

# The Impact of Online Learning in Atomic Theory on Students' Creative Thinking Skills

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**Abstract**—This study aims to analyse the improvement of students' creative thinking skills along the online learning in atomic theory topics. The study used a quasi-experimental method with a one-group pretest-posttest design. The participants of this study are students of SMK N 1 Waringinkurung. The analysed data is students' learning outcomes data. From these data, we can see creative thinking skills in terms of indicators. Indicators of creative thinking skills include fluent thinking, flexible thinking, original thinking, and detailed thinking. The results show that N-gain analysis results obtain the medium category with a percentage of 68%. The study concludes that online learning in atomic theory materials is effective in increasing creative thinking skills.

**Keywords**—the impact of online learning, atomic theory, creative thinking skills

## I. INTRODUCTION

Chemistry is believed has difficult characteristics for students to understand. Understanding chemistry is very necessary to build creativity as well as creative thinking skills. If the chemistry learning is arranged on using contemporary model/approach, it will be led to enhancing HOTS, such as creative thinking skills. Based on the preliminary study, students still have a low level of creative thinking. By the observations, students more often giving answers to teacher questions only based on the answers in the book, and not understanding the meaning of the answers given. Moreover, if students are given questions that are still related to this understanding, students find it difficult to answer. This is because of students tend to only memorize the answers. Creative thinking skills are a fundamental ability for science that is very important to be developed in students [1,2]. It is a form of expressing oneself through unique ways and obtaining diverse ideas [3].

Science teachers must think how to improve the learning to enhance creative thinking skills. Along the learning process, the teacher needs to encourage students to use their own knowledge to think creatively and to do creative actions. Sulistiyono et al [4] stated that in education, improving

learning process is the most effective means to improve creative thinking skills of students.

One effort to improve students' creative thinking skills is through adjusting the learning process with the characteristics and needs of students. One of the abstract concepts and cannot be observed directly by students, is atomic concept. Learning atomic concept requires some analogous examples so that students can more easily understand and can provide a more interesting explanation. In today's technological developments, and in line with the changing conditions of the covid-19 pandemic, online learning is the main choice for science teachers. Online learning should be arranged precisely to make sure that creative thinking skills still develop along learning. It should also be our concern that learning through online for too long time will cause boredom to student. Therefore, science teachers need to find the right approach or models to overcome at least 3 things, student boredom, the development of student creativity, as well as joyful learning. Using information technology (internet-based learning) to search the scientific information for inquiry is one learning process that fully recommended.

The use of these technologies can be used as an alternative learning process that is considered capable of improving students' creative thinking skills, namely implementing online learning. Lanqin [5] stated that online learning is learning that can be used as an alternative teaching and learning activities. Chia and Hui [6] and Ucu et al [7] suggested that an internet-based learning process can be used to improve learning independence and develop students' creative thinking skills. The results of Aliq's research et al [8] presented that to increase students' motivation in independent learning and followed by strengthening creativity in students, it can be done by implementing an internet-based learning process. In line with the results of research by Yvonne et al [9], Carita et al [10], and Wen et al [11], online-based learning can compensate for the rapid development of technology. The internet will be effective and can contribute to learning that will make students' insights more developed which reflects students' performance towards the development of creative thinking skills.

Based on the background described, this study will discuss issues regarding how online learning with scientific searching on using IT can improve students' creative thinking skills. From the background and the research question, this study aims to describe the improvement of students' creative thinking skills in online learning. Students' creative thinking skills studied include fluent thinking, flexible thinking, original thinking, and detailed thinking.

**II. METHODS**

This research uses a quasi-experimental method referring to Sugiyono [12]. The research objectives were students of SMK N 1 Waringinkurung. The design used in this study is one group pretest-posttest design. The description of the design is as follows:

TABLE I. ONE GROUP PRE-TEST POST-TEST

Pretest	Treatment	Posttest
A <sub>1</sub>	X	A <sub>2</sub>

The research variables include independent variables, namely online learning, and dependent variables, namely students' creative thinking skills. The instrument used was a test of creative thinking skills through question sheets that referred to atomic theory material. Questions are made in the form of descriptions, questions are arranged in such a way based on indicators of creative thinking skills so that answers to these questions can show students' creative thinking skills viewed from aspects of fluent thinking, flexible thinking, original thinking (originality), and detailed thinking (elaboration).

The questions given to the fluence aspect should encourage students to be able to think more than one answer, the flexibility aspects of the questions given should be able to produce a variety of answers so students will see several different points of view, the originality aspect must be able to encourage students to express new and unique ideas, and in the elaboration aspect, the question is directed at the development of an idea. Before the instrument used, it is done content validation by experts, they are two competent lecturers and two chemistry teachers who have 5-year teaching experience.

The analysed data is students' learning outcomes data. From these data, we can see creative thinking skills in terms of indicators. To know and determine the improvement in students' creative thinking skills, the N-gain test was performed, then analysed in a descriptive quantitative manner and categorized based on the N-gain criteria. It can use the N-gain index in table 2.

TABLE II. N-GAIN INDEX CRITERIA

Response Percentage (%)	N-Gain Criteria
(g) ≥ 70	high
70 > (g) ≥ 30	medium
(g) < 30	low

**III. RESULTS AND DISCUSSION**

The learning process was conducted online with inquiry-based learning. In the first step, students were exposed to a story how the universe is shaped. Is is led to the analogy how atom is arranged of the smaller particles such as electron, nuclear, proton and neutron, and how the electron moves around the nuclear of atom. In the next step, student ask for internet searching to find the articles or pictures or diagrams about atom (offline learning). They and then synthesize their founding and communicate in discussion session in online learning. After reflection, student doing the task to make a model of atom in working group. The steps of learning, i.e., analysing and synthesizing the articles, as well as doing the creation product is the way to enhance creativity.

By the research, the test on creative thinking skills were measured before and after class. Based on the results and data collected, it is obtained data on the success of students' creative thinking skills in the online learning process. The success of these students is presented in table 3.

TABLE III. PRETEST AND POSTTEST RESULTS PER INDICATOR OF STUDENTS' CREATIVE THINKING SKILLS

Indicators of creative thinking	N-gain (%)	Criteria
Fluence	71	High
Flexibility	70	High
Originality	70	High
Elaboration	67	Medium

Based on the data in table 3, it is shown that the indicator of fluency, flexibility, and originality are in the high category, while the elaboration indicator is in the medium category. This proves that the learning process that has taken place can give effect to each indicator of students' creative thinking skills. Furthermore, the data analysis of the results of the pretest and posttest is presented in table 4.

TABLE IV. PRETEST AND POSTTEST RESULTS PER INDICATOR OF STUDENTS' CREATIVE THINKING SKILLS

Data	Pretest	Posttest
Number of students	22	22
The lowest score	40	75
The highest score	60	90
The average score	47	81
% N-gain	68 (Medium)	

Based on table 4, shows that the results of the analysis of the pretest and posttest scores on students' creative thinking skills prove to be an increase after learning. A comparison of the level of students' creative thinking skills is presented in the graph in Figure 1.

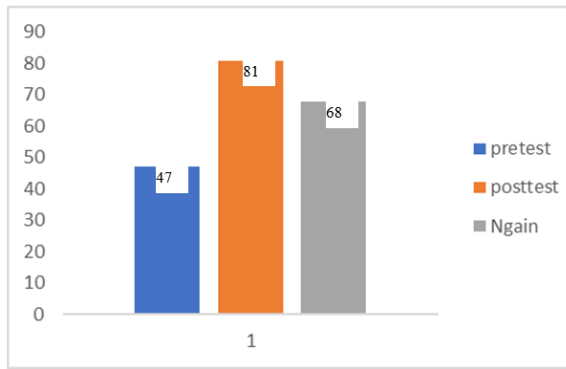


Fig. 1. Comparison of pretest-posttest on the level of creative thinking skills.

The analysis of these data proves students' skills to think creatively after the learning process has increased. It is shown that students have been able to provide answers following the indicators of creative thinking skills. In the indicator of fluent thinking (fluence) students have been able to provide answers by writing various ways and suggestions to be able to solve problems. Besides, students can think fluently and quickly to express an idea. Amtiningsih et al [13] argued that assessment conducted on the aspect of fluency is not only based on the assessment of results alone but the assessment of students' processes on solving a problem given by the teacher. In the indicator of flexible thinking (flexibility), students can see a problem from various points of view, able to find various ways to solve problems so students can write varied answers. In the indicator of original thinking (originality), students can show unusual ways of thinking from the elements, so students can create a unique idea, which is not normally expressed. This process is an attempt by students to get creative solutions [14].

In the indicator of detailed thinking (elaboration), students can develop an idea, so that the idea can be interesting and more detailed. Providing feedback on the answers given by students in answering questions can help to stimulate and develop thinking skills, especially in creative thinking. Students have slowly demonstrated and are accustomed to always thinking creatively. Thus, it is hoped that creative thinking skills in students are always developed by the teacher through the method in the learning process. Giving questions that can stimulate students' thinking in creative thinking can make students get used to solving the problems given creatively. Samuel and Alaba [15] and Cheng and Ryan [16] state that to help students think creatively, teachers must develop more creative methods in the learning process. Therefore, to improve students' creative thinking skills can be done through online learning or assisted by internet media.

The internet-based learning process can have a positive effect on students' creative thinking. Students are motivated in learning and the learning outcomes can increase. Irwandani [17] states that utilizing the sophistication of technology in the learning process can help students to develop thinking skills creatively and expand knowledge. Amidi [18] argues that learning with methods supported using interactive internet

media can make students more active in learning and can solve a problem through the creative thinking skills of students, and students will be more responsible for their success. Furthermore, Sofiatun and Suryanti [19] and Gwo and Fan [20] said that technology is the main factor influencing students' intention to learn because, through technology and students who can think creatively, it can increase students' learning intentions so that they can help to solve problems.

#### IV. CONCLUSIONS

The findings of this study conclude that online learning with inquiry-based learning can improve creative thinking skills. It is proven through data analysis on creative thinking skills that get N-gain scores in the medium category with a percentage of 68%. An increase in the creative thinking skills of students is characterized by students being able to develop answers based on creative thinking indicators, which include fluency, flexibility, originality, and elaboration.

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