Proceeding of Chemistry Conferences, Volume 2 (2017) ISSN: 2541-108X

Construction of Metacognition Skills Through Students` Worksheet with Problem Based Learning Approaches

S Haryani[1], A D Astiningsih[1], K I Supardi[1], and C Kurniawan[1]

Department of Chemistry, Semarang State University, Semarang, Indonesia

E-mail: haryanimail@gmail.com

Abstract. Student worksheets usually contain direct instruction for student to fill in, without any individually thinking steps was involved. Therefore, it is necessary to develop student worksheet which can lead the student to construct their knowledge. This research aimed to determine the worthiness and the effectiveness of student worksheet with problem based learning approaches through Reseach and Development (R&D) method. The instruments used in this research consist of experts validation sheets, students and teachers response sheet, *Metacognitione Activities Inventory (MCA-I) questioner*, test with metacognition indicators, and affective and psycomotoric observation sheets. The data were analysed by using descriptive quantitative method involving three experts on teaching materials, topic, and language aspects. The results show that 29.33; 26.67; and 22 on "very worthy" grade. The N-gain on metacognition analysis test at 0.70 with "high" grade and the *MCA-I* indicators was increased from 57.35 to be 78.01 with metacognition skill grade from began to grow then increased to be well developed. On the other hand, the student and teacher response were positive. These results indicate that the student worksheet with problem based learning approaches effectively improve the student metacognition aspects.

1. Introduction

One of high school (SMA/MA) graduate standard competency for knowledge domain in the Curriculum 2013 is metacognitive skill. The development of metacognition is important, because student's knowledge about the cognition process may guide them in developing the learning environment becomes more meaningful, and in choosing strategies to improve cognitive performance in the future [1-3]. Hollingword [4] state that as well as skills metacognition will be successful if developed through practice, students need to be equipped to learn to solve problems that is learning how to learn which able to develop and practice metacognition. Metacognition is a mental activity in cognitive structures which done consciously by the person to regulate, to control, and to examine the process of thinking himself/herself [5]. Problem-based learning (PBL) provides a learning environment that is appropriate to enhance learners' metacognitive [6], and is one learning model that are implemented with Curriculum 2013. According to Haryani at al [7], availability of Student Worksheet (LKS) made by the teachers or groups of teachers, is the implementation of the compiled RPP, and its impact can be felt by all students. Therefore, it is important to prepare LKS based on learning models as mandated by Curriculum 2013, and one of them is a PBL-based worksheet.

Based on the findings up today, the chemistry teachers in the MGMP groups of LKS preparation never again conducted through MGMP activities, and in fact in schools found LKS with a particular publisher. LKS compiled by the publisher has no different from the previous LKS though written based on Curriculum 2013. Different things from those LKS were containing KI and KS, formerly SK and KD. Thus, LKS that exist today, obviously not constructivist and not based on learning models. Availability of constructivist LKS of various materials and various learning models, will help teachers focusing the learning process, allowing teachers and students have the track record of the learning process, enabling students by hands-on and minds-on, and the most important is giving spirit to carry out student-centered learning.

Student Worksheet is a guide for students that are used to conduct an inquiry or problem solving. Requirements to be met refers to the requirement of LKS preparation which are didactic requirements, construction, and technical. Didactic requirement means should lead and fulfill effective teaching and learning activities. Construction requirement means the requirements related to language, sentence structure, vocabulary, level of difficulty and clarity should be in accordance with the knowledge level

of the user so that it can be understood by users. Technical requirements related to the physical form which are writings used, images that are used and the appearance [8-9].

Therefore, it is needed for the development of LKS that can develop the ability to think every student in metacognitive skills, so that every student has the opportunity to discover the concept of knowledge independently. LKS that developed was PBL-based LKS adjusted to the PBL syntax on the Fundamental Laws of Chemistry materials, because on these material students tend to memorize on the level of understanding, and not yet facilitated to prove various basic law based on facts of experiment results. The purpose of this study was to find the validity of the eligibility assessment of Fundamental Laws of Chemistry PBL-based LKS by the validator through LKS eligibility indicator as learning source and the effectiveness of the use of Fundamental Laws of Chemistry PBL-based LKS.

2. Research Method

The research development was using Borg and Gall procedure that has been modified with stages: data collection, planning, development of initial draft, initial field test that include small-scale trial and large-scale trial, and revision of the test results. After the initial draft is validated then conducted a small-scale trial held at SMA N 12 Semarang with sample as many as 10 students of class XI MIA 2 and a chemistry teacher. Large-scale trial used experiment with One Group Pre-test and Post-test design and implemented in MAN Purbalingga with class X MIA 1 and a chemistry teacher.

The research instruments include product validation questionnaire, students and teacher response questionnaire, learning tools validation sheets, MCA-I (Metacognition Activities Inventory) questionnaire, and essay test with metacognition indicators. Data collected by observation, testing, documentation, and questionnaire. Research product was PBL-based LKS to enhance student's metacognition. Metacognition measured by essay test results with conceptualize metacognition indicators, and non-test which was MCA-I questionnaire. Both forms of metacognition measurements conducted at the beginning and end of learning to see the results of effectivity test of LKS developed. Quantitative data were analyzed using N-gain test and t test of pre-test and post-test, whereas qualitative data of MCA-I questionnaire test as well as the students and teachers response to LKS analyzed using descriptive percentage.

The study aims to determine the eligibility and effectiveness of PBL-based LKS on Fundamental Laws of Chemistry developed. The design was experiment to test the effectiveness using One Group Pre-test and Post-test Design.

3. Results and Discussion

PBL-based student worksheet with the material of Fundamental Laws of Chemistry consist of cover, foreword, instruction to use worksheet, concept map, materials, exercises, and bibliography. Material of Fundamental Laws of Chemistry including: Lavoisier's Law, Proust's Law, Dalton's Law, Gay-Lussac's Law, and Avogadro's Law. LKS usage instructions addressed to teachers and students, while the concept map is one of the organizational strategy that aims to make it easier to learn the material. Student Worksheet with PBL syntax also included KI, KD, and indicators to clarify the purpose and boundaries in learning activities. In addition, provided exercises to strengthen the student's knowledge of the material already learned.

The results of the eligibility assessment of PBL-based LKS of Fundamental Laws of Chemistry obtained from validator with eligibility validation instrument adapted from BSNP. Validation for eligibility in terms of presentation, content, and in terms of language and all three met the criteria of very decent. PBL-based Student Worksheet of Fundamental Laws of Chemistry validation result revised to the recommendation, subsequently used for small-scale trial and large-scale trial. Small scale-trial are used to retrieve students and teacher response toward LKS developed, while large-scale trial is used to test the effectiveness of the LKS in the learning process, take evaluation data from pretest and posttest improvement using metacognition indicators, and response of students and teacher. The response of students and teachers purposed for validating the readability. The results of students and teacher response categorized as good in terms of the rules of the EYD, the use of symbols correctly, the writing was clear, the language used communicative, did not give rise to double interpretation, clear images on LKS, and the writing was easier to be read.

Large-scale trial was conducted to determine the effectiveness of PBL-based LKS of Fundamental Laws of Chemistry in the learning process to enhance metacognition skills through the evaluation questions using metacognition indicators. Metacognition skills in this study measured from the results of the evaluation using metacognition indicators based on pre-test and post-test, and also of the MCA-I questionnaire to know the progress of student's metacognition can be seen in the affective domain. Results of Pre-test and post-test in the study are presented in Figure 1.

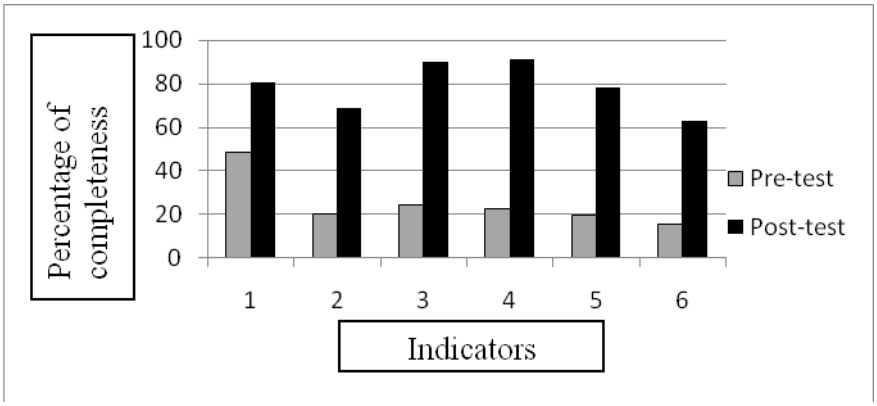

Figure 1. Percentage of completeness for each Metacognition Indicators

Information:
1. Constructing relationship of prior knowledge with the knowledge learned
2. Describing the concept of a unit and their interrelationships
3. Identifying information
4. Choosing the procedures used
5. Designing what will be learned
6. Sorting operations used

Metacognition indicators of the highest evaluation question were identifying information and choosing the procedures were used in the question number 3 and 4 are associated with sub material of Lavoisier's Law and Proust's Law. This is because the students had better understand of the sub materials because these including in early material from the fundamental laws of chemistry. In addition, reinforced by the experiment associated with daily life. This research was supported by the research results of Ikayanti & Sugiarto [10]; Haryani, et al. [5]; Haryani, et al. [7]; and Sari, et al. [11].

The mean of pre-test results was 24.393 and 77.643 for post-test results, and then analyzed to determine the improvement calculated by N-gain test. The mean N-gain ≥ 0.70, which indicated that the improvement of student's metacognition skill is in the high category. Thus through the PBL-based LKS student's metacognition skill can be improved for material of fundamental laws of chemistry. This is in line with research of Tosun & Senocak [12] that the PBL effectively used in metacognition which emphasizes the student's ability to think independently. Other researchers stated that the level of thinking on metacognition can thrive when familiarized to solve problems by thinking independently [13]. Metacognition skill were also measured using the MCA-I (metacognition Activities Inventory) test before and after the learning process, with the results shown in Figure 2.

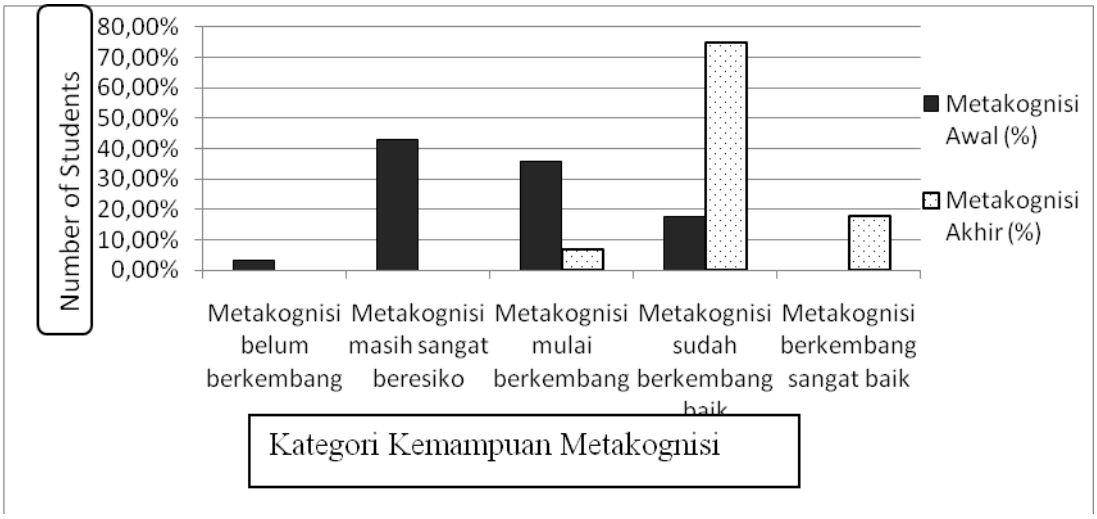

Figure 2. MCA-I Questionnaire Test Results of Metacognition Skill Start and End

Based on observer ratings and filling questionnaires, before learning student's metacognition skill is with an average of 57 (start developing) and student's metacognition skill after learning is at an average of 78 (already well developed) and student's attitudes in solve problems in finding the material concept independently with average of good ratings from the observer. This is supported by research of Rahayu & Azizah [13] and Haryani et. al. [14] starting that problem-based learning can improve the ability of metacognition.

The results of affective aspects used to get the criteria of student's attitudes in solving the problem when on discussion with average criteria of good for the student's attitude (curiosity, perseverance problem solving, responsibility, and cooperation) and the student's metacognition based on MCA-I (Metacognition Activities Inventory) test before and after the learning process can be seen in Figure 3.

The results of psychomotor aspects were observed throughout the experiment conservation of mass in groups. Based on these results showed that 5 students gain excellent and 23 students obtained good result so psychomotor aspects successfully achieved and PBL-based LKS effective in developing student's psychomotor aspects supported by the research of Sari, et al. [11]. The development of student's psychomotor aspect in learning fundamental laws of chemistry, especially on the conservation of mass contained in KD 4.11 that process and analyze data associated with the fundamental law of chemistry (especially in the experiment conservation of mass).

Further to the implementation of LKS result of the development, teachers and students are asked to respond. Based on the analysis of the results of the responses showed that PBL-based LKS of Fundamental Laws of Chemistry developed a very good result. Based on the responses of teachers and students, PBL-based LKS of Fundamental Laws of Chemistry able to support the learning process in accordance with the Curriculum in 2013, to learn to solve the problem, because there was interesting experiment, and different from existing worksheets.

In general, the results show that learning using PBL-based LKS of Fundamental Laws of Chemistry effective in improving the ability of student's metacognition. Unlike the LKS in general, in this LKS using PBL stages so that students are able to elaborate, explain, and detailing a problem that ultimately construct understanding of the concept.

4. Conclusion

Based on the research results can be concluded: 1) PBL-based LKS of Fundamental Laws of Chemistry eligible to use based on the results of expert assessment covering the design of learning materials aspect, material aspect, and language aspect; 2) Implementation of the PBL-based LKS of Fundamental Laws of Chemistry effective to improve student's metacognition as measured by the test, with an average N-gain 0.70, while based on a MCA-I questionnaire test with criteria of student's metacognition skill from start developing become well developed; 3) Application of PBL-based LKS obtain good feedback from teachers and students.

Refferences

[1] Coutinho S A 2007 The Relationship Between Goals, Metacognition, and Academic Success *Educate Jurnal*. **7**(1) 39-47
[2] Singh Y G 2012. Metacognitive Ability of Secondary Students and its Association with Academic Achievement in Science Subject. *International Indexed & Refered Research journal* **IV** (39) ISSN -0974-2832
[3] Cooper M & Santiago S 2009 Design and Validation of an Instrument to Assess Metacognitive Skillfulness in Chemistry Problem Solving *Journal of Chemichal Education* **86**(2) 240-245
[4] Hollingworth R and McLoughlin C 2002 *The Development of Metacognitive Skills among First Year Science Students.* Tersedia http://www.fyhe. Qut.edu.au./FYHE-Previous/Papers/HollingworthPaper.doc_(April 2007)
[5] Haryani S 2012 Membangun Metakognisi dan Karakter Calon Guru melaui Pembelajaran Praktikum Kimia Analitik Berbasis Masalah Semarang: Unnes Press
[6] Wasonawati R R T, Redjeki T, Ariani S R D 2014 Penerapan Model Problem Based Learning (PBL) pada Pembelajaran Hukum-Hukum Dasar Kimia Ditinjau dari Aktivitas dan Hasil Belajar Siswa Kelas X IPA SMA Negeri 2 Surakarta Tahun Pelajaran 2013/2014 *Jurnal Pendidikan Kimia* **3**(2337-9995) 66
[7] Haryani S, Wardani S and Prasetya A T 2015 Pedagogical Content Knowledge Debriefing For Chemistry Teacher Candidates 10th JCC 2015 UNS Surakarta 8-9 September 2015
[8] Creswell J W dan Clark V L P 2007 *Designing and Conducting Mixed Methods Research.*United States of America: Sage Publications, Inc.
[9] Magdalena O, Mulyani S. and VH E S 2014 Pengaruh Pembelajaran Model Problem Based Learning dan Inkuiri Terhadap Prestasi Belajar Siswa Ditinjau Dari Kreativitas Verbal pada MAteri Hukum Dasar Kimia Kelas X SMA N 1 Boyolali Tahun Pelajaran 2013/2014 *Jurnal Pendidikan Kimia* Universitas Sebelas Maret **3**(2337-9995)163
[10] Ikayanti S and Sugiarto B 2012 The Influence of Metacognitive Knowledge to Students Learning Outcomes on Salt Hydrolysis Matter in XI Science 4 RSBI SMAN Mojoagung Jombang *Unnes Journal of Chemical Education* **1**(2252-9454) 204-11
[11] Sari W S, Suryatna A and Sunarya Y 2015 Pengembangan Lembar Kerja Siswa (LKS) Praktikum Berbasis Inkuiri Terbimbing pada Subpokok Materi Pengaruh Penambahan Ion Senama Terhadap Kelarutan *Jurnal Riset dan Praktik Pendidikan Kimia* **3**(2301-721) 26
[12] Tosun C. and Senocak E 2013 The Effect of Problem-Based Learning on Metacognitive Awareness and Attitudes toward Chemistry of Prospective Teachers with Differents Academic Backgrounds *Australian Journal of Teacher Education* **38**(3)
[13] Rahayu P and Azizah U 2012 Students' Metacognition Level Through of Implementation of Problem Based Learning with Metacognitive Strategies at SMAN 1 Manyar *Unnes Journal of Chemical Education*. **2**(2252-9554)
[14] Haryani S and Permanasari A 2014 Developing Metacognition of Teacher Candidates by Implementing Problem Based Learning within the Area of Analytical Chemistry. *International Journal of Science Research*. **3**(6) 1223-1229