LEVEL OF SCIENTIFIC CREATIVITY AND SCIENTIFIC ATTITUDE AMONG PROSPECTIVE CHEMISTRY TEACHERS

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ABSTRACT

The purposes of this study are to identify level of scientific creativity, level of scientific attitude among the prospective chemistry teachers, and to study the relationship between level of the prospective chemistry teachers' scientific creativity and scientific attitude. This study used quantitative approach with descriptive research. This study involved 92 prospective chemistry teachers from 2 universities in Pekanbaru, Riau- Indonesia which were selected by using simple random sampling. Data was collected by using chemistry scientific creativity test containing 3 open-ended questions, and online questionnaire which were developed by researcher and validated by 3 experts. Furthermore, data from chemistry scientific creativity test was analyzed by percentage and then it was determined level of scientific creativity by comparing percentage of score to criteria level of scientific creativity. Data obtained from online questionnaires was analyzed using median, and score obtained from scientific creativity test and scientific attitude questionnaire further was analyzed using Spearman correlation by using SPSS. The result showed that level of scientific creativity among prospective chemistry teachers was moderate due to low ability in flexibility and fluency, level of scientific attitude among prospective chemistry teachers was high level, and there was no significant relationship between level of scientific creativity, and scientific attitude. Moderate level of scientific creativity makes it necessary to improve because it would influence how the prospective chemistry teachers conduct learning and teaching chemistry in the future and produce scientific creative future students.

ABSTRAK

Tujuan kajian ini adalah untuk mengenal pasti tahap kreativiti saintifik, tahap sikap saintifik kalangan calon guru kimia, dan mengkaji hubungan antara tahap kreativiti saintifik calon guru kimia dan sikap saintifik. Kajian ini menggunakan pendekatan kuantitatif dengan kajian deskriptif. Kajian ini melibatkan 92 bakal guru kimia dari 2 universiti di Pekanbaru, Riau-Indonesia yang dipilih dengan menggunakan persampelan rawak mudah. Data dikumpulkan dengan menggunakan ujian kreativiti saintifik kimia yang mengandungi 3 soalan terbuka, dan soal selidik dalam talian yang dikembangkan oleh penyelidik dan disahkan oleh 3 pakar. Selanjutnya, data dari ujian kreativiti saintifik kimia dianalisis dengan peratusan dan kemudian ditentukan tahap kreativiti saintifik dengan membandingkan peratusan skor dengan tahap kriteria kreativiti saintifik. Data yang diperoleh dari soal selidik dalam talian dianalisis menggunakan median, dan skor yang diperoleh dari ujian kreativiti saintifik dan soal selidik sikap saintifik selanjutnya dianalisis menggunakan korelasi Spearman dengan menggunakan SPSS. Hasil kajian menunjukkan bahawa tahap kreativiti saintifik kalangan calon guru kimia adalah sederhana kerana kemampuan fleksibiliti dan kefasihan yang rendah, tahap sikap saintifik kalangan calon guru kimia adalah tahap tinggi, dan tidak ada hubungan yang signifikan antara tahap kreativiti ilmiah, dan sikap saintifik. Tahap kreativiti saintifik yang sederhana menjadikannya perlu ditingkatkan kerana ia akan mempengaruhi bagaimana bakal guru kimia menjalankan pembelajaran dan pengajaran kimia pada masa akan datang dan menghasilkan pelajar masa depan yang kreatif secara saintifik.

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LIST OF ABBREVIATIONS

4C	-	Critical Thinking, Creativity, Collaboration, and Communication
SD	-	Strongly Disagree
D	-	Disagree
N	-	Neutral
A	-	Agree
SA	-	Strongly Agree

LIST OF SYMBOLS

r_s	-	Critical value
n	-	Total of respondents
f	-	Frequency
p	-	Probability

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The emergence of 21st century era makes the importance of integration of knowledge, skills, attitude, and value among the next generation (Tirri et al., 2017). Astuti et al. (2019) stated that the direction of education's rule inside the 21st century is different if it is miles compared to the preceding century. Beers (2011) stated that many studies report about skills and competencies that students must have in preparing for their future and to fulfill the demands of 21st century era.

According to Zubaidah (2016), the competencies in the 21st century included critical thinking, creativity, academic mastery, cognitive competencies, interpersonal and intrapersonal competencies. Based on enGauge 21st century skills, there are 4 dimensions, namely digital-age literacy, effective communication, and inventive thinking, in inventive thinking, it included curiosity, creativity, risk-taking, High Order Thinking Skills (HOTS), sound reasoning, adaptability, managing complexity, and self-direction (The North Central Regional Educational Laboratory, 2003). Partnership for 21st Century Skills (2009) has developed a vision to make students who can face new global economy. It includes 21st century student outcomes and support systems such as core subject and 21st century themes, learning and innovation skills (creativity, innovation, critical thinking, problem solving, communication, and collaboration), information, media, technology skills, and life & career skills.

Based on skills and competencies as demand in 21st century, creativity is always emphasized. It is line with Soland et al. (2013), who stated that creativity is an example of competency or skill that many educators assumed is a crucial skill to be had by people 21st-century era. Nakano & Wechsler (2018) also stated that referring to 21st century learning, students must have the essential skills one of them is

creativity. Creativity can be a process, product, skill, or ability related to the generation of new, novel ideas, knowledge (Zheng et al., 2019).

The countries in overall the world have emphasized creativity, either developed countries or developing countries. For example, many countries have incorporated creativity into the curriculum. In developed countries, such as curriculum in the United States, creativity is a crucial component in primary and secondary schools. It is a cognitive competency that educators must apply in learning and teaching activities (Pllana, 2019). In National Curriculum by Department of Education in the United Kingdom, one of goals of learning is by giving opportunity to students to develop their creativity to solve problems (Tom & Gisli, 2017). In developing countries such as Malaysia, through Malaysian Education Blueprint 2013-2025, creativity is also one of skills that can produce and encourage Malaysians to be competitive at the international level. In education system in Malaysia, creativity has been necessity that must be had by students, so that this skill is crucial to be implemented in learning and teaching process.

Indonesia also has emphasized creativity in curriculum (Curriculum 2013). It requires learning, and teaching activities must emphasize 4C's and HOTS, one of which is creativity (Ratnasusanti et al., 2018). In detail, according to Peraturan Menteri Pendidikan dan Kebudayaan No.69 Tahun 2013 (Regulation of Minister of Education and Culture No.69, year 2013), curriculum 2013 aims to prepare Indonesian people to have the ability to live as individuals and citizens who are faithful, productive, creative, innovative, and affective and able to contribute to the life of society, nation, state, and world civilization. This regulation supports the students to be creative and the teachers should conduct learning and teaching activities that consider the creativity.

In field of science, creativity is known as scientific creativity (Dergisi et al., 2017). That means during learning science, it requires scientific creativity. The question is, what is the difference between scientific creativity and creativity?, is scientific creativity being implemented? and are the teachers equipped with scientific creativity so that they implement it in the classroom?

Furthermore, besides skill such as scientific creativity, attitude is also crucial in 21st century era among the next generation (Tirri et al., 2017). In science curriculum, scientific attitude is term used in educational field, which countries emphasize scientific attitude in their curriculum. For example, curriculum in Pakistan emphasizes scientific attitude in science curriculum (Islam Pitafi et al, 2012), in the U.S.A., the U.K. and Australia have explicitly listed the development of scientific attitudes in their Science curriculum development (Gauld, & Hukins, 1980). Also, Indonesian curriculum in curriculum 2013 has emphasized the importance of assessing scientific attitude in the classroom (Tursinawati, 2017).

Scientific attitude and scientific creativity are two crucial components in curriculum countries overall the world. As a result, it raises questions about "how scientific creativity and scientific attitude in the classroom? are both components being implemented? and are students, the teachers, and future teacher equipped with scientific creativity and scientific attitude?

1.2 Creativity vs Scientific Creativity

Many people argued that creativity is same to all field. That is totally wrong, because Liang (2002) found that creative people cannot be ascertained whether they are creative in all fields or not because the individual can be creative in art, but it is probably not for science. In science, creativity is known as scientific creativity. Scientific creativity is the ability to deal with problems by coming up with idea and hypotheses. The difference between scientific creativity and creativity can be seen from the involvement of innovative experiment, discovery and problem-solving activities and it also can be seen through the characteristic (Obote, D.K., 2016). Also the scientific creativity is different to creativity in art and linguistic because it involves creative in scientific knowledge and science inquiry (Hu & Adey, 2002; Yang, 2019).

According to Aktamış et al. (2005), the characteristics of scientific creativity are related to the ability to solve problems, search for solutions, designing experiments, identifies difficulties, formulate predictions, hypotheses, and many abilities related to

scientific skills. On other hand, Torrance & Goff (1990) stated that the main characteristics of creativity are fluency, flexibility, and originality. Furthermore, there are dimensions in scientific creativity that make creativity in science is different from other fields. J.-W. Park, (2004) states that there are three dimensions model of scientific creativity namely creative thinking (divergent thinking, convergent thinking, and associational thinking), scientific knowledge (biology, chemistry, and physics), and scientific inquiry skills (observation, suggest hypothesis, explain natural phenomena).

In reality, Alsahou & Alsammari (2019) found in learning and teaching science, science teachers still use general creativity. They hold and implemented general creativity and able to identify major components of creativity. Another example is the study carried out by Zare et al. (2016), that study aims to investigate the impact of e-learning on creativity and academic achievement among chemistry students. However, the elements of creativity used are still general creativity. It is similar to a study conducted by Insyasiska et al. (2015) that also assesses students' creativity by using general creativity in biology class. According to Mohamed (2006), it leads to error if general creativity instrument is used to determine scientific creativity. Indeed, this issue showed that there is still ambiguous belief concerning creativity among science teachers.

Based on explanation above and by considering that scientific creativity is different with creativity, many sciences teachers missed out on the concept of creativity in science class, many studies still consider general creativity instead of scientific creativity in science class, thus, this study of scientific creativity is important to explore deeply.

1.3 Important Roles of Teacher in Implementing Scientific Creativity

Scientific creativity is a skill needed in life to face the development of globalization and the industrial revolution 4.0 (Rizqi et al., 2020). However, many studies found out that the level of scientific creativity of students is still low. Omar et

al. (2017) found out students' scientific creativity among Malaysia students form-four is at low level which is 26,99%. In Kenya, Kamonjo (2019) also found that secondary school students had a low level of scientific creativity in chemistry education. It also happened in Indonesia, the students' scientific creativity level is tend to low, and students still have obstacles in using scientific creativity (Lailiyah & Suliyanah, 2018; Rachmawati et al., 2018; Rizqi et al., 2020). Even though, Indonesian Curriculum demands to prepare graduates who have knowledge, attitude, and various skills. One of which is scientific creativity, where it needs the improvement of quality of education's Indonesia to anticipate the availability of developments in the future namely producing knowledgeable, good attitude, and skillful graduates such as scientific creative students (Rizqi et al., 2020).

Many factors influence the low level of students' scientific creativity such as the teacher as a person who plays an important role in the classroom. As a very influential person, the teacher is expected to foster the creative potential of each student by facilitating the development of knowledge, skills, and attributes related to creativity in the context of formal education (Andiliou & Murphy, 2010). In context of producing students' scientific creativity, it also depends on how teachers lead in the classroom. For example, Ramadhani & Sirait (2015) interviewed and found that teachers tended to carry out conventional learning using the lecture, question and answer method with occasional demonstrations in front of the class. The implementation of this conventional learning generally shows that activities teacher-centered learning. The implementation of conventional learning in schools or learning activities is still teacher-centered can cause students to be more passive in the learning process. As a result, students' creativity is curbed so that students' chances of bringing out their creativity are very low (Arwita, 2014).

Many studies found that there were science teachers who were at low level of scientific creativity or had limited conception about scientific creativity, for example, findings from Hong & Kang (2010) showed that there were 44 South Korean and 21 US secondary science teachers had limited conception creativity in science. The low level of scientific creativity among science teachers made it concerning because teachers have important role in supporting and facilitating students' scientific

creativity development (Suyidno et al., 2020). In addition, scientific creativity among teachers is important in science class because it will show how learning design and evaluation of learning outcome in the classroom (Arwita, 2014) and it provides learning environment in increasing probability to emerge creativity (Hadzigeorgiou et al., 2012). Furthermore, Kaçan (2015) emphasized that science teachers must think creatively in examining events from a scientific perspective, which is equally important for a prospective teacher.

The importance of scientific creativity for science teachers makes the awareness of the importance of knowing the level of scientific creativity as early as possible. It is supported by Demir (2015) stated that besides science teachers, it is equally important for a prospective teacher to be able to think creatively in examining events from a scientific perspective. Also, Demir & Şahin (2014) stated that as a future teacher and figure who will produce community leaders, the development of scientific creativity among prospective teachers is considered as important to do, this is because knowing their level of scientific creativity will provide a basis for themselves, and it is also useful to increase their potential. Alsahou & Alsammari (2019) stated that exploring beliefs in scientific creativity is very important as a prospective teacher. The importance of scientific creativity among science teacher candidates is due to upon graduation they will guide their future students. With high scientific creativity, they will easier come up with more practical solutions to any problems encountered, and then it impacts a more successful professional life (Bakaç, 2018).

Based on the explanation above, it can be concluded that the scientific creativity of prospective teachers is important to do first. Because knowing their level obtained can be a benchmark for educational stakeholders to take appropriate steps in increasing the level of scientific creativity among prospective teachers and as a first step to prevent the acquisition of students with low scientific creativity in the future. Therefore, the study of scientific creativity among prospective teachers is needed to carry out.

1.4 The importance of Scientific Attitude

Attitude is set of reactions towards something which based on someone's conceptual beliefs. In science, attitude that involved someone directly and related to investigation or scientific activities is known as scientific attitude. Scientific attitude is also defined as the way of viewing something, curiosity to obtain information about how and why something can happen in factual way (Sumi, 2019). Besides, Sa'adah & Kusasi (2017) stated that scientific attitude is attitude possessed by academic or scientist when facing problems.

Many studies found the importance of scientific attitude and it must be emphasized in learning science. In this case, through scientific attitude, it can produce good nation characteristics to be able to solve problem encountered. In field of education, the students who had good scientific attitude, will remain inherent in everyday life (P. M. Sari et al., 2018). Scientific attitude is important aspect in learning science because it cannot be separated with scientific concept development (Dynamika Putra et al., 2018). Also, scientific attitude can influence students' learning outcomes and the most important outcomes of science teaching (Gokul Raj & Malliga, 2015). Considering scientific attitude in learning-teaching activities of science, supports and enhances students' scientific activity (Osman, 2007).

The teachers have important role in supporting students' scientific attitude, the ability to carry out this role must also be owned by someone who will become a teacher so that later they can foster good learning outcomes in their students. It is supported by Agnafia & Fauziah (2019), who stated that in the efforts to prepare prospective teachers who are competent in the field of science, it is necessary first to investigate scientific attitude that science teacher candidates must have. As prospective teachers they have to prepare in advance a positive attitude which later will become a role model for their students.

The scientific attitude is important attitude that must be possessed by students, teachers, and also prospective teachers in science which is same with scientific creativity. The question is, does scientific attitude influence scientific creativity?

Therefore, this study aims to identify the level of scientific attitude among the prospective chemistry teachers and further study the relationship between level of the prospective chemistry teachers' scientific creativity and scientific attitude.

1.5 The Uniqueness of Chemistry

Scientific knowledge includes of physics, biology, and chemistry (J.-W. Park, 2004). Physics is the study of physical natural events that can be studied by observation, experiment, and theory (Sari, Sunarno, & Sarwanto, 2018). Another scientific knowledge, biology, is the natural science of living things or the scientific study of life that examines various problems related to various phenomena of living things at various levels of the organization of life and levels of interaction with environmental factors Hamidah, Sari, & Budaningsih (2014). Lastly, chemistry is one branch of sciences that is defined as subject matter that studies everything related to substances, including composition, structure and properties, changes, dynamics, and energy of substances (Santosa & Siregar, 2017).

In field of science, scientific creativity is crucial component that students must have. The students can obtain that skill by involving scientific knowledge, namely during learning science, either biology, physics, or chemistry in the class room. That is because scientific knowledge is one of scientific creativity dimensions (J.-W. Park, 2004). For example, in Biology, Ndeke et al. (2015) investigated the influence of gender and knowledge on scientific creativity among three biology students and physics (Astutik & Prahani, 2018). Last, Florence et al. (2015) carried out correlation study of secondary students' academic achievement and their scientific creativity in chemistry. However, among the branches of science, scientific creativity research in chemistry is still lacking. This is supported by systematic review carried out by Sidek et al. (2020), who found that majority of studies were studied among middle/primary school (natural science), and gifted students. Also, based on systematic literature review by Wiyanto et al. (2020), the majority of studies reviewed are physics, biology, and natural science.

The lack of scientific creativity studies in chemistry is concerning because chemistry is different from other branches of science. The difference between chemistry and other branches of sciences is phenomena. In chemistry, phenomena are described to three level of chemical representations, it includes of microscopic, macroscopic, and symbolic. For example, salt can dissolve in water (macroscopic), but a microscopic representation is needed to explain this phenomenon. Furthermore, symbolic are included in models, pictures, formulas, diagrams. Those level are known as triangle levels of chemical representations (Treagust et al., 2003). Thus, chemical representation makes chemistry is different than others.

The difference between chemistry and other scientific knowledge makes chemistry is unique. The uniqueness of chemistry makes the need for the study to focus on chemistry in investigating scientific creativity. As scientific knowledge is more unique than others, it can be clear evidence that the study of scientific creativity is indeed important to do in chemistry, especially among the prospective chemistry teachers as a determinant for the formation of scientific creativity among students in the future. It is also supported by Imaduddin (2018) that chemistry has different characteristics from other scientific knowledges so that the prospective chemistry teacher must master three levels of chemical representation that will be useful to teach chemistry in the future. Therefore, this study focuses on scientific creativity in chemistry, emphasizing chemical representation (microscopic, macroscopic, and symbolic).

1.6 Problem Statement

Many studies found many students still possessed low level of scientific creativity. The low level of students' scientific creativity is affected by many factors, such as teacher who has an important role in school and the authority to cultivate and support scientific creativity. By seeing many problems among teachers about scientific creativity, it needs to know the level of scientific creativity of teachers as soon as possible. Thus, the study of scientific creativity among prospective teachers is important to carry out. The level of scientific creativity of prospective teachers needs

to be identified because it can be a first step to prevent the acquisition of students with low scientific creativity in the future.

Besides scientific creativity, scientific attitude is also important to be emphasized in learning science. Through scientific attitude, it can produce students with good characteristics such as students with outstanding learning outcomes and enhance students' scientific activity performance. However, there is an issue that students' scientific attitude is not yet adequate. In this case, the teacher has an important role in encouraging scientific attitude because they transfer information and gives direction in the classroom. The same with scientific creativity, it is necessary to identify firstly the prospective teachers' scientific attitude level. It is caused by their responsibility to form future students with good scientific attitudes.

Chemistry is unique scientific knowledge because of chemical representation so that makes it different from others. The uniqueness of chemistry makes the need for study of scientific creativity and scientific attitude in chemistry filed. In this case, to become a person with high level scientific creativity and attitudes, chemical representation must be mastered. Thus, this study focused on field of chemistry, specifically, to identify level of scientific creativity and scientific attitudes among prospective chemistry teachers.

Based on problem statements above, a study on the level of scientific creativity and scientific attitudes among the prospective chemistry teachers needs to be done. It is begun from to identify the level of prospective chemistry teachers' scientific creativity and, after that followed by identifying the level of scientific attitude among the prospective chemistry teachers. Further, it also aims to study the relationship between scientific creativity and scientific attitude.

1.7 Research Objectives

The objectives of the research are:

a) To identify level of scientific creativity among the prospective chemistry teachers.

b) To identify level of scientific attitude among the prospective chemistry teachers.

c) To study the relationship between level of the prospective chemistry teachers' scientific creativity and scientific attitude.

1.8 Research Questions

The research questions in this study are:

a) What is level of scientific creativity among the prospective chemistry teachers?

b) What is level of scientific attitude of the prospective chemistry teachers?

c) What is the correlation coefficient of relationship between level of the prospective chemistry teachers' scientific creativity and scientific attitude?

1.9 Hypotheses

Hypotheses in this study are,

H_o = There is no statistically significant relationship between level of scientific creativity and scientific attitude

H_1 = There is a statistically significant relationship between level of scientific creativity and scientific attitude

1.10 The Conceptual Framework of the Study

The theory used in this research is the theory of scientific creativity by J.-W. Park (2004). Scientific creativity consists of 3 dimensions, namely creative thinking, scientific inquiry skills and scientific knowledge. Seeing that there are still students who have low scientific creativity and teachers who do not understand the principles of scientific creativity, a study on level of scientific creativity among the prospective chemistry teacher needs to be done as an effort to prevent the emergence of the same problem that will occur again in the future.

This study uses 3 dimensions of scientific creativity: scientific inquiry skills, creative thinking, and scientific knowledge. In scientific inquiry skills dimension, it includes predicting, interpreting data, and designing experiment. Another dimension is creative thinking, which includes three aspects of creative thinking: flexibility, fluency, and originality. Last dimension is scientific knowledge, in this study, scientific knowledge focuses on chemistry that emphasizes chemical representations (microscopic, macroscopic, and symbolic).

In addition, as important component in science, scientific attitude also is discussed in this study. It begins from identifying the level of scientific attitude and further studying the relationship between scientific creativity and scientific attitude. The elements of scientific attitude used in this study are curiosity, critical attitude, open mindedness, and objectivity.

Therefore, the objectives of this study are to identify level of scientific creativity among the prospective chemistry teachers, identify level of scientific attitude of the prospective chemistry teachers, and study the relationship between relationship between level of prospective chemistry teachers' scientific creativity and level of

scientific creativity scientific attitude. The conceptual framework is showed in Figure 1.1.

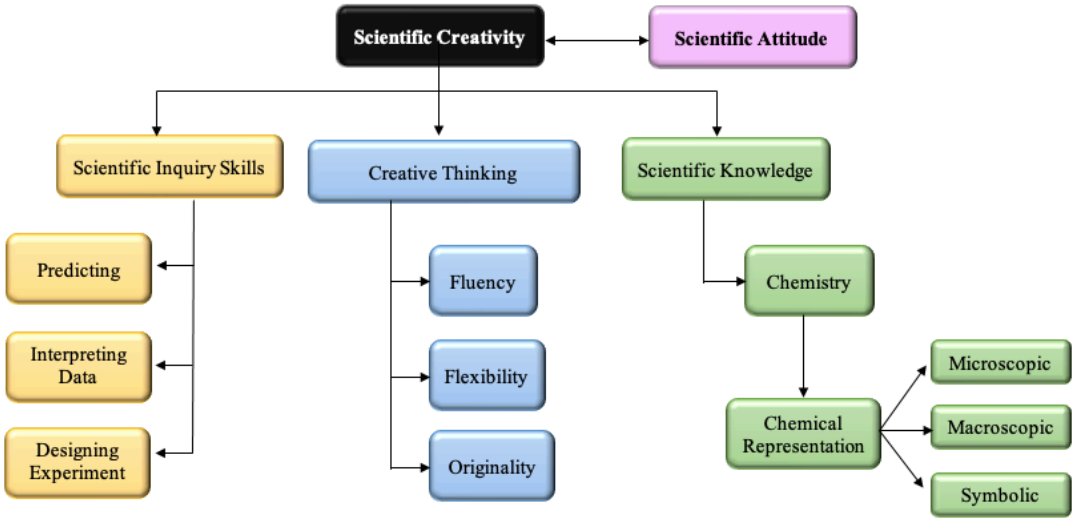

Figure 1.1 Conceptual Framework

1.11 Rationale & Significance of the Study

The demand for learning outcomes in 21st century is to produce creative people in education is students. This is line with the regulation of Ministry of Education and Culture, as mentioned in Undang-undang Republik Indonesia No.20 tahun 2003 pasal 3, the national education works for developing the ability and attitude, as well as a dignified national civilization to educate the nation's life, aiming at developing the potential of students to be creative people. Also, it is mentioned on pasal 40 Tentang Pendidik dan Tenaga Kependidikan that educators have the responsibility to create meaningful, exciting, creative, dynamic, and dialogic learning situations.

In Curriculum 2013 specific to chemistry subject, the demand of learning outcomes is not only the academic achievement but also the students can live life with a positive attitude, one of which is creative based on the potential of chemical processes and products. This is reinforced by the fourth core competency (KI-4) stated in the chemistry syllabus that students must be able, cultivate, reason, and present in

the realm of the concrete and the abstract realm related to the development of what they learn in school independently, acting independently effective and creative, and able to use methods according to scientific principles. In producing lesson plans, teachers must pay attention to the core competencies contained in the syllabus. Based on the regulations that have been described, not only students, but teachers must also be creative.

In chemistry learning, teachers must have scientific creativity that will impact how they carry out learning in class so that it further will affect the students being taught. In this case, teachers, chemistry education students, or prospective chemistry teachers must also know the demands of teachers in the future to become scientific creative teachers.

In addition, beside of scientific creativity, scientific attitude also needs to be concerned because it relates to attitudes in learning chemistry. In Curriculum 2013, scientific attitude is also one of the competencies contained in Indonesian curriculum. Students are required to be active in finding concepts or facts through observation, experimentation and concluding data from the results obtained. Therefore, teachers must master the competencies of Curriculum 2013 in accordance with the material presented to students in order to achieve the goals of education. Educational students in university or known as prospective teachers must also be equipped with learning that can develop the process of activities that have been regulated in Curriculum 2013. Scientific attitude is not only important for teachers and students, but it is also important to know the scientific attitude among prospective teachers. Because they are the ones who will determine how students' scientific attitudes are formed in the future. Therefore, both scientific creativity and scientific attitudes relate to affective term in chemistry curriculum.

1.11.1 Contribution of Educational Research on Scientific Creativity

This study will add information in educational research on scientific creativity and scientific attitude, especially chemistry education. That is due to the lack of this

field discussed. It also becomes the consideration of other researchers to pay attention to the importance of identifying the prospective teachers' skills to prepare them before taking part in the school. For this reason, the information obtained can be helpful to see the field facts about the readiness of the prospective teacher in terms of attitude (scientific creativity and scientific attitude).

1.11.2 Ministry of Education of Indonesia

This study is useful to ministry of education in obtaining information on the level of scientific creativity in higher education (the prospective teacher). The government can consider the result to give more training and certification of developing human resources to improve the quality of learning. In this case, the prospective chemistry teacher who wants to apply for a job in the school must be trained regarding aspects that will be achieved. Hence, before teachers are distributed to the schools, teachers' weaknesses can be detected and resolved first through training and certification so that teachers in schools are competent teachers.

1.11.3 Lecturer of Chemistry Education

For the lecturer of chemistry education in university, the information of the level of scientific creativity of their students can be as evaluation about how formed their students' scientific creativity after lectures and whether the usual method of learning can be formed students' scientific creativity. Certainly, it will help the lecturer to know about their students' quality and readiness before becoming the real chemistry teacher.

1.11.4 The Prospective Chemistry Teacher

This study is significant to the prospective chemistry teacher as self-evaluation about their skills so that they must learn more and effort to improve their scientific creativity and scientific attitude.

1.12 The Scope and Limitation of Study

In this study, the researcher only scopes level of scientific creativity among the prospective chemistry teachers in Pekanbaru, Riau- Indonesia using 3 dimensions of scientific creativity model from J.-W. Park (2004). The scientific knowledge used is only chemistry that focuses on chemical representations (microscopic, macroscopic, and symbolic). The aspects of creative thinking used are only fluency, flexibility, originality, and the scientific inquiry skills used, namely designing experiment, interpreting data, and predicting. Furthermore, to study level of scientific attitude among prospective chemistry teachers, this study scopes only use 4 elements of scientific attitude, including curiosity, critical attitude, objectivity, and open mindedness.

The limitations of this study are it only refers to scientific creativity by J.-W. Park (2004), and only identify the level of scientific creativity without further study of how to improve the level of scientific creativity. In addition, the elements of scientific attitudes are limited to only 4, namely, curiosity, critical attitude, objectivity, and open mindedness.

1.13 Operational Definition

The operational definitions in this study namely:

a) Scientific Creativity

Scientific creativity is intellectual abilities to provide sure products are original and feature the non-public or social, is designed with a specific motive in mind using the knowledge provided (Hu & Adey, 2002). Meanwhile, according to J.-W. Park (2004) scientific creativity is form of thinking style or trait, it emphasizes scientific knowledge, scientific inquiry skills, and creative thinking. Antink-Meyer & Lederman (2015) also defined scientific creativity as an overview of an individual's thinking skill that can produce many original ideas from many fields to solve problems. In this study, scientific creativity is defined as skill that included scientific knowledge, scientific inquiry skills, and creative thinking.

b) Scientific attitude

Scientific attitude is defined as an attitude that must be had by a scientist or academician when faced with scientific problems (Kaleka & Nur, 2018). Moreover, Candrasekaran (2014) defined scientific attitude is a way of thinking logically and clearly without interference, which means that this scientific attitude does not accept any facts that have no relevant evidence. Besides, scientific attitude is an attitude that appears like a young scientist when children participate in science learning activities (Maretasari & Subali, 2012). This study defines scientific attitude as attitude that appears when prospective chemistry teachers (chemistry education students) participate in chemistry learning.

c) Scientific Knowledge

In scientific creativity, scientific knowledge includes chemistry, biology, and physics (J.-W. Park, 2004). This study focuses on chemistry. Chemistry is one of scientific knowledges, and it is defined as branch of science that studied the composition and properties of matter and the changes that occurred (Santosa & Siregar, 2017). To understand chemistry concepts, the students need to master chemical representation (Laliyo et al., 2019). Therefore, scientific knowledge used in this study is chemistry that emphasizes chemical representation namely symbolic, macroscopic, and microscopic.

d) Scientific Inquiry Skill

Scientific inquiry skill can give students a process in learning and following the structure to understand scientific content (Wilson, 2007). Scientific inquiry involves science process skills to develop scientific knowledge (Kremer et al., 2014), and (Peterson & French, 2008)stated that scientific inquiry skill may also be called science process skills. Category of skill in scientific inquiry skills and science process skills is also the same, such as observing, predicting, controlling variables, designing experiment, interpreting data, inferring, and classifying. However, interpreting data, predicting, and planning/designing experiment are much related to other skills. Therefore, scientific inquiry skill is defined as the ability of prospective chemistry teachers to apply the scientific method that includes interpreting data, predicting, and designing experiment.

e) Creative thinking

Creative thinking is a useful ability to create ideas or find solutions to overcome problems in daily life and this skill is also crucial, which will be

brough to real working (Mahmudi, 2010). Anderson & Kratjwohl (2001) stated that creative thinking as divergence thinking is the essence of the thought process. Runco and Acar (2012) stated that divergent thinking is the main contributor in creativity and a manifestation of creative potential. The answer of divergent thinking is coded in three dimensions: fluency, flexibility, and originality (Zhu et al., 2019). In this study, creative thinking is defined as divergent thinking that includes flexibility, fluency, and originality.

1.14 Conclusion

This chapter described the study's aspects, namely problem background, statement of problem, research objective, research questions, the rationale and significance of study, the scope and limitation of study, and operational definition. The chapter outlined what the background problem that level of the prospective chemistry students is important to be studied. Based on the problem, this study will be conducted to identify the level of scientific of creativity of the prospective chemistry teachers. The significance of study also is discussed in this chapter to describe the importance of this study among several parties such as the ministry of education of Indonesia, the lecturer of chemistry education, and themselves (the prospective chemistry teachers). The output of this study can be in terms of contribution in educational research and beneficial for the educational parties, especially in chemistry education.

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