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The Profile of Creative Thinking and Scientific Communication Ability of Junior High School on Environmentally Friendly Technology Material

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Abstract: Students' creative thinking and scientific communication skills are needed by students so they can compete healthily and be able to solve various increasingly complex problems in the 21st century. This research aims to determine the profile of student's creative thinking and scientific communication abilities in learning environmentally friendly technology. The method used in this research is quantitative descriptive. The research sample consisted of 35 students, 16 men and 19 women. The instrument used is an essay test on environmentally friendly technology material. For creative thinking skills, indicators for fluent thinking, flexible thinking, original thinking, and the ability to elaborate are used, while for scientific communication indicators for representing knowledge are used. From the results of data analysis, it show that only 1 student (3%) has creative thinking abilities in the high category, 21 students (60%) in the medium category, and 13 students (37%) in the very low category. Students' scientific communication skills for indicators represent 4 students in the very high category (11.4%), 2 students in the high category (5.7%), 10 students in the medium category (28.6%), and 2 students in the low category. (5.7%), and 17 students (48.6%) in the very low category. So students' overall creative thinking and scientific communication abilities must be improved.

Keywords: Creative thinking; Scientific communication; Middle School Students; Environmentally Friendly Technology.

Introduction

Science subjects are subjects that have been introduced to students from elementary school (SD) to junior high school (SMP). Science learning in junior high school is not a scientific discipline but is developed as an integrative science subject. Integrative science means combining various aspects, namely the domains of attitudes, knowledge, and skills. As integrated science, application-oriented education develops thinking abilities, learning abilities, curiosity, and developing caring and responsible attitudes toward the social and natural environment. Substantially, science can be used as a tool to develop domains of attitudes, knowledge, and skills (Prasetyowati, 2014).

Science is a systematic collection of theories, and its applications are generally limited to natural phenomena. The birth and development of scientific models such as observation and experiment require scientific attitudes such as curiosity, openness, and honesty (Trianto, 2014). Based on the attachment to Permendiknas number 22 of 2006, science subjects are related to how to find out about nature systematically, so that science is not only mastery of a collection of knowledge in the form of facts, concepts, or principles but is also a process of discovery (*inquiry*) (Iswatun *et al.*, 2017). The objectives of SMP Integrated Science learning according to Depdiknas (2006) are: increasing the efficiency and effectiveness of learning, increasing interest and motivation, and achieving several basic

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competencies at once. To achieve this goal, science teachers who have interdisciplinary science abilities demonstrated in science (knowledge), science teachers who can foster students' interest and motivation to learn so that students do not feel bored in the learning process, and science teachers who can encourage students to develop their potential optimally.

In the 2013 curriculum, learning is designed with a scientific approach, namely through the process of observing, asking, reasoning, trying, and communicating, here students are required to be able to develop their scientific abilities. Thus, it can be concluded that the 2013 curriculum aims to form and improve human resources as capital for the development of the Indonesian nation and state as well as increasing healthy competition between educational units regarding the quality of education to be achieved. The characteristics of the 2013 curriculum place greater emphasis on developing students' attitudes, knowledge, and abilities and applying them in various situations in schools and society, so as to create human resources that can face the problems that befall this nation.

Challenges in the world of education have been identified in The Partnership for the 21st Century. The Partnership for the 21st Century identifies four Learning and Innovation skills which are the four most basic things that must be possessed in the 21st century, namely: creativity, critical thinking, communication, and collaboration (Bishop, 2017). 21st-century skills are often called 4Cs, in Indonesian they can be remembered by the abbreviation 4K, namely Creativity, Criticality, Communication, and Cooperation. This is in line with the statement from (Yuliati & Saputra, 2019) which states that in the 21st century, humans are required to have abilities in various fields including the ability to think critically, the ability to think creatively, the ability to communicate and collaborate, as well as the ability to master information and communication technology. In today's developments, human resources who have the ability to think, which includes logical, critical, and creative reasoning abilities, able to communicate ideas, especially in solving problems (Kemendikbud, 2013).

According to Harriman (2017), creative thinking is thinking that tries to create new ideas. Creative thinking is a series of processes, including understanding the problem, making guesses and hypotheses about the problem, searching for answers, proposing evidence, and finally reporting the results. Creative thinking refers to a student's ability to generate and develop ideas for problems and alternative solutions. The ability to think creatively is an individual's ability to look for new ways, strategies, and ideas about how to obtain a solution to a problem (Moma, 2017). According to Suryaning Ati *et al.* (2021), creative thinking skills are used to help the problem-solving process. The ability to think creatively can stimulate students to develop advanced thinking abilities. The ability to think creatively is very important for students to master, because by thinking creatively a person is able to see things from a different point of view to find new ideas and possibilities and is able to link various knowledge and be able to solve various problems that arise, especially in the increasingly modern 21st century complex. Wang (2011) said that the potential for creative thinking exists in everyone and can be improved through learning so that in the world of education creative thinking is considered an element that can be synergized with achieving teaching and learning goals. Students' characteristics and attitudes can be shaped by generating imagination and creative power as a basis for discovering new, innovative and critical things.

Creativity is one of the results of creative thinking. Creative thinking is a mental activity that is used to build a new idea (Siswono, 2008). The characteristics of creativity are grouped into two categories, cognitive including originality, flexibility, fluency and elaboration, while non-cognitive including motivation, attitude, and creative personality. It is very important for teachers to pay attention to student creativity in the learning process. A creative attitude can be demonstrated by the ability to solve problems with confidence and students' great curiosity (Annisa *et al*., 2019).

In the current era, it cannot be denied that the prosperity and glory of society depend on creative contributions, in the form of new ideas, new discoveries, and new technology. To achieve this, creativity must be fostered from an early age (Hasanah *et al*., 2021). So that students can have good creative thinking skills, a learning environment is needed that can develop students' abilities in solving problems. The ability to think creatively is a learning goal that students must have (Handayani & Koeswanti, 2021).

In reality, students' mastery of creative thinking skills in Indonesia is still low. This is proven by the results of the Global Creativity Index (CGI) survey by the Martin Posperity Institute in 2015 of 139 countries in the world which showed that Indonesia's creativity was ranked 81st with a global creativity index of 0.037. Indonesia is lagging behind Sweden which occupies first place with a global creativity index of 0.92. Indonesia's low creativity in the international arena is due to the learning carried out by teachers in schools so far not measuring creative thinking abilities (Utami, 2019). This is in line with the results of Fardah's research of Nasution (2017) which shows that the creative thinking of students from the total number of students in the high

category group is 20%, the medium category group is 33.33%, and the low category group is 46.67%.

Sutijah (2021) also found data on the first cycle of learning in his classroom action research, the score of students' creative thinking ability of the 32 students present, there were 2 students who were able to think creatively in the high category, 9 students who were able to think creatively in the medium category, and the rest still have low creative thinking abilities (21 people). This is also in line with the results of a survey conducted by Ramadhan *et al*. (2019) in Bantul Regency which found that from a sample of 954 students, a creative thinking ability score of 41.07 was obtained. This shows that students' creative thinking abilities are low. The low ability to think creatively is also shown in the research results of Handayani *et al*. (2018) which states that students still have difficulty solving PISA questions. Students are not yet able to provide unique (creative) answers and are less accustomed to working on non-routine questions in the learning process. Sari (2015), stated that the ranking of Indonesian students on the international scale from year to year is always at the bottom. It can be seen that the value of TIMSS in Indonesia is very worrying. Our country's TIMSS score is below 500, which is categorized as a low standard of student ability. The low PISA and TIMSS scores are because Indonesian students in general have not been able to solve questions with characteristics such as the TIMSS and PISA questions which are contextual in substance and require achievement, creativity, and argumentation in their solution. (Wardhani, 2011).

Apart from creative thinking, communication skills are also important things that students must master in the 21st century. Communication is a process when a person or several people, groups, organizations, and communities create and use information to connect with the environment and other people (Brent & Stewart, 2006). In the Big Indonesian Dictionary, the definition of communication is the sending and receiving of messages or news from two or more people so that the message in question can be understood. Learning activities are a very strategic means to train and improve students' communication skills, both communication between students and teachers, as well as communication between students. When students respond to the teacher's explanation, ask questions, answer questions, or express opinions, this is communication.

Communication is one of the human activities that is often carried out, communication is capital and the key to success in relationships and careers, because only with communication can good relationships be built and nurtured. Communication skills are one of the competencies needed to convey ideas and thoughts in various life contexts. The task and role of teachers is no longer as a provider of information (transfer of knowledge), but as a driver of student learning (stimulation of learning) so that they can construct their own knowledge through various activities including communication aspects (Umar, 2012). In educational circles, the term scientific communication is also known. Scientific communication can be defined as the ability to speak, read and write scientifically (Norris & Phillips, 2003). Scientific communication skills are students' ability to communicate scientific knowledge resulting from their findings and studies to various target groups for various purposes (Aziza, 2019). The 21st century generation must be able to communicate well, using various communication methods and strategies. Communication networks can utilize various methods, methods, and strategies based on ICT (Information and Communication Technology). Low communication skills can affect the ability to process information, difficulty integrating thoughts and speech, and difficulty adapting to the environment.

Students' scientific communication skills in general still need to be improved. This is proven by a number of studies, including research conducted by and Haryanti & Suwarma (2018) at a State Middle School in Bandung City, which found that only 43.75% of students' oral communication skills met the specified standards. The lack of communication skills of students in Indonesia is also demonstrated by the findings of research conducted on 70 class VIII students at a private junior high school in the city of Bandung conducted by Taryono (2016). Thus, in initial research conducted by Angger *et al*. (2016), who conducted research on the scientific communication abilities of Class X senior high school in Sukoharjo, it was found that the average scientific communication ability of students was 18.59% and it could be concluded that the scientific communication ability of students was still low. Wrench et al. (2009) explain that around 20% of students in schools may suffer from communication apprehension. Students' verbal communication tends to be low and only appears when students are forced.

Based on the above, it can be seen that students' creative thinking and communication skills are still low. This is in line with a study conducted by Trilling & Fadel (2009) which shows that secondary school, diploma, and higher education graduates are still less competent in: oral and written communication, critical thinking and solving problems, work ethics and professionalism, working as a team and collaborating, working in different groups, using technology, and project management and leadership. Compared to 20 or 30 years ago, Indonesian graduates now need more skills to be successful in facing the tough competition of the 21st century.

The meaningfulness of learning will be increasingly felt when the learning content is related to the context in students' lives so that they can understand and remember it longer. Environmentally friendly technology materials are materials that are related to everyday life. Environmentally friendly technology material are actually not new material for junior high school students, even in elementary school (SD) this material is already related to theme 2 material in gra elementary school about saving energy. Learning al environmentally friendly technology material is given to middle school students in class IX semester 2. In this research, the author conducted a preliminary study to look at the profile of creative thinking abilities and scientific communication abilities of students at SMPN 3 Soreang on environmentally friendly technology material as a basis for subsequent research.

Method

This test is a preliminary study to determine students' creative thinking and scientific communication abilities. The research subjects were class IX J at a State Middle School in Bandung Regency with 35 students consisting of 16 boys and 19 girls. Class IX J was chosen as the subject because the students are more diverse compared to other classes. The research was carried out in the even semester of the 2022/2023 academic year.

Creative thinking ability was measured using the creative thinking ability test developed by Torrance (1977). The indicators used in this research are fluent thinking; thinking flexibly; thinking original; and the ability to elaborate. The measurement of students' scientific communication refers to indicators of scientific communication abilities from Levy *et al*. (2009). The indicators used in this research are indicators that represent knowledge. The instrument used is essay questions for Environmentally Friendly Technology material.

The data collection procedure was carried out by giving an essay test totaling 5 questions for the ability to think creatively about environmentally friendly technology material with a processing time of 50 minutes, and for scientific communication it was carried out by giving an essay test totaling 4 questions about environmentally friendly technology material with a processing time of 40 minutes. minute. Data analysis uses quantitative descriptive analysis to determine the profile of students' creative thinking abilities and students' scientific communication abilities. Each question is assessed based on its own criteria. Assessments for students' creative thinking and scientific communication tests can be seen as follows:

$$final\ score = \frac{\text{total score obtained}}{\text{maximum total score}}\ x\ 100 \quad (1)$$

The final grades are categorized based on the level of students' creative thinking and communication skills which consist of very high, high, medium, low, and very low.

Table 1. Criteria for assessing students' creative thinking and scientific communication abilities

Interval	Category
86 – 100	Very high
76 – 85	High
60 – 75	Medium
55 – 59	Low
≤ 54	Very low

(Purwanto, 2008)

In this research, there is qualitative and quantitative data. Qualitative data was obtained from the results of teacher answers related to interviews with teachers regarding the learning that had been carried out, while quantitative data was obtained from essay tests given to measure students' creative thinking and scientific communication abilities. The tests used in this research have been judged by expert lecturers.

The research procedures to be carried out are divided into several stages, namely the preparation stage, the research implementation stage, and the final research stage. Each stage of this research will be explained as follows:

Preparation Phase

The preparation stage for this research includes preliminary studies, determining sample classes, conducting literature studies, analyzing content standards for basic competencies in junior high school science subjects, analyzing material, compiling research instruments, and analyzing instruments. The following is an explanation of each stage:

First, do a preliminary study. Preliminary studies in the research included interviews and direct observations at schools. Interviews were conducted with science teachers to find out how the science learning process was going what the teacher's teaching experience was, what problems occurred during class learning, as well as identifying and formulating the problems that occurred.

Second, determine the class as the sample in the research. In this study, class IX J was used as the sample class. *Third*, conduct a literature review on creative thinking abilities and scientific communication abilities. The literature review aims to obtain information related to creative thinking skills and scientific communication.

The literature review in this research comes from journals that contain the results of educational research.

Fourth, analyze the content standards for basic competencies in junior high school science subjects to get an overview of the basic competencies that must be achieved in science learning with Environmentally Friendly Technology material. *Fifth*, analyze junior high school science lesson material on Environmentally Friendly Technology material. Material analysis was carried out to determine concepts related to Environmentally Friendly Technology material. This material analysis also aims to determine student activities carried out to support the development of their concepts.

Sixth, arranging the instruments. The instruments used in the research will be prepared and compiled by the researcher. The instruments that will be used are creative thinking skills instruments, scientific communication skills instruments, and teacher interviews related to the implementation of previous learning carried out by the teacher. After preparing the instruments, a judgment is then carried out by experts to validate the contents of the instruments used in the research with the aim of ensuring that the instruments used are valid and can be used in research. *Seventh*, carry out instrument analysis to measure the reliability and validity of the instrument using the SPSS application, and validate it with expert lecturers.

Research Implementation Stage

The research implementation stage is the stage for carrying out data collection from class IX J students to see the profile of student's creative thinking and scientific communication abilities.

Final Stage of Research

In this final stage, data processing is carried out on the results of descriptive tests related to students' creative thinking abilities and scientific communication abilities, as well as the results of interviews with teachers related to learning that have been carried out at previous schools, analyzing and discussing research results, and drawing conclusions.

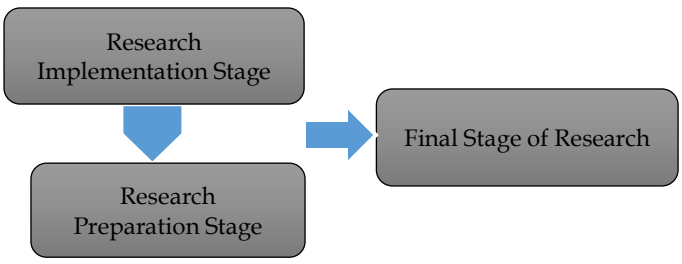

Figure 1. Research Procedure

Data collection techniques in this research were used to collect research data in the form of interviews and written tests. The following will explain in detail the data collection techniques used in this research:

Interview

Interviews were conducted with science teachers to find out how the science learning process was going and what the teacher's teaching experience was, what problems occurred during class learning, as well as identifying and formulating the problems that occurred. The interview guidelines provided can be seen in table 2.

Table 2. Aspects of Questions in Interviews

The aspect in question
Variations in learning models carried out so far
Measuring Creative Thinking Ability
Measuring Scientific Communication Skills
Practicing Creative Thinking Skills
Practicing Scientific Communication Skills

Test

The test used in this research is an essay test given to students to measure students' creative thinking abilities and scientific communication abilities. The indicators of creative thinking and scientific communication abilities used are as follows:

Table 3. Indicators of Students' Creative Thinking Skills

Indicator	Definition
Fluency	The ability to generate lots of ideas
Flexibility	The ability to generate a variety of ideas or use a variety of methods
Originality	The ability to produce ideas that are truly new, different, and have not existed before.
Elaboration	Ability to detail ideas you have.

The indicator used in student scientific communication is representation.

Table 4. Indicators of Student Scientific Communication

Indicator	Defenition
Representing information	Representing information in the form of tables, schemes, and graphs.

Results and Disscusion

Based on the results of interviews with teachers, the following information was obtained. Based on the table 5, information is obtained that so far teachers have implemented varied learning models, and so far teachers have also trained students' creative thinking and scientific communication skills, only they do not

specifically measure students' creative thinking and scientific communication abilities, only a small part (20%) who have measured students' creative thinking and scientific communication abilities. Based on the results of written tests conducted to measure students' creative thinking abilities, the following information was obtained:

Table 5. Teacher Interview Results

Question	Frequency Yes	Frequency No	% Yes	% No
Have you been implementing varied learning models?	5	0	100	0
Have you ever measured students' creative thinking abilities?	1	4	20	80
Have you ever measured students' scientific communicatio n skills?	1	4	20	80
Have you trained your students' creative thinking skills?	5	0	100	0
Have you trained your students' scientific communicatio n skills?	5	0	100	0

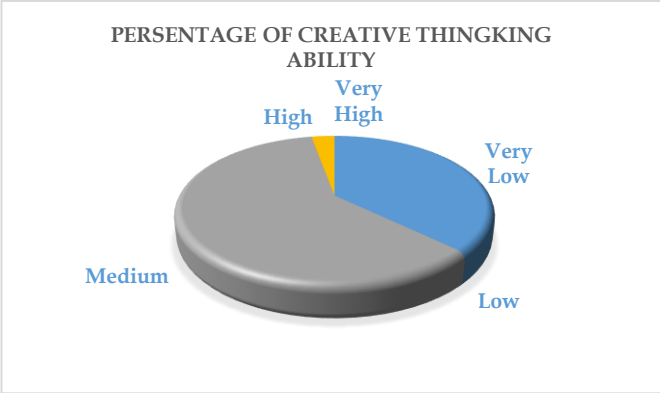

Figure 2. Percentage of Creative Thinking Ability

It is known that the creative thinking ability of students in the high category is only 1 student (3%), in the medium category 21 students (60%), and in the very low category 13 students (37%). So, students' creative thinking abilities still need to be improved. For students' scientific communication skills, you can see the following figure 3.

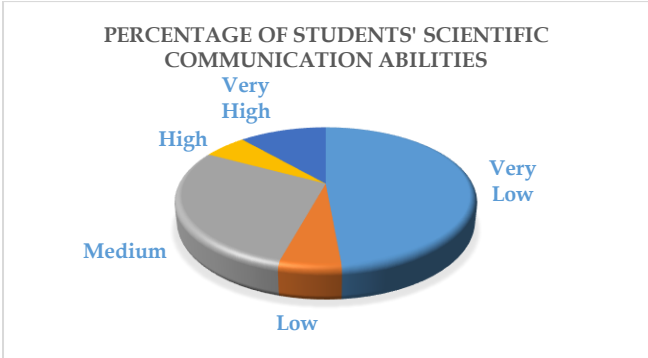

Figure 3. Percentage of Students' Scientific Communication Ability for Representing Indicators.

Based on the figure 3, it is known that the indicators of students' scientific communication skills represent the very high category of 4 students (11.4%), the high category of 2 people (5.7%), the medium category of 10 students (28.6%), the low 2 people (5.7%), and very low category 17 people (48.6%). So students' scientific communication skills for representing indicators still need to be improved. Based on the results of this research, it can be seen that even though teachers have implemented varied learning models, have trained creative thinking and scientific communication skills to their students, students still have low creative thinking and scientific communication skills. For this reason, teachers must continuously train their students' creative thinking and scientific communication skills and also measure the extent of their students' creative thinking and scientific communication abilities. So it is hoped that teachers can be more focused and directed in developing students' creative thinking and scientific communication skills.

Currently, schools do not prepare students to use the knowledge they gain to solve problems that occur in real life. Science teachers in junior high schools do not have data regarding the assessment of creative thinking abilities. Many teachers in both primary and secondary education still pay little attention to their students' creative thinking abilities (Fardah, 2012). During the learning process at school, the teacher has not implemented learning strategies aimed at measuring students' creative thinking abilities. The data held only extends to concept mastery. Students' abilities will be further developed if the learning strategy implemented aims to train students to apply the concepts they have

learned to a problem so that solutions can be found in the form of ideas, designs, or product designs (prototypes) (Chasanah, 2017). To develop creative thinking skills, students must be given the opportunity to develop creativity by doing as much work as possible during learning. Creativity allows children to create something new and combine existing ideas with new ideas (Wahyuningsih et al., 2020).

The ability to think creatively will develop if it is supported by personal and situational factors. Hurlock (1999) revealed that there are several factors that can influence the development of creative thinking, including internal factors, namely: gender, socioeconomic status, birth order, and intelligence, and external factors, namely: time, opportunities to gain knowledge, how to educate children, encouragement, a non-possessive parent-child relationship, facilities, and a stimulating environment.

External aspects (environment) also have a big influence on the development of students' creative thinking abilities, one of which is that the school environment influences students' creative thinking abilities. The research results of Shih-Yeh Chen., Chin-Feng Lai., Ying-Hsun Lai, and Yu-Sheng Su in Heriyanto et al. (2020) show that a project-based learning approach is able to promote students' creative thinking, especially with regard to fluency and flexibility. Moreover, the students in their interviews thought appropriate creativity thinking tools were an approach that could promote their creativity significantly. From the results of this research, the learning model and combination of technology and learning strategies used by the teacher in delivering the material will help students understand the concepts given so that students are able to develop their creative thinking abilities.

Heriyanto *et al*. (2020) also stated that the factors that influence the thinking ability of junior high school students are the learning model applied by the teacher, the combination of technology and learning strategies, the students' ability to understand problems, the learning approach applied by the teacher, and the students' ability to exchange ideas and work. the same in the group. A good teacher is able to develop the abilities within each student, including motivating students to think creatively in learning (Suryabrata, 2001).

The low level of students' scientific communication skills is due to the fact that the learning they do tends to be lectures and practice questions, discussions and practicums are rarely carried out (Angger *et al*., 2016). Apart from that, students also rarely get assignments to carry out observations or research and project assignments. In fact, when students carry out project assignments, students' communication skills are indirectly trained. Apart from that, students' communication skills are also trained when they convey the results of their projects through presentations in front of an audience, especially when students are asked to request a project report, their written communication skills will also be trained. So far, assignments have been given more to working on practice questions contained in student textbooks, so students' ability to communicate is not well-trained (Taryono, 2016).

Conclusion

Based on the description above, it can be concluded that students' creative thinking and scientific communication abilities are still low. The creative thinking ability of students in the high category is only 1 student (3%), in the medium category 21 students (60%), and in the very low category 13 students (37%). For students' scientific communication skills, 4 students (11.4%) were found in the very high category, 2 students (5.7%) in the high category, 10 students in the medium category (28.6%), 2 students in the low category (5 .7%), and the very low category was 17 students (48.6%). So, students' overall creative thinking and scientific communication abilities must be improved.

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Dine Nurdian: writing-original draft preparation, result, discussion, methodology, conclusion; Saefudin and Amprasto; proofreading, review, and editing

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