

The Quality of Chemistry Learning Process Viewed from Learning Outcome Indicators and Process of Teaching

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Abstract—This research aims at describing and explaining the quality of chemistry learning of senior high school students. This research was a qualitative study focusing on analysing the formulation of learning outcome indicators and the learning process organized by teachers as well as factors influencing the learning process. Three chemistry teachers teaching at grade ten, eleven, and twelve from three different schools located at the district of Buleleng, the Province of Bali, were involved in this study. Document analysis and interview technique were used to collect information. The result of this study revealed that: 1) The formulation of learning outcome indicators involved lower order thinking and higher order thinking categories. However, most formulations were fallen into low order thinking category. 2) The learning process used various approaches, methods, and strategies. 3) The factors influencing the teaching learning process came from three resources, namely: the students, the teachers, and the schools.

Keywords—chemistry learning process, learning outcome indicators, teaching process.

I. INTRODUCTION

Teaching and learning processes are seen as “coin sides.” On one side of the coin, there is a teaching process and on the other side there is a learning process. The learning process of students can be occurred on the absence or presence of teachers. On the absence of teachers, the learning process is initiated and directed individually known as self-directed learning [1][2]. On the presence of teachers, the learning process is seen as the effect of teaching strategy used by teachers. This means that all learning activities conducted by the students are based on teachers’ instruction or guide. The latest definition is referred to as the teaching learning process or learning process only, i.e. the process of learning of students conducted under teachers’ instruction [3].

On the learning process of students, teachers play an importance role. They will play a role as learning resources, as a learning manager, as a learning facilitator, as a learning evaluator or assessor, as well as a role model of behaviour [4]. As the learning resources, it can be mentioned that

teacher is the cheapest learning resources who can be accessed interactively in or out of the classroom. Teacher’s explanation is still important, although it should be seen one skill in a broad repertoire of teaching skills [5]. In this case, teachers are required to master the content of learning materials. As the manager of classroom learning, teachers are responsible to manage the learning process. In this case, teachers should plan, do, and check the learning process. They develop learning programs or lesson plans, conduct learning process, and assess the students learning outcomes. As the facilitator of classroom learning, teachers are responsible to help students to solve any problems they have during the learning process. In this case, the teacher should have good interpersonal skill, such as friendly, charming, and patient to create joyful leaning [6]. As the evaluator of learning, teachers are responsible to make educational decision based on the result of learning obtained by students. In this case, teachers should develop instrument for learning assessment and assess as well as evaluate students learning outcomes [7]. As the role model of behaviour, teachers are expected to demonstrate good personal and social behaviours in terms of respect, morality, religious and social values that can be taken by the students for their personal development model [8][9].

One way to improve the quality of learning process can be done through curriculum development. The changing of curriculum, from KTSP (*Kurikulum Tingkat Satuan Pendidikan*) to 2013 Curriculum is one of education innovation done by the government of Indonesia. The 2013 Curriculum is already implemented about four years’ step by step at schools. At present, some schools are still operating two curriculums (the KTSP and the 2013 Curriculum). These two curriculums have slightly different structures. The differences are significantly existed in the formulation of competency of students and the approach of learning. The competency of students is described in terms of core competency (*Kompetensi Inti*) and basic competency (*Kompetensi Dasar*). The learning approach focuses on the use of scientific approach with five steps learning strategy, namely: observing, questioning, collecting information,

associating, and communicating. This learning strategy is introduced as 5M learning strategy. The 5M is defined as observing (*Mengamati*), questioning (*Menanya*), collecting data (*Mengumpulkan data*), associating (*Mengasosiasi*), and communicating (*Mengomunikasikan*) [10]. In addition, teachers are also recommended to use other innovative learning strategies in teaching, such as problem based learning (PBL), discovery learning, and project based learning. It is believed that these learning strategies facilitate students to learn, especially in learning science subjects, such as chemistry, in scientific ways utilizing the so called scientific methods. The development of scientific attitudes is also promoted in terms of religious and social values practised in daily life [7][9].

The learning competency is classified into three categories, namely: religious and social competencies, knowledge competency, and skill competency. Although the curriculum sets out three areas of learning outcomes, it seems that the majority concern on teacher in teaching is focused on the development of students' knowledge of the subject. In addition, it is also found that the formulation of learning outcome indicators (LOI) falls into low level of thinking. This indicates that the quality of learning is still low [11].

There are several factors that known to be able to affect the implementation of curriculum at schools. In general, those factors can be viewed from teacher side as well as the school side. Since the curriculum has some new ideas, the problem can be raised from the teacher's understanding about the curriculum and facilities provided by the schools. Some teachers face difficulties to implement the curriculum. Although the curriculum is changed, the way of teachers teach does not change very much and still using the so called conventional teaching strategy (the direct instruction model of teaching) [4]. Some schools fail to provide facilities for learning. Therefore, learning process is conducted slightly different from the curriculum requirement [12][13]. These phenomena need to be investigated intensively to find out the real situation of chemistry classroom learning.

The content of subject matters in 2013 Curriculum is not structured based on the topic of learning materials, but it is presented integratedly in the form of basic competency. For examples, the basic competencies of senior high schools (SMA) chemistry for grade ten are as follows. The basic competency for knowledge development (code 3.2) states "comparing ionic bonds, covalent bonds, coordination covalent bonds, and metal bonds as well as their correlation with the physical properties of compounds." The basic competency for skill development (code 4.2) states "presenting group discussion results about elements stability, Lewis structure, ionic and covalent bonds, coordination covalent bonds, polar and nonpolar compounds, metal bonds, and the properties of compounds." [14]. The topics of learning materials should be derived from the description of competency. For the above

competencies, the topic of learning materials is chemical bonding.

Teachers are expected to formulate specific learning outcome for each topic in the form of indicators. These indicators are used as guidelines to formulate learning objectives, to conduct learning process, and to formulate instrument for assessing learning outcome. Therefore, the quality of learning is determined by the level of LOI formulated by teachers. If teachers formulate appropriate indicators, then the learning outcome will have high quality and vice versa, if teachers formulate inappropriate indicators, then the result of learning will fall into low quality of learning. Several teachers find difficulties to formulate indicators, especially for attitude aspect, in connection to the topic [7]. Teachers usually formulate general indicators for expected religious and social values. The indicator is not apparently connected to the topics.

Chemistry learning at SMA focuses on the learning of the structure and properties of matters, the change of matters, the energy involved in the change of matter, and the important of chemistry in daily life. These learning materials can be learnt theoretically and practically. Practice, in this case, learning through experiment is hardly required because chemistry is not only learning a macroscopic phenomenon of matter, but also more importantly learning a microscopic phenomenon of matter as well as symbolics of phenomena. The most important aspect of learning that can be used to predict the quality of learning is the formulation of LOI. Therefore, it is important to know the kinds of LOI formulation done by teachers.

Theoretically, the LOI is formulated based on the taxonomy of learning. The level of LOI is classified into two, namely: low order thinking (LOT) and higher order thinking (HOT) [15]. This category is also known as critical thinking skill. Based on the Bloom's Taxonomy, the LOT includes remembering, understanding, applying, and the HOT includes analysing, evaluating, and creating [11, 16, 17]. In the formulation of *Trikaya* Taxonomy, Subagia dan Wiratma [9] described the HOT including thinking, speaking, and acting levels. The LOT is characterised by an instruction words, such as identify, explain, mention, use, whereas the HOT is characterised by instruction words, such as compare, contrast, justify, make.

Based on the description above, the research questions answered in this study are as follows. What kinds of LOI formulated by teachers for chemistry learning at SMA? What are the learning processes used by the teachers in teaching chemistry at SMA? What are the factors influencing the learning process of chemistry at SMA? The answers of these questions are important for improving the quality of learning process of chemistry at SMA.

II. METHODS

This research was a qualitative study aimed at describing and explaining systematically the formulation of LOI made by teachers, the strategy of learning used in the classroom or

at laboratory, and the factors influencing the teaching learning process of chemistry. This research was conducted in the district of Buleleng, the Province of Bali. Three chemistry teachers teaching in grade ten, eleven, and twelve from three different schools were involved in this research. Document analysis and interview technique were used to collect data and an interpretive analysis was used to develop the meaning of the findings [18][19]. Twelve documents of lesson plans were analysed intensively to find out topics of chemistry learning, learning competencies, LOI, and learning strategies used by the teachers. Five questions were focused on interview, namely: the question of learning approach, learning methods, learning strategies, problems faced in learning, and factors influencing learning.

The result of this study is presented in terms of the description of the LOI formulation made by teachers, the learning strategies used by the teachers, and the factors

influencing the learning process of chemistry. Conclusion is formulated based on interpretive analysis in which the meaning of event or phenomena is constructed step by step through data reduction, data display, and triangulations of methods as well as resources [20].

III. RESULTS AND DISCUSSION

3.1 Learning Outcome Indicators

This study involved twelve lesson plans used by three chemistry teachers for teaching chemistry at grade ten, eleven, and twelve in three different schools. The formulation of LOI by the teacher is collected from those lesson plans mentioned above. The LOI is classified into two, namely: LOT and HOT categories. The category of learning outcome indicators in relation to the basic competences was presented in Table 1.

TABLE 1. BASIC COMPETENCIES AND INDICATORS

Grades	Basic Competencies	LOI Categories
X	Understanding scientific methods, the principle of chemistry, safety work at laboratory, and the importance of chemistry in daily life	Explain the definition of chemistry (LOT) Explain the characteristics of chemistry (LOT) Explain scientific methods (LOT)
	Comparing ionic bonds, covalent bonds, coordination covalent bonds, and metal bonds as well as their correlation with the properties of matters	Explain the stability of VIII group elements (LOT) Explain the trend of stability of element excluding VIII group (LOT) Explain the process of ionic bond formulation (LOT) Explaining the properties for ionic compounds (LOT)
	Applying relative molecular mass concepts, reaction equation, fundamental law of chemistry, and mole concepts in stoichiometry	Determine empirical and molecular formula (HOT) Determine water molecules in hydrate compounds (HOT)
	Applying relative molecular mass concepts, reaction equation, fundamental law of chemistry, and mole concepts in stoichiometry	Design an experiment to prove Lavoisier Law (HOT) Conduct experiment to prove Lavoisier Law (HOT) Prove the application of law of constant proportion through calculation (HOT)
XI	Predicting the formation of precipitate from reaction based on solubility and solubility products	Identify the relationship between Q_s and K_{sp} in precipitation reaction based on experiment data (LOT)
	Determining ΔH reaction based on Hess Law, standard H data, and bond energy	Determine ΔH reaction based on Hess Law (HOT) Figure out Hess cycle diagram (HOT) Figure out H diagram (HOT)
	Understanding collision theory to explain chemical reaction	Determine molarity of solutions (LOT) Explain collision theory in (LOT)
	Analysing hydrolysis salts	Identify salt types (LOT) Identify hydrolysed salts (LOT)
XII	Explaining vapour pressure depression, boiling point elevation, freezing point depression, and osmotic pressure	Observe freezing point depression Calculate freezing point depression of solutions (LOT)
	Explaining reduction and oxidation reactions in electrolysis	Observe reactions that are occurred at cathode and anode (LOT) Write reaction that are occurred at cathode and anode (LOT)
	Describing structures, nomenclature, properties, functions, and identify carbon compounds	Differentiate chemical properties of ester (HOT) Write the name of ester compounds (LOT) Write esterification between alcohol and carboxylate acids (LOT)
	Describing structures, nomenclature, classification, properties, and functions of macromolecules	Identify natural and synthetic polymers (LOT) Explain physical and chemical properties of polymers (LOT)

The formulation of LOI listed in Table 1 above showed that the majority formulation was fallen into the LOT category indicated by the instruction words, such as identify, explain, observe, and write. Several LOI formulations already included HOT category, such as determine water

molecules in hydrate compounds, design an experiment to prove Lavoisier Law, prove the application of the Law of Constant Proportion through calculation, figure out Hess cycle diagram, and differentiate chemical properties of ester.

It seemed that teachers found difficulties in formulating LOI for HOT category.

To promote high quality of learning, it was important to formulate LOI included in HOT category. Based on Bloom's Taxonomy, the instruction words that could be used to formulate HOT of LOI were compile, create, develop, generalise, integrate, propose, appraise, assess, criticise, depend, evaluate, justify, support [11]. For example, for the topic of scientific methods it could be formulated indicators, such as "analyse the steps of scientific methods used in an experiment or evaluate the appropriate steps of scientific methods use in an experiment. For the topic of salt hydrolysis, it could be formulated indicators, such as differentiate hydrolysed and non-hydrolysed salts. For the topic of freezing point depression, it could be formulated indicators, such as investigating the effect of solution concentration towards freezing point depression. From the formulation of indicators made by the teachers, it could be concluded that the teachers needed to learn how to formulate higher level indicators of learning outcome, i.e. an indicator with HOT categories. This will produce high quality of learning because the LOI will be used to guide all process of learning.

3.2 The Process of Learning

The process of learning was viewed from three terms of teaching methodology, namely: approach, methods, and strategy. The terms used by the teachers in chemistry learning at schools were described in Table 2.

TABLE 2. APPROACHES, METHODS, AND STRATEGIES OF LEARNING

Approaches	Methods	Strategies
Inductive	Information	Inquiry
Deductive	Discussion	Problem based learning
Scientific	Experiment	Cooperative learning
Contextual	Question-answer	Discovery learning
Process		5M learning

Based on the information in Table 2 above, it could be mentioned that teachers used two opposite types of scientific approach, i.e. inductive and deductive approaches. In addition, they also used several innovative approaches, such as scientific approach in terms of 5M learning strategies, contextual approach, and process skill approach. These approaches were considered relevant because those approaches gave opportunities to students to learn in scientific ways. The scientific approach is the learning approach that is recommended by the government to be used for all teaching learning process in implementing the 2013 Curriculum, i.e. the 5M learning strategy [10].

The methods used for conducting learning process were information, discussion, experiment, and question-answer. It could be mentioned that these methods were appropriate to be use in chemistry learning. The use of information methods could not be neglected due to students' ability in learning. It was found that some students had problems in

reading, analysing problems, and in promoting questions. So, teachers' patient was badly required in facilitating student learn. It seemed that the experiment method was also rarely used. This had a strong relationship with learning facilities provided at schools and time available for whole semester or annual teaching. The existence of some chemicals and chemical apparatus, sometimes, limited laboratory activities [12][13][21].

The use of discussion method was not always seen fruitful for learning because of imbalance students' participation in group learning. Some students were actively involved in discussion, but some just sitting calmly, enjoying their time, and waiting the results. Sometimes, teachers did not aware of this situation and think that the discussion was running well.

The question-answer methods was important in learning. However, most students did not like to be asked. They prepare to listen to teachers. When the teacher asks question, they do not directly answer it, but they scanned the book to find an answer. Once he or she found the answer, he or she would rise hand up and respond to the question. What was the meaning? This meant that the students did not have the knowledge on top of their head. The knowledge was still in the book. Some teachers were also not aware of this situation and still rewarding the students.

The strategies used were inquiry learning, discovery learning, problem based learning, and 5M learning. These learning strategies were considered relevant under the usage of scientific approach. Because those strategies encouraged students to learn actively by involving observation, problem formulation, hypothesis or prediction formulations, data collection, data analysis, conclusion formulation, and findings communication. One strategy of learning that did not appear yet was the project based learning. It seemed that this had connection to the capabilities of teachers to design project for students and time available for semester or annual learning process at schools. Limbach and Waugh in [11] reported that due to the tight schedule for teaching, teachers may have difficulties planning HOT-filled lessons to be completed in one or two class periods. Subagia and Wiratma [7] found out many problems faced by teacher in conducting learning process at schools.

In the implementation of 2013 Curriculum, all teachers were trained to use the 5M learning strategy. It was seen explicitly on teacher lesson plans, i.e. the use of 5M steps. However, teachers failed to provide phenomena to be observed by students in order to obtain expected observation results. Therefore, the following step, i.e. is the questioning, did not work as expected because the students did not have good observation results which produced good questions. So, the rest of 5M steps was described unclearly. It was important to know that in order to use 5M learning strategy, teachers should think carefully of observing and questioning steps and also predict the result of observation leading to arise appropriate questions and the question formulation leading to the following steps of the 5M learning strategy.

3.3 Factors Influencing Learning

There were several factors influencing the learning process of chemistry at SMA. These factors came from three different resources, namely: the students, the teachers, and the schools. The student's factors were low students' motivation, low students' discipline, low students' ability to promote problems or questions, low students' effort in reading, and low students' ability to analyse problems. It seemed that these factors were connected to each other. For example, low students' motivation caused low effort in reading as well as low ability to analyse and promote problems or questions. Low students' ability in learning caused low students' discipline in the classroom. Artonang [22] reported that the way of teachers teaching influences the way of students learns. It was mentioned that low students' motivation was caused by non-meaningful learning demonstrated by teachers.

The teacher's factors were the selection of appropriate methods and strategies of learning as well as the preparation of interesting lessons. The selection of appropriate methods and strategies in preparing lesson was not easy. In this case, teachers needed to fully understand about the characteristic of materials as well as students' learning style. Every topic had different characteristics requiring different learning strategies. Every student had different learning styles that might not be fit with the learning strategy used by the teacher. Therefore, teachers should select the most appropriate strategy swinging from students' characteristics and the characteristic of learning materials. Many teachers still leaning on the use of direct instruction model of learning because they felt confident to do it. Sometimes, they did not feel confident to conduct learning process using new strategies.

The school's factors were learning environment, learning facilities, and learning resources. The environment of learning, especially classroom environment, should fit the standard, e.g. the number of students in a classroom. The biggest number of student in a classroom, the lower quality of learning will be produced and vice versa, the smaller number of students in a classroom, the higher quality of learning will be produced. In addition, the existence of learning facilities and resources was important to promote good quality learning process. The process of learning could not be optimally conducted if there were not enough facilities and resources to support it. A clear example could be seen on the teaching learning process at laboratory. Teacher would not use laboratory if the laboratory was not well equipped [12, 13].

IV. CONCLUSION

The quality of chemistry learning process discussed in this paper is the phenomena of chemistry learning process conducted at schools as the implementation of 2013 Curriculum in a small scale. In general, it can be mentioned that the quality of chemistry learning process is still low. This can be seen from the LOI formulation made by the

teachers and the process of teaching. The improvement of chemistry learning quality can be started from improving teachers' capabilities to formulate LOI because the LOI will be used to guide all process of learning including planning the lesson, choosing learning strategies, conducting learning process, and formulating instrument for assessing students' learning outcomes.

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