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(ICOMSET 2015)

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Organized by

Faculty of Mathematics and Science
State University of Padang
Padang, Indonesia

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Message

from the

Rector of State University of Padang

Ladies and Gentlemen,

It give me great happiness to extend my sincere and warm welcome to the participants of the International Conference on Mathematics, Science, Education and Technology (ICOMSET 2015). On behalf of Universitas Negeri Padang, let me welcome all of you to the conference in Padang, West Sumatra Province, Indonesia.

We believe that from this scientific meeting, all participants will have time to discuss and exchange ideas, findings, creating new networking as well as strengthen the existing collaboration in the respective fields of expertise. In the century in which the information is spreading in a tremendous speed and globalization ia a trend. Universitas Negeri Padang must prepare for the hard competition that lay a head. One way to succeed is by initiating and developing collaborative work with many partners from all over the world. Through the collaboration in this conference we can improve the quality of our researches as well as teaching and learning process in mathematics, science and technology.

I would like to express my sincere appreciation to FMIPA UNP and organizing committee who have organized this event. This is a great opportunity for us to be involved in an international community. I would also like to extend my appreciation and gratitude to keynote speakers and participants of this conference for their contribution to this event.

Finally, I wish all participants get a lot of benefits at the conference. I also wish all participants can enjoy the atmosphere of the city of Padang, West Sumatra.

Thank you very much

Prof. Dr. Phil. Yanuar Kiram
Rector

Message

from the

Dean of Faculty of Mathematics and Science
State University of Padang

Rector of State University of Padang
Vice-Dean of Faculty, Mathematics and Science
Head of Department in Faculty of Mathematics and Science
Distinguished Keynote Speakers
Organizers of this conference
Dear participants
Ladies and gentlemen

I am delighted and honored to have this opportunity to welcome you to ICOMSET 2015 - the International Conference on Mathematics, Science, Education and Technology, which is hosted by Faculty of Mathematics and Science, State University of Padang.

As the Dean of Faculty of Mathematics and Science, I wish to extend a warm welcome to colleagues from the various countries and provinces. We are especially honored this year by the presence of the eminent speaker, who has graciously accepted our invitation to be here as the Keynote Speaker. To all speakers and participants, I am greatly honored and pleased to welcome you to Padang. We are indeed honored to have you here with us.

The ICOMSET organization committee and also the scientific committee have done a great work preparing our first international conference and I would like to thank them for their energy, competence and professionalism during the organization process. For sure, the success I anticipate to this conference will certainly be the result of the effective collaboration between all those committees involved.

This conference is certainly a special occasion for those who work in education, mathematics, science, technology, and other related fields. It will be an occasion to meet, to listen, to discuss, to share information and to plan for the future. Indeed, a conference is an opportunity to provide an international platform for researchers, academicians as well as industrial professionals from all over the world to present their research results. This conference also provides opportunities for the delegates to exchange new ideas and application experiences, to establish research relations and to find partners for future collaboration. Hopefully, this conference will contribute for Human and Natural Resources.

I would like to take this opportunity to express my gratitude to all delegates and sponsors for their full support, cooperation and contribution to the ICOMSET 2015. I also wish to express my gratitude to the Organizing Committee and the Scientific Committee for their diligence. The various sponsors are also thanked for their kind support.

In closing, I realize that you are fully dedicated to the sessions that will follow, but I do hope you will also take time to enjoy fascinating Padang, with its tropical setting, friendly people and multi-cultural cuisine.

I wish the participants a very fruitful and productive meeting and with that. Finally, we respectfully request the Rector of State University of Padang to open the ICOMSET 2015 officially.

Thank you,

Faculty of Mathematics and Science
Prof. Dr. Lufri, M.S.

Message

from the

Chairman of Organizing Committee

Firstly, I would like to say welcome to Padang Indonesia. It is an honor for us to host this conference. We are very happy and proud because the participants of this conference come from many countries and many provinces in Indonesia.

Ladies and gentlemen, This conference facilitates researchers to present ideas and latest research findings that allows for discussion among fellow researchers. Events like this are very important for open collaborative research and create a wider network in conducting research.

In this conference, there are about 120 papers that will be discussed from various aspects of mathematics, science, technology, education and other related topics.

For all of us here, I would like to convey my sincere appreciation and gratitude for your participation in this conference.

Thank you very much

Drs. Hendra Syarifuddin, M.Si, Ph.D
Chairman

THE DEVELOPMENT OF GUIDED INQUIRY-BASED WORKSHEET FOR LABORATORY WORK ON TOPIC OF COLLOIDAL SYSTEM FOR SENIOR HIGH SCHOOL INSTRUCTION

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ABSTRACT

Research and Development (R&D) study was done to create aninstructional material on topic of colloidal system for senior high school students. The main goal was to produce a valid and practical guided inquiry-based worksheet for laboratory work for senior high schoolinstruction. The research used 4- D models,a model that comprises four stages including: (1) defining, (2) designing, (3) developing, and (4) disseminating. This research was performed until developing stage in SMAN 14 Padang. Kappa formula was used to examine validity and practicality of the product. Worksheetwasvalid in terms of content, language, graphics, and construct. Mean score of kappa moment for validity was 0.84. The mean score for practicality was 0.80 (for teachers) and 0.93 (for students). Analysis showed that 88% students completed the worksheet appropriately. Onaverage, worksheet for experimental work on colloidal system topic produced had high degree of validity and practicality.

Keywords: inquiry learning, guided inquiry, guided inquiry-based worksheet, research and development, and 4-D model

1. INTRODUCTION

In an attempt to foster the quality of education, ministry of education has currently settled the new curriculum called Curriculum 2013[1].In Curriculum 2013, students are encouraged to think critically, creatively, and innovatively [2]. Learning approach mandated is scientific learning in which students are encouraged to actively inquire knowledge through observing, posing questions, collecting data, associating, and communicating activities[3].

Chemistry is a branch of science that develops from laboratory works resulting concepts, principles, and theories consented throughout the world [4]. As a subject, chemistry entails laboratory work as an essential part in learning[5]. Thus, an experimental-based approach is definitely desired for chemistry instruction at school.

In an experiment, students should be able to apply their understanding to do exercise (problem), solve a problem, and perform scientific skill[4]. However, most experimental works in school laboratories in Indonesia have not yet done optimally. One of the problems is derived from the worksheet used in the experiment. The worksheet merely contains procedures and confirmative information. It does not guide students to develop critical, creative, and innovative thinking.

Inquiry learning is one of learning models that uses experimental methods in learning process. This model emphasizes on the process of critical and analytical thinking to exploreand find the answer of a problem posed [6]. A type of inquiry learning called guided inquiry guides students to explore information with critical (analytical) questions[7]. The questions posed in guided inquiry learning will direct students to build and develop basic concepts of learning[8].Guided inquiry-based experiment will guide students to think critically on why and what they are doing [9]. In any case, guided inquiry-based learning is characterized by the inclusion of five stages of learning including orientation, exploration, concept building (discovery), application, and closure[7].

An appropriate learning instrument is a critical factor for the success of guided inquiry-based learning. One of them could be a guided inquiry-based experiment worksheet. Along with the demand of Curriculum 2013, the worksheet will direct students to observe, pose questions, make conclusion, associate, and communicate during learning process. Several studies on guided inquiry reported that it could increase students' motivation in science learning [10]. Others reported that guided inquiry learning helped students to understand the concepts and thus achieved better learning outcomes [11][12]. Guided inquiry methods increased the confidence of pre-service teachers in learning science**[13]**. Several researchers doing R&D research on guided inquiry-based learning instrument (i.e., worksheet or module) reported that it was valid, and practical and effctive to be used in learning process[14][15].

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Based on the explanations discussed above, researchers wanted to do an R&D research on guided inquiry-based worksheet for experimental work on topic of colloidal system. The research aimed to produce a valid and practical worksheet for senior high school chemistry instruction. It was hoped that the worksheet produced would be a process-oriented one that can be used to help both teachers and students to fulfill the demand of Curriculum 2013.

2. METHODOLOGY

This study belongs to *Research and Development* (*R&D*), a research done to develop a new product or enhance the old one through an accountable action [16].Guided inquiry-based worksheet was designed with Thiagarajan, Semmel and Semmel instructional design model called 4-D model thatconsists of defining, designing, developing and disseminating stages [17].

In defining stage, five analyses namely beginning-end analysis, students analysis, assignment analysis, concept analysis and learning goals analysis were done. In designing stage, guided inquiry-based worksheet was designed for an experimental work on Colloidal System topic. The design was referred to learning cycle of Hanson's guided inquiry (2005) and the writing was in accordance to the guidebook of learning instrument development released by ministry of education in 2008.

In the third stage, validity test, revision, and practicality test were done. In disseminating stage, researchers did socialization of the worksheet and distributed several copies of the worksheet to teachers and students. It was aimed to get the feedbacks from students and teachers on worksheet produced.

Instrument used in this research were validation sheet given to high school teachers and lecturers in Department of Chemistry, State University of Padang, and questionnaire distributed to teachers and students. Validation was done to evaluate the content, construct, language, and graphics used in the worksheet. The questionnaire collected data on practicality of the use of guided inquiry-based worksheet during learning process. The data were then analyzed with kappa moment (k)as described in formula 1 and decision category in Table 1 below.

$$\text{Kappa moment(k)} = \frac{P-Pe}{1-Pe} \text{.....(formula 1)}$$

Where:

k = Kappa moment describing validity of the product.

P = Realized proportion; counted by summing the score given by validators and then divided it by maximum total score.

Pe = Unrealized proportion; counted by substracting the maximum total score with the sum of total score given by validator, which then divided by the maximum total score

Tabel 1. The category of decision based on Kappa moment (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

3. RESULT AND DISCUSSION

3.1. Result

To accomplish the demand of Curriculum 2013, a guided inquiry-based worksheet for experimental work on Colloidal System topic was produced by using 4-D instructional design model. The following explanations describe the result of this study.

3.1.1. Defining stage

The anaysis done in this stage included beginning-end analysis, students analysis, assignment analysis, concept analysis and learning goals analysis. Beginning-end analysis was done to determine the main problems faced by both teachers and students in chemistry learning. Data showed that teaching and learning process was mainly teacher-centered in practice.Likewise, experimental work was not performed comprehensively at schools.

Students analysis was done towards grade XII senior high school students (whose ages range from 15 to 17 years old). According to Piaget, senior high school students (also called adolescent) are in the stage of operational development where they can already develop a thinking skill[17]. They can think in a logic way, make interpretation, and draw a conclusion. Data revealed that students in this study liked learning instruments that contained pictures and were attractive and well structured.

Assignment analysis was performed on core competencies (Kompetensi Inti, KI), basic competencies (Kompetensi Dasar, KD), and learning topics. As a result, three learning indicators were obtained. They were : a) distinguishing solution, colloid and suspension from each other based on their characteristics, b) explaining the synthesis of colloid by condensation and dispersion process with data from experimental work, c) describing the stability and adsorption properties of colloid and their use.

Concept analysis was executed to analyze main concepts to be taught. They included the differences of mixtures (solution, colloid, and suspension), types of colloid, characteristics of colloid, and synthesis of colloid (condensation and dispersion)[19].Learning goals analysis is the alteration of assignment and concept analysis into learning goals**.** The analysis yielded three learing goals which then were used to design the product intended. The learning goals were included in three points just like those of learning indicators stated above.

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3.1.2. Designing stage

Guided inquiry-based worksheet for experimental work was designed based on guided inquiry learning cycles developed by Hanson. Format of the writing was suited to the guidebook of learning instrument development released by ministry of education in 2008. The steps included in this stage were:

a. Determining the topic ofworksheet for experimental work.
b. Determining KI and KD of the topic.
c. Specifying learning indicators from KI and KD.
d. Formulating learning goals from the indicators[They would be the goals of the experiment].
e. Deciding prerequisite knowledge and information for students to formulate hypothesis.
f. Designing procedures for the experiment
g. Designing table of observation and key questions to guide students in finding the concepts from experiment's data. On the same page, related information was given to assist students to find the answer.
h. Providing questions and problems for the practice (application)
i. And lastly, directing students to make conclusion.

3.1.3. Developing stage

In this stage, inputs and suggestions from validator were used to revise the worksheet. The stage included validation, revision, and practicality test.

3.1.3.1 Validation

Validation of the worksheet was done on four components namely content, construct, language, and graphics components. Those components were validated by expert validators (judgment experts), which consisted of three chemistry lecturers and two chemistry teachers. The validation on guided inquiry-based experiment worksheet is presented in Table 2.

Table 2. Score of validity on four components given by validator I to V

Components	k(1)	k(2)	k(3)	k(4)	k(5)
Content	0,96	0,88	0,79	0,79	0,60
Construct	1	1	0,80	0,80	0,79
Language	1	0,84	0,84	0,75	0,84
Graphics	1	1	0,75	0,92	0,67
Decision given by validators	Valid with revision	Valid with revision	Valid with revision	Valid with revision	Valid with revision

Note : k (I)=kappa moment of validator I ; k (II)kappa moment of validator II ; k (III)= kappa moment of validator III ;k (IV)= kappa moment of validator IV ; k (V)= kappa moment of validator V

3.1.3.2. Practicality test

Data of practicality was obtained from questionnaire distributed to 25 students and chemistry teachers (presented in Table 3). Practicality of the product can also be inferred from data on students' responses to questions in the worksheet. The result is presented in Table 4.

Table3. Data of practicality of guided inquiry-based worksheet from teachers' and students' questionnaire

Subject	Teacher	Student
Mean kappa moment	0,80	0,93
Practicality category	Very high	Very high

Table 4. Percentage of students who correctly answered questions in guided inquiry-based worksheet

No	Category	% of students	% of mean
1	Formulating hypothesis	84	88
2	Filling table of observation	92	
3	Answering key questions	89	
4	Doing exercises	89	
5	Inferring conclusion	92	

3.2. Discussion

Judgment experts were asked to validate the worksheet on content, construct, language and graphics components [16,17]. Data were then analyzed with Kappa Cohen formula. On average, guided inquiry-based worksheet produced had high degree of validity. Several components needed to be revised as suggested by the validators. Yet again, the product could be said valid as it had appropriate content and construct [20].

Several suggestions from validators were taken to revise the worksheet. First, we formulated the design of the experiment in more precise way and then connected it with the observation anticipated. Then, we added more references, added table of content page, and added more information to help students in answering the key questions. The revised worksheet was then tested to determine its practicality in learning (experimental work).

3.2.1. Practicality analysis from teachers' questionnaire

Shown that Table 3, the mean score of practicality of the worksheet was 0.8 It means that the worksheet had high degree of practicality. Therefore, guided inquiry-based worksheet for experimental work on Colloidal System topic was suitable for use in teaching and learning process at school.

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Practicality is a fundamental aspect that a learning instrument should possess. Practicality can be seen from how easy it is to be used and interpreted[21]. Worksheet for experimental work that produced could direct students to find concepts and relate the facts obtained during experiment with theories behind it. The key questions, given had created a students-centered learning where teachers functioned as a facilitator and motivator.

3.2.2. Practicality analysis from students' questionnaire

Table 3 shown that, the mean score of kappa moment from students' perspective was 0.93 it indicates that the worksheet had very high degree of practicality in learning process. The worksheet was easy to use, effective, and attractive to students during learning process [21].

Data in Table 4 shows that on average, 88% of students could fill in the worksheet correctly. This suggests that the worksheet could direct students to connect the facts obtained in the experiment with theories provided in the information section. It could also help students answering the key questions to help them find the concepts, use it to do problems (exercises) and make conclusion. Researchers cannot deny that the use of color and design in the worksheet indeed attracted students to study [23].

To sum up, guided inquiry-based worksheet for experimental work on Colloidal System topic could direct students to find concepts and helped them to understand the lesson.

4. CONCLUSION

A guided inquiry-based worksheet for experimental work on Colloidal System topic for senior high school instruction was successfully produced. The worksheet had high degree of validity and was practical in learning process.

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