guided inquiry-based teaching materials in the form of worksheets on colloidal material is produced in very high categories, there are still some components that must be corrected according to the suggestions given by the validator, including the following : repair the writing of "turbid" colored colloid, the colloid grouping table should not be separated, the cover on the worksheets is made more interesting, correct the spelling of the Indonesian language according to the rules, the title of the material for each sub-chapter is made clearer. In accordance with the advice given by the validator, a revision of the worksheets was carried out on colloidal material to be developed for further testing of the product.

2. Practical Analysis of the Teacher Response Questionnaire

The practicality of teaching materials in the form of guided inquiry-based worksheets on colloidal material seen from the use of products from limited trial results in the field concerns the practicality and implementation of the products developed. From the results of the teacher response, the questionnaire assessment obtained an average of 0.79 with a high category. Based on this, it is known that the developed worksheets are practical at the pilot school.

The teacher gives a high practicality value because the worksheets developed has met the criteria according to the assessment tool (teacher response questionnaire sheet). As said Sukardi (2011: 52) and Neli et al (2013) practicality considerations can be seen from aspects of ease of use, aspects of presentation, and ease of interpretation. Viewed from the aspect of ease of use, guided inquiry-based worksheets that are developed make it easier for teachers to achieve learning goals and facilitate teachers to improve student activities in learning. From the presentation aspect that the content of the material on the worksheets with the competencies achieved is appropriate and from the aspect of ease in interpreting that guided inquiry-based worksheets are easily interpreted by the teacher. With regard to practicality in development research, Van den Akker (1999: 10) states that practicality refers to the degree to which users (or other experts) consider products to be used and preferred under normal conditions. With the meaning of the word that guided inquiry-based worksheets can be said to be practical if the worksheets can be used easily by teachers and students in learning.

3. Practical Analysis of Student Response Questionnaire

Based on the assessment of the practical instrument of the student response questionnaire, the average value of moment kappa was 0.82. This reveals that chemical teaching materials in the form of worksheets produced have very high practical categories to be used in the learning process. The high interest or attention of students can occur because students feel happy with the communicative images, making students' mindset more systematic and helpful in constructing their understanding, and able to increase reading interest, motivation and curiosity of students. In accordance with Sadiman (2006: 29) says that an image speaks more than a thousand words. Sadiman further said that images have several advantages including, images that can overcome the limitations of observation. So that with the pictures in the worksheets can

help students more easily understand the material being studied. Based on the above, it can be concluded that guided inquiry-based worksheets on colloidal material can guide students to find concepts and help students understand colloidal material.

4. Analysis of Effectiveness Tests

a. Analysis of Student Learning Outcomes

Based on the data in Table 6 it can be concluded that more than 60% of students whose learning outcomes are above the MCC as many as 66.6% of students, as many as 16 people. Based on this, guided inquiry-based worksheets are effectively used in the learning process. This is in line with the opinion of Budimah (2014: 5) which states that learning is said to be effective if the value of students after learning gets a value above MCC of more than or equal to 60%. To measure the effectiveness of teaching materials on improving cognitive abilities can be used test instruments and then analyzed using the N-gain formula. The results of the N-gain calculation are obtained on average obtained by the gain score of 0.44. Based on Hake's criteria shows that the effectiveness of teaching materials on improving cognitive abilities is included in the category of "medium" effectiveness. These results indicate that guided inquiry-based worksheets are effectively used in the learning process with the medium category. However, when viewed from student learning outcomes experienced a significant increase. Changes in student learning outcomes before and after using the product developed showed differences in student learning outcomes at the time of the pre-test and the post-test can be seen in Table 6. Based on the results of the pre-test there were only 5 students whose learning outcomes were completed with a class average value of 65.0. The post-test results after using guided inquiry-based worksheets increased the value of students who completed 16 people with an increase in the class average to 80.62.

b. Analysis of Student Learning Activities

Based on observers' observations, it was concluded that in the learning process using guided inquiry-based worksheets, students seemed enthusiastic and active. When using worksheets, it appears that students start it first by reading brief information, observing and analyzing the model, discussing answering key questions, and doing the exercises and about the application. In practicum activities, students start first by reading brief information, answering pre-lab questions, doing practicum according to the procedures given, observing and constructing their understanding by analyzing the data they collect, then students then answer post-lab questions, and then students also observe macroscopic, microscopic, and symbolic to help their understanding. The results of the observation of learning activities in the first to the third meeting were 73.8%, 76.4%, and 87.68%. The average results of the analysis of student learning activities obtained by the percentage of students' activeness when using guided inquiry-based worksheets are 79.29%, which means that the effectiveness of guided inquiry-based worksheets is in the category of "effective".

IV. CONCLUSION

Based on the research that has been done, it can be concluded that the guided inquiry-based Worksheet (LKS) on colloidal material for grade XI students at the senior high school produced has a very high category of validity, very high practicality and effective use in the learning process.

ACKNOWLEDGMENTS

Thanks to Dr. Hardeli, M.Si., Dr. Indang Dewata, M.Si., Prof. Dr. I Made Arnawa, M.Si., and colleague SMAN 1 2X11 Enam Lingkung.

REFERENCES

[1] Aini, F. Q., Mawardi., and Oktavia, B. 2017. “Guided Inquiry Based Student Worksheet on Chemical Equilibrium Topic”. German: LAP Lambert Academic Publishing.

[2] Bouslaugh, Sarah and Paul A. W. 2008. Statistics in a Nutshell, a desktop quick reference. Beijing, Cambridge, Famham, Köln, Sebastopol, Taipei, Tokyo: O'reilly.

[3] Budimah, Herpratiwi, and Undang Rosidin. 2014.“ Pengembangan Modul Pembelajaran Ipa Berbasis Karakter Materi Kalor SMP Kelas VII Di Bandar Lampung. Jurnal Sains dan Pendidikan . 1 (1) : 1-8.

[4] Chang, Raymond. (2003). General Chemistry, The Essential Concepts, Third Edition, Mc Graw Hill, New York.

[5] Hake. 2002. Relationship of Individual Student Normalized Learning Gains in Mechanics with Gender, High-School Physics, and Pretest Scores on Mathematics and Spatial Visualization. Indiana University.

[6] Irham, S. M., Mawardi and Oktavia, B. 2016. “The Development of Guided Inquiry Based Worksheet on Colligative Properties Solution for Chemistry

Learning". International Conference On Mathematics and Science Education.

[7] Kunandar, 2007. Guru Profesional Implementasi Kurikulum Tingkat Satuan Pendidikan dan Sukses dalam Sertifikasi Guru. Jakarta: RajaGrafindo Persada.

[8] Piawi, K., Nizar, K.U and Mawardi .2018. "Development of student worksheet based on guided inquiry with class activity and laboratory in thermochemistry material". Proceeding International Conferences on Education, Social Sciences and Technology (ICESST 2018).

[9] Rahmiati, S., Mawardi. 2016. "Teaching materials development of student work Sheet (sws) guided inquiry based on the materials for 1 Learning rate of chemical reaction". Proceedings of Academics World 28th International Conference, Tokyo, Japan, 28th March 2016.

[10] Riduwan. 2009. Belajar Mudah Penelitian Untuk Guru-Karyawan dan Peneliti Pemula. Bandung: Alfabeta .

[11] Repdayanti, Mawardi and Oktavia, B. 2018. "The Development of Student Worksheets based on Guided Inquiry by Class and Laboratory Activity for Reaction Rate Material at the 11th Grade in High School". International Journal of Progressive Sciences and Technologies (IJPSAT).

[12] Sugiyono. 2006. Metode Penelitian Pendidikan. Bandung: Alfabeta.

[13] Thiagarajan, Sivasailam, Dorothy S. Semmel, and Melvyn I. Semmel. 1974. Instructional Development for Training Teachers of Exceptional Childern A Sourcebook. Indiana: Indiana University Bloomington.

[14] The College Board. 2012. AP® Chemistry Guided-Inquiry Experiments: Applying the Science Practices (Teacher Manual). New York: The College Board.

[15] Van den Akker, Jan. 1999. Design Approaches and Tools in Education and Training. Dordrecht: Springer Science Business Media, B.V.

[16] Zammiluni, Mawardi and Ulianas, A. 2018. "Development of Guided Inquiry Based Work Sheet with Class and Laboratory Activity on Chemical Bonding Topic in Senior High School". International Journal of Chemistry Education Research – Vol. 2 lss. 2 August 2018