Effectiveness of solubility equilibrium module based on lesson study to improve critical thinking ability of chemistry students and teachers in senior high school Kampar district, Riau

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Abstract. The study on solubility equilibrium materials based on Lesson Study (LS) have been conducted by chemistry teachers in Kampar District, Riau. This lesson study was involved three main step, namely step plan (planning), do (open class) and reflection. Meanwhile the selected samples in this study were student of Senior High School 1 and chemistry teacher community in Kampar District, Riau. The number of chemistry teacher community and student were involved 6 peoples and 35 peoples, respectively. Research data was analyzed descriptively quantitative. The average score of students' critical thinking abilities was obtained by 84.21 with very high criterion quality and average score of critical chemistry teacher's ability on chemical equilibrium material equal to 68 with high criterion. The results of this study indicate that the process of making module discussions and application of solubility equilibrium module can improve the ability of chemical teachers' thinking effectively.

1. Introduction

Thinking skills are abstract abilities and it can not be seen before proven by concrete activities. It is grouped in the higher order thinking skills, creative thinking, problem solving and decision making [1]. While the thinking skill is always addressed to find the meaning and understanding of things, exploring various possibilities of ideas or arguments, making decisions, solving problems and so on to make reflection. The research on critical thinking skill in chemistry field has conducted through metacognitive self-regulation skills and applied for university students [2]. The result in this study indicated that the metacognitive self-regulation was related positively toward chemistry self-efficacy in learning chemistry and found no significant relationship between chemistry self – efficacy for cognitive skills and critical thinking. Stephenson and Sadler-McKnight have developed critical thinking skills using the science writing heuristic in chemistry laboratory [3]. This technique was applied in the teaching and learning chemistry with combines writing, inquiry, collaboration and reflection. The result demonstrated that the science writing heuristic laboratory significantly improved students’ critical thinking skill compared with traditional approach. Research conducted by Munoz, et al [4] showed that thinking skills should be nurtured and built well, if it is explored using appropriate methods and procedures.

In this study, an efforts have been made to improve the critical thinking skills of students / teachers by investigating the effectiveness of chemical modules based on Lesson Study (LS). Cerbin and Kopp
shows that LS is a teacher-building system for continuous improvement of learning quality or continuously improving learning [5]. LS provides a process for collaborating and designing lessons, as well as evaluating the success of teaching strategies that have been implemented in an effort to improve student learning and learning processes. In LS Processes, the teacher can work together to plan (lesson plan), teaching and observing a collaborative developed lesson. Meanwhile, the teacher could be implemented learning in the classroom, others observe, and recorded questions from learners. The use of the LS process with professional development programs is a vehicle for returning teachers to a proportional teaching culture [6]. According to Gutierrez that misconceptions and difficulties in the learning experienced by teachers can be overcome by lesson study [7]. These results are supported by Erna, et al that the application of the LS also can improve the competence and professionalism from participant of Chemistry Teacher Professional Program [8].

In this work, learning media was used modules of solubility equilibrium and designed systematically based on the 2013 curriculum and packaged carefully in form of learning units. The learning media were developed and studied independently in a certain time unit, in order to the student were able to hold the tough competence. Inayah reported that module-equipped learning could improve the students’ critical thinking [9]. This research method was combined the application of LS with modules to study the effectiveness and was to improve students’ / teachers’ critical thinking skills. The data were analyzed descriptively and quantitatively with number of learning cycles three times. The study involved students and teachers from a Senior High School in Kampar Regency, Riau, Indonesia. A total of 35 students and six teacher were in treatment. The results showed that the developed LS and module could improve the students’/teachers’ thinking ability.

2. Research Methodology

This research was conducted at The Laboratory of Chemistry Education, The Faculty of Teacher Training and Education, Riau University (UNRI) and at Senior High School 1 Kampar, Riau, Indonesia. The research was focused on learning community of chemistry teacher (6 peoples) and students from The Senior High School 1 Kampar (35 peoples), Riau, in the academic year 2017/2018. This study used an approach of quantitative descriptive. The descriptive data was obtained from the implementation of step LS through plan-do-see. The step LS was performed systematically, factually and accurately toward the students' critical thinking / teachers on the subject of solubility equilibrium. The research instruments were used including assessment of learning planning, observation of learning and thinking ability test from students and teachers.

At the stage of the plan was performed by preparing the module based on solubility equilibrium critical thinking and conducted using the 2013 curriculum. At the step of do was conducted by using teacher model to implement chemistry learning by employing module and learning community of the chemistry teacher. Then, the chemistry teacher should observe the class by using observation sheet. The next step to see the model teacher reflects on the learning that has been performed. The obtained reflection was concluded to improve the quality of learning. The quantitative data were obtained based on the evaluation of students and teachers by using test questions to determine critical thinking of students/teachers. The critical thinking abilities from students and teacher assessment based on the evaluation of answer questions with categories was showed in Table 1.

| Percentage (%) | Clasification |
|----------------|--------------|
| 81-100         | Very high    |
| 61-80          | High         |
| 41-60          | High enough  |
| < 40           | Low          |
3. Results and Discussions
The product obtained from the LS plan activity was formed a module in subject of solubility equilibrium. The module was procured through the informative discussion between lecturers and chemistry teachers at Senior High School. The obtained module was designed in the form of individual learning and adjusted with the character of the student with the age of 15-18 years and also adjusted based on the material of solubility equilibrium. The individual learning was arranged with the learning steps as outlined in the learning tool i.e. learning implementation plan. There were three learning cycles performed on this research. The assessment results in plan step that made by high school chemistry teacher was summarized in the Table 2.

Table 2. Percentage values obtained from learning plan stage

| Observer | Step values, plan (%) |
|----------|----------------------|
|          | Cycle I   | Cycle II  | Cycle III |
| 1        | 97.0      | 97.0      | 100       |
| 2        | 97.67     | 98.67     | 100       |
| 3        | 97.3      | 100       | 100       |
| Averages | 97.3      | 98.56     | 100       |

Based on Table 2, there was an increase in the students’ critical thinking values in cycles I to cycles III analyzed in the plan stages. Generally, averages values of the plan stages in each cycle was 98.62 % and this value was included as very good category. The excellent value obtained was contributed by a good collaborative and continuous informative discussion between lecturer and the community of chemistry teacher in Senior High School. The increasing value of critical thinking were also donated by before the learning begins was always focused on planning, development and evaluation based on reflection of learning. For instance, the chemistry teacher should evaluate the problems contained in the module of solution equilibrium based critical thinking skills. Figure 1 showed that the community of teacher chemistry at Kampar district was very enthusiastic about reflecting on the learning to gain quality learning. Application of the lesson study by Myer was an effective method for development of teacher reflectivity [10].

The focus of cycle I was prepared the creation of chemical equilibrium module in daily life and aligned with indicators of critical thinking. Mulnixreported that critical thinking is a skill that needs to be mastered and practiced in order to see the relevance between the various references in the environment [11]. In the cycle II concentrated to facilitate student to be able for expression of ideas or questions such as why, and how of phenomena the have been poured in the module of solubility equilibrium. Furthermore, in the cycle III centered on the character learning on the students via independence, communication and confidence by giving tasks and evaluated through presentation. Improvement of learning at stage of the Plan was necessary for the commitment and moral orientation of student to always be critical. Each student could have critical thinking skill if the character learning is always practiced in the learning process [12]. The result of observation on learning solubility equilibrium in open class for each learning cycles was summarized in Table 3.

Table 3. The results obtained accurately from the observation assessment on the learning equilibrium of solubility.

| Learning cycle | Observer values (%) | Averages | Category |
|----------------|---------------------|----------|----------|
|                | I       | II       | III      |          |
| I              | 63.39   | 88.90    | 97.22    | 83.17    | B (Good) |
| II             | 97.22   | 94.44    | 88.90    | 93.52    | A (Very good) |
| III            | 100.00  | 97.22    | 97.22    | 98.15    | A (Very good) |
Based on Table 3, the average evaluation for each observer demonstrated an increase in percentage values from cycle I to cycle III. In the cycle I obtained the value of learning was category B, and the learning values increased at cycle II and cycle III with category A. Generally, average values found in the learning solubility equilibrium at cycle I to cycle III was 91.61 with category A (very good). In the cycle I, the learning value obtained low because in this cycle was not linked yet with the existing material on the student experience. Then, the teacher was not asked any question related with the theme to be learned. The ability to link the material with other knowledge that integrated between the development of sciences and technology, and the real life has not been conducted by the teacher. Therefore, students’ thinking ability has not been optimally explored by the teacher. The use of developed module has helped students to optimize students’ thinking skill. Based on observations made, there has occurred a student interaction with the module, student with student and student with teacher. It contributed to good learning. Finally, the students were motivated in learning and the classroom atmosphere demonstrated students either independently or enthusiastically expressing their ideas. The results of documentation at open class was seen in Figure 2. The students were showed independently studying the equilibrium module and others express their understanding within the group.

**Figure 1.** Reflection session conducted kindly by the chemistry teacher at Senior High School 1 Kampar, Riau

**Figure 2.** Open class session performed seriously in Senior High School 1 Kampar, Riau

Good learning outcomes were found because every end of learning, it was always a held reflection or called stage see in lesson study. At the stage see, the teacher and observers in the cycle I were still found learning collaborate in their group. The students have not dared to express their ideas, but in the cycle II, the students were accustomed to learn collaborate and dared to express their ideas on front of the class for presentation their work. This happen because each student was given the opportunity to express their ideas and the students were excited and proud because they were awarded rewards in the form of star labels.

In the cycle III, the learning was performed to make students become active and motivated to learn through the teacher telling students to ask why, why and how to relate the learning with real life. Example, how does one eat excessively, sure we become fat, why? Well, students could always reveal answer on the material of solubility equilibrium in order to the students’ thinking ability becomes higher. The evaluation result from students’ thinking ability at Senior High School 1 Kampar, Riau on the module of Solubility Equilibrium can be shown in Table 4. Critical thinking skills of students were categorized as very high, this was influenced by the use of modules designed before learning begins. The implication for student that they were accustomed for independent learning and more guidance during discussions. According to Sukiman explained that the module was a printed learning media that was designed carefully and arranged systematically in accordance with learning objectives and functioned to increase learning motivation of student, improve teacher creativity, realize unlimited sustainable progress and realize more concentrated learning [13]. Learning processes based on lesson study could also improve significantly misunderstanding of students [14].
Table 4. The achievement of critical thinking skills carried out in material of Solubility Equilibrium at Senior High School 1 Kampar, Riau.

| Cycle | Evaluation values | Average | Category |
|-------|-------------------|---------|----------|
| I     | 84,75             |         |          |
| II    | 83,75             | 84,21   | Very high|
| III   | 84,14             |         |          |

In the meantime, the values of thinking ability of teacher who grouped the chemistry learning community at Senior High School 1 Kampar, Riau was summarized in Table 5. Critical thinking skills of teachers were lower than the students because the teacher have shown success on designing effective student in learning. The teacher succeeds to improve ability of student critical thinking because the problems in the module were a challenging question, because they were concept applications. Shim and Walczak proposed that critical thinking skills of student are a mental process for analyzing or evaluating information [15]. The information could be obtained from observation, experience, common sense or communication. The ability to think critically of each student is different, therefore it needs to be grown and developed early.

The critical thinking ability of the teacher was high category, due to the problem given at the time of evaluation were distinguished by the level of difficulty, whereby the level of problem to give the teacher was more difficult than the problem given to students. In addition, the value of model teacher was found higher compared to the teacher as an observer, because before the learning the model teacher was attempted earnestly to prepare himself in mastering the material to be learned. While, the observer teacher was prepared to observe the students in learning, consequently they were not less focus on the material. Research conducted by Aoibhin proposed that the formation of the learning community was involved in the learning cycles repeated during the academic year and investigated to find out how effectively teacher were involved in the teaching process [16].

Table 5. The critical thinking ability of chemistry teachers achieved using the solubility equilibrium module based on Lesson Study at Kampar District.

| Teacher  | Evaluation values | Average | Category |
|----------|-------------------|---------|----------|
| Model    | 80                |         |          |
| Observer 1 | 75         |       |          |
| Observer 2 | 65         |       |          |
| Observer 3 | 55         | 68     | High     |
| Observer 4 | 65         |       |          |
| Observer 5 | 68         |       |          |

4. Conclusions
The results in this work demonstrated that the use of solubility equilibrium module was very effective to improve the critical thinking abilities of student and chemistry teacher in Senior High School at Kampar District, Riau based on Lesson Study. The value of planning in learning was obtained every cycle with category A (very good) and the value of learning implementation was observed in each cycle with category A (very good). While, the value of critical thinking skill of student based on tests were obtained an average value of 84.21 with very high category and the average value for critical thinking teacher was 68 with high category.

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