Intertextual learning strategy with guided inquiry on solubility equilibrium concept to improve the student’s scientific processing skills

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Abstract: The aim of this study was to develop intertextual learning strategy with guided inquiry on solubility equilibrium concept to enhance student’s scientific processing skills. This study was conducted with consideration of some various studies which found that lack of student’s process skills in learning chemistry was caused by learning chemistry is just a concept. The method used in this study is a Research and Development to generate the intertextual learning strategy with guided inquiry. The instruments used in the form of sheets validation are used to determine the congruence of learning activities by step guided inquiry learning and scientific processing skills with aspects of learning activities. Validation results obtained that the learning activities conducted in line with aspects of indicators of the scientific processing skills.

1. Introduction

There are two things related to inseparable chemistry, chemistry as a product (chemical knowledge in the form of facts, concepts, principles, laws, and theories) the findings of scientists and chemists as a process (scientific work). Therefore, chemistry learning and chemical learning outcomes should take into account the chemical characteristics as products and processes [1]. Chemistry as part of Science, is inseparable from the process. Tawil and Liliasari (2014) declared the process of doing activities related to science commonly called the scientific processing skills [2]. In science teaching and learning activities, in addition it is important to develop scientific processing skills to ensure that students master the concepts taught well [3].

Scientific processing skills is progressing in line with various studies of science process skills. Karsli and Şahin (2009) stated that the scientific processing skills are the skills used by scientists to construct knowledge, solve problems, and make decisions [4]. Each process skill is a typical intellectual skill used by all scientists, and can be used to understand any phenomenon as well. In line with Özgelen (2012) which states that the skills of the process of science is a skill used by scientists to build knowledge, solve problems and produce decisions [5]. Meanwhile, according to Çepni et al define the skills of the science process as a fundamental activity that facilitates in learning science, linking methods and research techniques, helping students to be active in learning [4].

One of the learning strategies that can be used to improve scientific processing skills is the intertextual learning strategy. Intertextual learning strategies are chosen because intertekstual
learning is a learning strategy that links the conceptual relationship between macroscopic, microscopic, and symbolic representation [6]. Gilbert and Treagust (2009) suggest that the linkage between the three chemical representations is one of the keys used in chemical education [7]. The linkage between the three chemical representations proposed by Adadan (2014) plays an important role in learning science to build and communicate abstract understanding [8]. When student given a phenomenon from macroscopic level, student must be observe and make decision with linkage three level representation in chemistry learning, so student doing some indicator from scientific processing skill. As stated by Tawil and Liliasari (2014) several indicators of scientific processing skills include observing, classifying, interpreting, concluding, and designing experiments, conducting experiments. Intertextual learning strategies include learning activities that connect chemical representations, students' real experiences in everyday life and classroom events [9]. Wu (2003) states that learning environments, including teachers, chemistry and learning tools, should explicitly show the relationship between macroscopic, submicroscopic and symbolic in the inquiry context [9].

In the preparation of intertextual learning strategies can be combined with the stages contained in inquiry. Through the inquiry stage students are expected to build the concept through observing activities, making hypotheses, designing experiments to conclude (Some indicators of scientific processing skills). Several studies suggesting a link between inquiry and scientific processing skills are found in studies conducted by Özgelen (2012) and Basaga, Gebban, Tekayya (1994). Özgelen argues that the student's scientific processing skills can be bridged using the inquiry model [5] and Basaga et al states that through inquiry the student's scientific processing skills can improve [10].

In general, the inquiry is divided into two, namely open inquiry and guided inquiry, as proposed by Hassard [11]. Open inquiry requires a high-level thinking as proposed by Orlich, *et al* [11]. Guided inquiry can be provided for students who do not have experience in doing inquiry [11]. In addition to that Moore, Herzogb and Perkinsa (2013) state that guided inquiry helps students specifically for investigations guided by facilitators or with guidance to make the investigation process more effective [12].

Magnusson and Palinscar suggest that guided inquiry can integrate scientific facts and principles in science [11]. If connected with intertextuals have the same characteristics to relate students' real experiences, chemical representations, and learning in the classroom. The students' real experiences can be facts that students find in everyday life. In addition to the students' experience, students can find scientific facts and principles in science when conducting classroom learning and chemical concepts using macroscopic, submicroscopic, symbolic representations.

In guided inquiry according to Bilgin (2009) teachers and students play an important role in compiling questions, building answers, and composing materials and issues, activities in guided inquiry also help students to build responsibility, cognitive student, report, solve problems and skills understand [11]. Based on the role of students in the inquiry activities proposed by Bilgin in line with the indicators contained in the scientific processing skills proposed by Tawil and Liliasari. Guided inquiry is chosen because in the inquiry phase is consistent with the indicators contained in the scientific processing skills. As the observing stage, put forward the problem, making hypotheses, designing and experimenting and concluding. Through these stages can prove students' scientific processing skills.

The concept of solubility equilibrium is chosen because in the concept of solubility equilibrium can be developed activities to display student's scientific processing skills. Solubility equilibrium is a complex topic since it integrates solubility, molarity, physical, chemical equilibrium and Le Chatelier’s principles concepts. Also, it interacts with biology concept such as osmotic pressure and osmosis [13]. For example in solubility concept, student must know to determining the saturation level of the solution. Students directed to observe the phenomenon about saturation level so that students are expected to be able to formulate the problem through asking then making hypotheses and testing hypotheses through experimental activities. So it is expected that through the stages can improve student's scientific processing skills.

The purpose of this research is to know the effectiveness of intertextual learning strategy with guided inquiry to improve student's scientific processing skills on solubility equilibrium concept. Based
on this objective, the research question states "How do student’s scientific processing skills on solubility equilibrium concept using intertextual learning strategies with guided inquiry?"

2. Method
The method used in this research is Research and Development (R & D) to generate intertextual learning strategy with guidance to improve student's scientific processing skills. The object of this study is an intertextual learning strategy with guided inquiry on the concept of solubility. Subjects In this study were 21 of 11th graders in one high school in West Bandung. Instrument used to know how far it can improve students’s scientific processing skills validated to decide the accuracy of measurement of the student's scientific processing skills indicators. The research was conducted up to a limited trial stage. In the early stages of development, a study of basic competencies, solubility equilibrium concepts to be developed, and various contexts about the scientific processing skills. All of them are done to obtain the indicator that will be achieved in developing the scientific processing skills.

3. Results and Discussion
3.1 Development of intertextual learning strategies with guided inquiry is based on the concept of solubility equilibrium
Development of intertextual learning strategy begins with the preparation of indicators of scientific processing skills. The scientific processing skill indicators are derived from the basic competencies of the skills. After determining scientific processing skills on solubility equilibrium concept, intertextual learning strategy with guided inquiry for improving student’s scientific processing skills are designed before being validated. The intertextual learning strategy composed consists of three activities. Activities undertaken are based on concepts to be conveyed to students. Stages used in each activity have similarities, because the strategy is structured based on the stages contained in guided inquiry.

First activity is based on the concept of solubility. In the first activity the concept of solubility prepared is related to the concept of the saturation level of the solution. This is done because the concept of solubility is closely related to the concept of the saturation level of the solution, especially the saturated solution. The second activity deals with the concept of solubility equilibrium. In the second activity the students are guided to be able to determine the solubility product constant. The third activity is based on the concept of predicting the formation of sediment.

3.2 Validation of intertextual learning strategies with guided inquiry is based on the concept of solubility equilibrium
Sheet validation of intertextual learning strategy with guided inquiry to improve student's scientific processing skills with guided inquiry steps, teacher learning activities, student learning activities, student’s scientific processing skill aspect, suitability of learning activities with guided inquiry steps, suitability of learning step with student’s scientific processing skill aspect and suggestions for improvement.

Validation is done by experts in the field of lecturers in the department of chemical education. Validation results obtained that the learning activities conducted in line with aspects of indicators of the scientific processing skills. Based on the validation done for the concept of solubility some indicators that can be used to demonstrate students’ scientific processing skills are observing, asking questions, making hypotheses, interpreting.

3.3 Scientific processing skills on solubility equilibrium concept
The student's scientific processing skills are measured using 6 test items to measure the scientific processing skills. Students are given pretest and posttest questions to find out whether student's scientific processing skills are improving. Among the pretest and posttest activities, students follow the learning activities using an intertextual learning strategy with guided inquiry. The research results of intertextual learning strategies that learning environments, including teachers, chemistry and learning tools, should explicitly show the relationship between macroscopic, microscopic and symbolic in the
inquiry context [9]. The learning activities used help students to relate the three chemical representations. Students may also link prior knowledge with their new knowledge. Group discussions that are widely used in the process, can facilitate students to work together in conducting investigations, students also have the opportunity to express opinions during the learning process.

The most common skill of the students' scientific processing skills are inferring skill and observing skill, as shown in figure 1. Student's scientific processing skills in conclude skill based on posttest results have the lowest value. This can happen because in the instrument used for conclude skill it involves determining the solubility of some slightly soluble compounds. Students are still having trouble in determining the solubility value from the solubility-product constant (K_{sp}). In learning activities, students can make conclusions from an experience. For example, when students are asked to inferring from the issues raised about the maximum limit of a solute the student can make the conclusion as expected. This is because in the learning activities of the students directly observe the phenomenon about the solubility of substances associated with the maximum amount of substances that can dissolve in a particular solvent.

![Figure 1. Graph of the percentage of scientific processing skills](image)

Based on intertextual learning strategy with guided inquiry, students get chemistry learning experience especially on the solubility equilibrium concept by connecting the macroscopic level through direct observation, microscopic level by describing the condition in solution with certain solubility and know the chemical formula of the compound used as the symbolic level.

4. **Conclusion**

Based on the data obtained, student’s scientific processing skills through intertextual learning strategies with guided inquiry are based on the concept solubility equilibrium to be increased in terms of observing and inferring skills. Through observation activities and data interpretation students are given some data to be able to obtain information. From the information provided students can easily make observations and interpretation of data so that based on the results of tests conducted by students easily able to answer the problems given. Activities conducted through discussion can bridge the students' difficulties in understanding the given phenomenon. Students also got opportunity to express their opinions and communicate during learning process.

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