Natural Science Learning with Modified Free Inquiry to Develop Students’ Creative Thinking Skills

Agustina Martha Eristya* and Nurfin Aznam
Yogyakarta State University, Indonesia

E-mail: martha.eristya@gmail.com

Abstract. Various studies showed that the students’ inquiry process in learning has not met the objectives in each stage. On the demands of the 21st century about learning and innovation skills, the one that can increase it is the learning to sharpen the students’ thinking skills. Many previous studies proved that thinking skills give an impact on inquiry process, particularly on creative thinking skills in learning natural sciences. Learning natural science with typical modified free inquiry approach with orientation, formulating problems, formulating a hypothesis, collecting data, testing and drawing conclusions facilitate to develop students’ creative thinking skills. Modified free inquiry are emphasized in exploring, designing, and carrying out experiments independently. The purpose of the research is uncover relationship between modified free inquiry can develop students’ creative thinking skills. The benefit of this research is to get to know that learning natural science with modified free inquiry approach can develop creative thinking skills. The research method that was used a literature review method. The result show that learning with the modified free inquiry approach that can work well will develop students’ creative thinking skills.

Keywords: Inquiry learning; Modified free inquiry; Creative thinking skills.

1. Introduction

Learning is such an effort of students to understand themselves and the surrounding environment in order to be more meaningful to meet life's necessity. Based on the demands of 21st century, one of the skills required is such an innovation skill, creativity and technological skill named Learning and Innovation Skills [1]. The objectives of learning and innovation skills are that students should be able to think creatively, work creatively and create innovative inventions.

According to Regulation of Minister of Education and Culture number 22 of 2016 concerning the standard of the process of primary and secondary education, it states that it is necessary to apply discovery/inquiry learning in order to strengthen the scientific approach. This is in line with [2] who suggested that the subject of natural sciences is related to how to systematically find out about nature, so that the subject of natural sciences is not only about the mastery of knowledge in the form of facts, concepts, or principles but also a process of discovery. Therefore, it is suggested that the learning in curriculum 2013 should use the inquiry learning approach. If the learning is done with a scientific approach, the knowledge can be obtained from the activities of observing, understanding, applying, analyzing, evaluating and creating while the stages of the scientific method include formulating
problems, formulating hypotheses, conducting experiment skills, data analysis skills or interpreting data, making conclusions skills and communication skills. Those stages are similar to the activities of scientists to find out knowledge. According to [3], using inquiry means facilitating student creativity. First, students can design scientific investigations through questions about their curiosity. Second, students can work in groups to design the procedures to answer their own questions. Third, students can communicate their findings with their peers through presentations, posters and or reports. The scientific approach is quite appropriate to the science learning with discovery process but, in fact, it is still not optimally conducted. This is identified that students still face some difficulties in the stage of making variables and hypotheses during experiment and the stage of drawing conclusion.

In learning, students use the guided inquiry-linked print out worksheets that equipped with questions to ensure students' understanding. The learning argument is done using guided approach as the stages of scientific method are still guided persistently by the teacher. In the stage of drawing conclusion, there are auxiliary sentences compiled by the teacher so that the activity of this stage seems like a dictation.

Learning natural science with the guided approach has been accepted by students, but it has not been able to spare students to manage their creativity independently. Based on that fact, one type of inquiry that can help students manage their creativity freely is the modified free inquiry as it is an inquiry approach where the teachers are limited to provide guidance to students in conducting scientific or stages. In fact, when the teachers use that approach, they do not connive in students thoroughly but they still give little guidance not as much as the guided inquiry approach.

Modified free inquiry is an approach where the teacher provides a problem that requires students to solve those problems through observations, exploration or research procedures to get the answers by their own initiative [4]. In this case, the teacher limits the guidance to students to solve the problems independently. The modified free inquiry approach can facilitate learning with student centered learning which characterized by the students' activity. Whereas, in fact, many students are less actively engaged in learning since they will understand the material only from the teacher's explanation and review references using internet may cause a misconception or students cannot catch the meaning of the lesson described.

Based on that background, students' creative thinking skills must be developed. One of the alternatives that can be done is to engage students in learning in order to sharpen their skills in solving problems. In this paper, the author proved that one of the learning models that can support student involvement in learning is modified free inquiry learning. It is expected that students' creative thinking skills can be developed.

The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

2. Research Method
This research used a literature review method. Literature review is an objective research, comprehensive summary and critical analysis of research or non-research that is relevant to a topic being studied [5]. The researcher studied literatures, articles, books, and other sources such as dissertations, conferences and processes relevant to a particular problem, field of research or theory provides descriptions, summaries and synthesizes data. The use of the inquiry approach in learning which indirectly can influence creativity through the stages of inquiry was the keywords in this literature review. The inquiry approach conducted by the author is a modified free inquiry. The researcher synthesizes that learning with a modified free inquiry approach can develop creative thinking skills.

3. Result and Discussion
This section presents the results used and the proposed discussion
3.1 The Learning with Modified Free Inquiry

Inquiry is defined as an investigative activity that aims to describe the relationship between objects and events. [6] Inquiry itself is the process of defining and investigating problems, formulating hypotheses, designing experiments, collecting data, and drawing conclusions. This is in line with [7], the inquiry learning process is emphasized on students’ ability to understand, identify carefully and comprehensively, and drawing conclusion. Inquiry-based Learning is seen in the problem mapping process and the depth of understanding of the problem that results in the presentation of a valid and convincing solution or answer.

Inquiry learning can develop students’ skills such as creative, social, organization and planning skills [6]. The inquiry process includes: the background of the problem, formulating hypotheses, designing an investigative approach, testing ideas, integrating knowledge, and developing certain attitudes. The learning process using inquiry method can be carried out by the following steps: (a) Orientation, the teacher orientation step conditions students to be ready to engage in the learning process such as explaining the topic of the material, the learning objectives, the main activities of learning, and explaining the importance of learning topics and activities. This is done in order to provide student learning motivation. (b) Formulating problems, the step that brings students to a problem. Problems should be formulated by students themselves. The problem studied encourages students to formulate problems that demand answers, so that students are motivated to find out the answers. (c) Formulating a hypothesis is formulating a temporary answer to a problem that is being reviewed and needs to be tested furthermore. (d) Collecting data is an activity to gather the relevant information to test the proposed hypothesis. At this stage, the task and the role of teacher is to prompt the students to think and find out the relevant information. (e) Testing the hypothesis is the process of determining the answers considered acceptable according to the data or information obtained at the data collection stage. At this stage, the students develop their ability to think rationally which means that the truth of the answers given is not only based on argumentation, but also must be supported by data and can be accounted for. (f) Drawing conclusions is the process of describing findings based on the results of testing hypotheses. At this stage, the conclusions drawn are often not focused on answering the formulation of the problem as there are many data obtained in the inquiry process so that the role of teacher is needed to be able to show students which data is relevant [8].

The types of inquiry approaches including guided inquiry, modified free inquiry, and free inquiry. A modified free inquiry approach is the combination of the two types of inquiry. They are guided inquiry and free inquiry. The difference is that students are given the freedom to prove or do and design experiments according to the learning objectives provided by the teacher [9]. The level of modified inquiry is explained in writing [10] the formulation of the problem obtained from the teacher, the problem has been limited by the teacher or students, the guidance was given in the form of guiding questions, the design of the experiment carried out by students by designing and doing, while teacher’s role is only as a students’ guidance. After the experimental design, aspects of the results analysis and drawing conclusions are carried out by the students. The modified free inquiry approach is implemented in learning by encouraging students to be able to identify a problem related to learning material, solve problems by making design activities in groups, conducting experiments and reporting the results of experiments [11]. The modified free inquiry approach is the adoption of open-ended inquiry. This is in accordance with the opinion of [12], the modified free inquiry approach is a modification of free inquiry with open-ended inquiry with modifications located in giving students freedom to solve problems both in the independent work and in group work.

A modified free inquiry approach is a learning process in which requires the students to collect data through questions as an alternative to data collection procedures [13]. Student activities in modified free inquiry learning are emphasized in exploring, designing, and carrying out experiments so that the teacher minimizes giving the guidance to students but the teacher must ensure the learning activities worked by asking leading questions. The other aspect distinguishing between modified free inquiry with another inquiry approach is that the teacher gives a problem and the student is given the opportunity to be able to solve the problem. The teacher plays a role in providing the assistance.
needed to ensure that students conduct investigations independently and without afraid done many failures. The teacher asks leading question to help students to think about possible investigation procedures. Questions are given as a stimulus for students to be able to solve it with the idea of creative inquiry [14].

The modified free inquiry approach implemented in the learning process will influence students' psychomotor abilities because they are accustomed to active activities such as planning, implementing and preparing reports [12]. Based on modified free inquiry activities, students are more creative in developing activities in experimenting stage. According to [9], if the modified free inquiry is conducted by students in secondary schools, they will not have adequate cognitive level. There are five stages in modified free inquiry learning, started with testing the problem by demonstrating or addressing puzzling questions. The data collection and verification stage is students’ activity in collecting information related to the problems that have been submitted and followed by making hypotheses. The experimental stage is students’ activities in making experimental procedures and conducting experiments based on the problem ideas proposed through a series of questions that have been provided by the teacher then write the results of the experiment so that it can answer the problems posed by the teacher at the beginning of learning. The stage of formulating conclusions is students are asked to process and analyze the results of their experimental data. The analysis stage is students’ activities in making and expressing conclusions that can simultaneously answer the teacher's questions at the beginning of the learning [4].

The modified free inquiry approach is a level of inquiry that freed students, but they are still under the activities guidance of a modified free inquiry approach using inquiry syntax modified according to the characteristics of modified free inquiry itself. Stages or the syntax is in accordance with the characteristic of modified free inquiry, the orientation of the teacher, to formulate the problem of teachers, develop hypotheses made by the students, collect data, test hypothesis, and make inferences from students. The role of the teacher in the modified free inquiry approach is just as a facilitator and motivator by asking questions that make students carry out their duties in accordance with what will be achieved in the learning objectives with a modified free inquiry approach.

In the semi-guided inquiry approach or modified free inquiry teacher imitated the activity by giving guidance, so students can try to do the work independently, and are expected to find the solution. However, if there are students who could not solve the problem, then teacher will offer indirect guidance by giving relevant examples with problems, or through group discussion. The following is the syntax learning modified free inquiry in Table 1.

| Phase           | Teacher activities                                                                                                                                                                                                 |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Orientating     | The teacher explained topic and learning objectives. The activity of classroom learning was presented through motivation and presentation problems at the beginning of the learning.                                   |
| Formulating     | The teacher presented problems which will be solved by students.                                                                                                                                                     |
| Problem         |                                                                                                                                                                                                                     |
| Formulating     | The teacher offered students the opportunity to formulate hypothesis through groups and guided them in determining variable individually.                                                                            |
| Hypothesis      |                                                                                                                                                                                                                     |
| Collecting Data | The teacher asked the students to observe provided tools and materials, formulate sketch experiment and determine procedure work experimental in discussion. The teacher asked student for consulting the experiment that have been designed. |
| Testing         | The teacher gave students chances to analyze the results based on tabulation of data created on independent, and they can discuss in answering some questions already listed in student worksheet                                           |
| hypotheses      |                                                                                                                                                                                                                     |
Phase | Teacher activities
---|---
Making conclusion | The teacher asked student for interesting conclusion results.

According to [28], modified free inquiry in the form of a problem that will be used as a topic to be investigated is still given or guided by the existing curriculum reference. That is, in this learning students do not choose or determine the problem to be investigated individually, but students who learn with this approach accept the problems of the teacher to be solved and still receive guidance, but the guidance given is less than guided inquiry learning and unstructured.

3.2 Creative Thinking Skills

Creative thinking is often understood as creativity [15]. Creativity is someone’s ability to create something new, such as ideas or new creations which are different with what are already exist. According to [16], thinking creatively is a consistent and continuous thinking to produce something originally corresponding with necessity. In line with the idea, according to [17], creativity is the ability to think new different ways and to solve unique problems.

Creativity is one of the abilities in high level because it needs broad way to find something challenging [18]. Creative thinking is the ability to give new ideas by finding many possibilities to answer problems, emphasize facet quantity, dependence diversity answer, and solving problem [19].

Creative thinking could be measured through some indicators of ability. They are fluency, flexibility, originality, sensitivity, processing capabilities, and redefinition capabilities [20]. Component creative thinking including fluency, flexibility, and novelty [21] The ability of creative thinking includes fluency, flexibility, elaboration and originality. Fluency is a characteristic of creative thinking by giving many ideas in solving problem. The explanation of flexibility is characterized by creating thinking with bring up new ideas, or looking for alternative solution in completing the same problem. Originality explanation is also characterized by creative thinking which can generate outside normal ideas with the own way in solving problems. Elaboration explanation is characterized by creative thinking which can develop ideas from the existed ideas or detailing problem to be more simple [22].

The components of creative thinking above are fluency, flexibility, elaboration and originality. The components of creative thinking can be called characteristics of creative thinking skill. They are in accordance with [23], creative thinking is a thinking process that has the following characteristics: (1) fluency, the ability to clearly express ideas or opinions; (2) flexibility, the ability to issue ideas or opinions which is not monotonous from various points of view; (3) originality, the ability to issue unique and unusual ideas or opinions; (4) elaboration, the ability to explain the factors that influence and add detail to the ideas or opinions so that it is more valuable.

Creative process, according to [24], includes preparation, incubation, illumination, and verification. Preparation is the stage where a person prepares to solve problems by learning to think, seeking answers, or asking others. Incubation is the stage of searching data and collecting data/information which is not continued. This stage stimulates the process of inspiration. In Wallas theory, ideas or inspirations which are the starting point of new discoveries/new creations come from the pre-conscious realm, or arise in a state of full unconsciousness. At the illumination stage, the stage of the emergence of inspiration or new ideas and psychological processes initiate and follow the emergence of new inspiration or ideas. Verification or evaluation is the stage of a new idea or idea tested against reality that requires critical thinking and creative thinking.

Creativity is divided into six elements, including: (a) The relationship between emotional thinking and metaphorical thinking, the ability of individuals to describe ideas and synthesize those ideas; (b) Flexibility and elaboration; (c) Open to experience and originality; (d) Finding problems and solving problems; (e) Willingness to take risks; (f) Curiosity [25].
Based on the views of various experts that have been mentioned, they have corresponding opinions about the components of creative thinking including fluency, flexibility, elaboration, and originality. Creative thinking skills have four pillars which are often said to be components of a scientific approach, namely: (a) Associating, connecting skills from various disciplines so as to form innovative and creative new ideas; (b) Questioning, questions from students give rise to formulations that can generate new ideas because questions contain creative ideas waiting to be expressed; (c) Observing, the ability to make observations develop innovation and generate many ideas; (d) Experimenting, creative students conduct repeated experiments for something they want to know until they find answers to the questions [16].

The pillar of creative thinking as a component of the scientific approach can be applied in student learning in schools with the method of inquiry. Learning by referring to the creative process starts from finding problems, solving them until communicating the results so that appropriate learning approaches to teach creative thinking skills include inquiry, problem solving, discovery, metaforming and scientific [16].

3.3 The Relationship between Modified Free Inquiry Learning with Creative Thinking Skills.

Learning in school by conducting investigations and those suggested by the government are learning with an Inquiry Approach. The inquiry Approach can activate students with steps of inquiry in the characteristics of inquiry learning. The Modified Free Inquiry Approach is one of the levels of inquiry by giving students freedom with the teacher’s guidance. The step of the modified free inquiry approach is similar by the steps of inquiry in general. They are orientation, formulating problems, formulating hypotheses, collecting data, testing hypotheses and drawing conclusions. The freedom given to students is marked by the minimizing guidance of teachers. This makes abler to discuss in groups independently.

Group learning with a guided inquiry approach has been carried out on learning in school. However, the modified free inquiry approach has not been developed in schools. Modified Free Inquiry Approaches have not been developed in schools to train high-level thinking skills to answer the challenges of the 21st century about learning and innovation skills. The expected skills are high-order thinking skills such as creative thinking skills. In line with [29] stated that students are able to gain knowledge, develop thinking and reasoning skills, enhance metacognitive skills, and build positive attitudes through inquiry activities. Inquiry learning activities are conducted by exposing students to an experimental activity. Students are trained to be skilled in obtaining and processing information through thinking activities by following scientific procedures, such as, skillfully performing observations, measurements, classifications, conclusions and communicating the findings. Then the student can develop the thinking ability to think creatively [30]. Inquiry is a process of investigation to find solutions to a problem with an orientation step, formulate a problem, formulate a hypothesis, collect data, test hypotheses, and formulate conclusions.

Modified free inquiry is a form of inquiry with problems presented by teachers with students given the freedom to design activities to overcome problems. The emphasis on the modified free inquiry approach is that students formulate hypotheses based on the problem formulation given by the teacher, independently design trial procedures based on the tools and materials that have been provided, make data tabulations according to the experiment, and draw conclusions from the experiments that have been done. The teacher has the role of providing limited guidance so that students can carry out independent investigations so as to train students’ creativity. Noted that the pillars of creative thinking skills include associating, questioning, observing, and experimenting which underlie the components of creative thinking skills can be carried out in learning with an inquiry approach. Students do connect theories with existing problems, generate new ideas to problem solving, make observations until develop many ideas, and conduct experiments to find solutions of problems.

In modified free inquiry learning has syntax in learning according to the characteristics of inquiry, namely orientation, formulating problems, formulating hypotheses, collecting data, testing hypotheses,
and making conclusions. Orientation syntax includes the teacher doing the introduction in learning. The syntax of formulating the problem is done by the teacher by presenting the problem formulation that will be solved by students. The syntax of formulating hypotheses is that students are given the opportunity to formulate hypotheses through discussion in groups. Syntax collects data, namely students determine work procedures by looking at the materials and tools that the teacher has provided, then the draft results are consulted with the teacher. Syntax examines the hypothesis that students test and tabulate data and hold discussions in groups. The syntax concludes that students conclude the experiment independently.

In essence, natural science is a building of science as a scientific product, scientific investigation process, scientific attitude, and its application in technology and society. In the learning process, the teacher is not only as a communicator of knowledge and facilitator of knowledge but has the goal of paying attention to values that can be integrated in learning. Learning with the modified free inquiry approach is expected to make the learning process paradigm into student centered learning well implemented. Modified free inquiry learning to provide students with creative stimuli in overcoming a problem.

Creative thinking skills means that creative thinking skills are the ability to think in new ways and generate unique ideas/ideas to solve problems. The components of creative thinking skills are fluency, flexibility, originality, and elaboration. Components of creative thinking skills can be used as indicators which have been fulfilled creative thinking skills in learning activities. Indicators of creative thinking skills are as follows: fluency is giving a lot of ideas in solving the problem that is being observed, flexibility is to bring new unique ideas to solve problems by connecting various disciplines, originality is to bring original and innovative ideas can be in the form of questions that arise related with problems, and elaboration is explaining the factors that influence the ideas presented based on the findings in the experiment. Indicators of creative thinking skills can be achieved in learning with a modified free inquiry approach. Students’ creativity skills in designing independently by activating students in the learning process through group learning and Inquiry-based Learning. According to [26], student activities to design an inquiry produce creative thinking skills. Students are given the opportunity to consider, elaborate and detail ideas into the steps of the investigation, communicate the results of their investigations, apply the knowledge. Indicators of creative thinking skills to overcome the problems presented. The newer ideas raised by students in the matter will improve students’ creative understanding. In addition, practicum with local materials enables students to think creatively in terms of searching materials from their surroundings and also looking for appropriate procedures [27].

4. Conclusion
Creative thinking skills are needed to answer the demands of the 21st century that are taught in the learning process of activating students. Learning modified free inquiry into learning natural sciences, hoping students will have active learning activities and prioritize the independence of students with restrictions on guidance by the teacher so that students are trained in creativity. The result show that learning with the modified free inquiry approach that can work well will develop creative thinking skills.

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