# A Preliminary Study of Student's Initial Technology and Engineering Literacy

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**ABSTRACT**

Job opportunities in the 21st century require candidates to have skill on critical problem solving, create a creative solution and involve technology and information. Literacy of technology and engineering are important to be emphasized on students so it can prepare them to compete globally and are able to solve 21st century issues. This research is aimed to describe initial technological and engineering literacy of students of SMP N 6 Purworejo. This research's type is descriptive analysis. Sampling technique which is utilized is random sampling. The populations are students at grade IX of SMP N 6 Purworejo. The data is obtained from test instruments of technology and engineering literacy. The validity and reliability of test instrument are qualitatively analyzed by using Quest application. The score of reliability and estimate is 0.77 which means the test instrument has high reliability. This preliminary research result indicates that 3.1% of students are included in a very poor category, 25% poor category, 34.37% acceptable category, 31.25% good category, and 6.25% very good category. Meanwhile, result of technology and engineering of students for each indicator is divided into 3 categories, which are three indicators indicate low category, one indicator is very low and the other is moderate. A learning which involves design and technique process should be attuned to improve students' critical thinking and problem solving skill. Besides, natural science learning by involving real experience on principles of technology will make students to literate in technology and engineering.

*Keywords: 21st century skills, Technology and engineering literacy*

## 1. INTRODUCTION

The 21st century is also called as a century of technology in which everything utilizes computer system. Globalization and modernization era have occurred in every aspect of life. One of the aspects that experiences a big change is education. Teaching-learning activities which were previously performed using conventional method have become more diverse and interesting. However, all learning system in schools have many involved technological development [1]. New education paradigm focusses on preparing students to have working readiness and 21st century skill such as creative, critical, communication, collaboration, problemsolving and ICT literacy skills[2]. These skills are utilized to face 21st century challenge and become globally competitive human resource.

Indonesia is actively doing infrastructure development with the tenth GDP position worldwide to become a country destination of foreign engineer. However, Indonesia is estimated to lack of 280 million of engineers in the next five years. The number of engineers produced by universities are unable to fulfill the needs [3]. It is relevant with the statement [4] that skilled workers in Indonesia are relatively slightly. It is cause the low numbers of registered or graduated Indonesian citizens who are majoring science and technology. Whereas, each country is required to prepare qualified and globally competitive human

resource. Qualified human resource is obtained through qualified learning process which builds students' thinking ability to overcome a problem along with the era development [5]. Curriculum 2013 that is currently implemented in Indonesia has been in line with the need of 21st skill and industry revolution 4.0 [6]. One of 21st century which is implemented by students is Technology and Engineering Literacy (TEL).

Technology and Engineering Literacy (TEL) is an ability to understand and utilize basic knowledge and skill which are owned and related to technology principles and strategies required to achieve a goal or problem solving [7]. Technological and technical literate students should be able to implement critical thinking, reasoning, and action in all technological and technical literacy [4]. In technology and engineering literacy, students are expected to apply knowledge and reasoning when facing a problem [5].

Technological and engineering are different but related things [6]. Technology is not only a product but also a part of all processes started from designing, arranging, operating to improving. Designing and testing, completing and finding a solution to produce a perfect one is an engineer's work [6]. Additionally, [5] it is mentioned that engineering is a designing or creation process, while technology is the product of the process. In the National Assessment and Educational Progress (NAEP) 2014, it's known that the assessment target of technology and engineering literacy is divided into three main connecting things, such as Technology and Society, Design and Systems, and Information and Communication Technology. Those fields are expected to make students implement knowledge, intellection, and certain reasoning possessed to solve problem which is faced in 21st century. Intellection and reasoning are called as practice [7]. Three types of practices which are expected to show on students are technological principles, developing solutions and achieving goals, and communicating and collaborating[8].

*Preliminary Technology and engineering literacy* of students are required for further research base in developing learning set which can facilitate the development of students' technology and engineering literacy. This research is aimed to describe test instrument of technology and engineering literacy and find out preliminary technology and engineering of students.

## 2. RESEARCH METHOD

### 2.1. Research Design and Participant

This research is descriptive qualitative research. The test instrument to measure technology and engineering literacy of students have been adjusted to aspects and indicators as included in The 2018 National Assesment for Education Progress (NAEP) [8]. This test instrument is given to students of SMP N 6 Purworejo at grade IX. The populations were all students at grade IX of SMP N 6 Purworejo that had 32 students of grade IXB as the samples taken using random sampling technique. The data was collected since 24-29 August 2020. The data was obtained from test instrument of technology and engineering literacy. The validity and reliability of test instrument was qualitatively analyzed by using Quest application. The obtained data was descriptively analyzed.

### 2.2. Research Instrument

The test instrument has been adjusted to technology and engineering literacy indicator. After the test instrument was consulted and went through some revisions, test instrument was examined on students of grade IX of SMP N 6 Purworejo. The data was qualitatively analyzed by using Quest application to find out the quality of test instrument. Then, qualitative test result was performed to find out empirical validity and reliability. Teachers' interview result is utilized to find out learning method utilized by them in doing classroom learning activities.

### 2.3. Data Analysis

Data which is utilized in this research is it is on initial ability of technology and engineering literacy of students of SMP N 6 Purworejo in academic year 2020/2021. The aspects which are measured are understanding technological principle and developing solutions and achieve goals. Understanding technological principle expects students have ability to explain features and processes of a system (technology) and make a prediction, comparison, and evaluation of a technology. Developing solutions and achieve goals expects students to use knowledge on technology, device and skill to solve an device issue, implement knowledge possessed to solve, design and make a product through an appropriate process and by using relevant device[8]. Score criteria of technology and engineering literacy of students are provided on table 1.

In order to obtain students' technology and engineering literacy data, scoring towards students'

answer from 10 questions is measured. Category of technology and engineering literacy for each student is categorized on table 2.

**Table 1.** The score range of technology and engineering literacy of students

| Score Range | Information |
|---|---|
| 0-19 | Very Poor |
| 20-39 | Poor |
| 40-59 | Moderate |
| 60-79 | Good |
| 80-100 | Very Good |

**Table 2.** The percentage of technology and engineering literacy of students for each student

| Persentage (%) | Information |
|---|---|
| 81.25 < X ≤ 100 | Very high |
| 71.50 < X ≤ 81.25 | High |
| 62.50 < X ≤ 71.50 | Moderate |
| 43.75 < X ≤ 62.50 | Low |
| 0 < X ≤ 43.75 | Very low |

# 3. RESULT AND DISCUSSION

## 3.1. Result

### 3.1.1. Learning Method

Based on the result of interview with a classroom teacher, it is known that learning method which is utilized is dominantly discussing and lecturing. Practices are performed in the laboratory once in a while. Activities involving technology and engineering are rarely performed.

### 3.1.2. Validity of Instrument

Result of technology and engineering literacy test validity of students is obtained after test is performed and analyzed by using Quest application referring to [9].Table of test instrument validity of technology and engineering literacy is provided on table 3.

### 3.1.3. Reability of Instrument

The reliability of instrument test of technology and engineering literacy of students is obtained after test is performed and analyzed by using Quest application which refers to [10]. The reliability of test instrument is provided on table 4.

**Table 3.** Validity of test instrument of technology and engineering literacy

| Item Name | INFIT MNSQ | Information |
|---|---|---|
| Item 1 | 0.90 | Accepted |
| Item 2 | 0.89 | Accepted |
| Item 3 | 1.08 | Accepted |
| Item 4 | 0.98 | Accepted |
| Item 5 | 1.11 | Accepted |
| Item 6 | 0.89 | Accepted |
| Item 7 | 1.15 | Accepted |
| Item 8 | 0.86 | Accepted |
| Item 9 | 1.24 | Accepted |
| Item 10 | 1.13 | Accepted |

**Table 4.** Summary of item estimates

| Information | Result |
|---|---|
| Mean | 0.00 |
| SD | 0.89 |
| SD (adjusted) | 0.78 |
| Reability of Estimate | 0.77 |

### 3.1.4. Initial Technology and Engineering Literacy of Students

Based on the performed analysis, result which is obtained is provided on table 5.

**Table 5.** Recapitulation of initial technology and engineering literacy of students for each indicator

| Score Range | Information | Frequency | Percentage of Study Grades |
|---|---|---|---|
| 0-19 | Very Poor | 1 | 3.1% |
| 20-39 | Poor | 8 | 25% |
| 40-59 | Moderate | 11 | 34.37% |
| 60-79 | Good | 10 | 31.25% |
| 80-100 | Very Good | 2 | 6.25% |

### 3.1.5. The Percentage of Technology and Engineering Literacy of Students for Each Indicator

Based on the analysis which has been performed, the percentage of technology and engineering literacy of students for each indicator is obtained and provided on Table 6.

### 3.2. Discussion

This research is a preliminary research stage. A preliminary research is performed to find out the initial technology and engineering literacy of students of SMP N 6 Purworejo. Method utilized in this research was descriptive analysis method which described a phenomenon which existed at the research location systematically, factually, accurately and as it is. The information which is considered as important is collected as a basic of further research development. Test instrument of technology and engineering literacy is made to get initial technology and engineering literacy of students. Valid and reliable data are obtained by using test instrument which has been through validity and reliability test.

The first step to obtain valid and reliable test is by designing instrument guide based on aspect and indicator which will be observed and its question item number. After they are designed well, test instrument guide and test questions are consulted with experts for evaluation. After that, the author will revise it. The further step is field study. The data which will be obtained after field study is analyzed by using Quest application to find out the validity and reliability of test instrument. If the result of analysis is reviewed from INFIT MNSQ, item 1-10 are accepted (provided on table 3) or relevant with Rash's model because the score of INFIT MNSQ is on the range 0.77-1.30 and outfit score t≤2. Therefore, all items have been with Rash's model [9]. Based on the qualitative analysis with Quest application, the estimation score of reliability of technology and engineering literacy question item is 0.77. The score indicate that the reliability of question is high. Higher reliability score indicates that sample is relevant with item which is tested [11]

**Table 6.** The percentage of technology and engineering literacy of students for each indicator

| No. | Aspect of Technology and Engineering Literacy | Indicator | | Percentage (%) | Category |
|-----|-----------------------------------------------|-----------|--|----------------|----------|
| 1 | *Understanding tehnological principles* | a. | Describe the features of a system or process | 60.5 | Modedate |
|   |   | b. | Contains predictions, comparisons and evaluation | 28.1 | Very low |
| 2 | *Developing solutions and achieve goals* | a. | Using knowledge of technology, tools, and skills to solve device malfunctions | 53.1 | Low |
|   |   | b. | Apply knowledge to solve problems | 59 | Low |
|   |   | c. | Design and manufacture products using the right processes and tools | 47 | Low |

There are two aspects of technology and engineering literacy which is measured in this research. First, aspect of understanding technological principles which focuses on knowledge and understanding of students on technology and their ability to think and reason by using the technology knowledge. Second, aspect of developing solution and achieve goals are focused on the implementation of knowledge of technology, device and skill of students to solve a problem and reach the goal as presented in the social, curriculum, design, and realistic context [8]. Both aspects are divided into five indicators which refer to NAEP TEL 2018, which describe the features of a system or process, contains predictions, comparisons and evaluation, using knowledge of technology, tools, and skills to solve device malfunctions, apply knowledge to solve problems, and design and manufacture products using the right processes and tools. Based on the preliminary research, it is known that 3.1% students are in very poor category, 34.3% in moderate category, 31.25% in good category, and the remain 6.25% in very good category. The result indicates that most of technology and engineering literacy of students are less than the average score. The highest score is 80, which is categorized as very good. The score of 80 is still below the category standard.

The result of qualitative analysis of technology and engineering literacy of students for each indicator is presented on table 6 and figure 1.
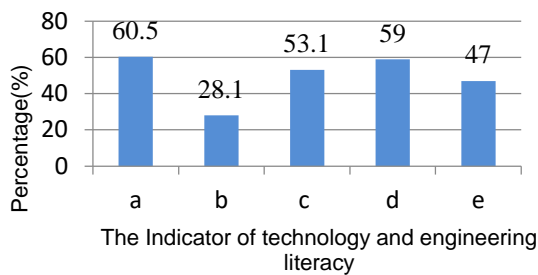
**Figure 1** The result of qualitative analysis of technology and engineering literacy of students for each indicator

Figure information:

a = Describe the features of a system or process

b = Contains predictions, comparisons and evaluation

c = Using knowledge of technology, tools, and skills to solve device malfunctions

d = Apply knowledge to solve problems

e = Design and manufacture products using the right processes and tools

Technology and engineering literacy of students for each indicator is distributed to two categories, which are low and moderate. The students' ability in explaining features of a system or process is categorized in moderate category. While the ability to make a prediction, comparison and evaluation are in low category, use knowledge on technology, device and ability to solve malfunction problem is in low category. The abilities to apply the knowledge to solve a problem and to design and make a product by using process and appropriate device are in low category.

### 3.2.1. Aspect of Understanding Technological Principles

#### 3.2.1.1. Indicator 1a: Describe The Features of A System or Process

Based on the figure 1, students who are able to answer the question correctly in the indicator of describe the feature of a system or process is 60.5% of total students. Which means, technology and engineering literacy of students on this indicator is included in moderate category, relevant with table 6 which refers to. Students' ability to explain features of a system or process should be improved. It is relevant with the statement [8] that students should be able to use their understanding on principles of technology to explain feature and function of technology and system.

#### 3.2.1.2. Indicator 1b: Contains Predictions, Comparisons, and Evaluation

Students who are able to correctly answer the question in indicator of contains predictions, comparisons and evaluation, which is 28.1% of 32 students. The ability of students in this indicator is categorized as low. This result has not been relevant with the statement on NAEP 2018 that the assessment target required students to analyze, compare and connect principles of technology. This ability of students are categorized as low. [8].

### 3.2.2. Aspect of Developing Solutions and Achieve Goals

#### 3.2.2.1. Indicator 2a: Using Knowledge of Technology, Tools, and Skills To Solve Device Malfunctions

Based on figure 1, it is known that 53.1% of students are able to answer items of indicator questions by using knowledge of technology, tools, and skills to solve device malfunctions correctly. Question items with this indicator measure students' ability to solve basic problem such as planning, monitoring, evaluation, and revision in designing a technology [7]. It means that a half number of students have this ability.

#### 3.2.2.2. Indicator 2b: Apply Knowledge To Solve Problems

Students who are able to correctly answer the question with indicator of apply knowledge to solve problems is 59% of total sample. Based on the result, it is known that the ability of students in this indicator categorized as low.

#### 3.2.2.3. Indicator 2c: Design and Manufacture Products Using The Right Processes and Tools

Based on figure 1, it is known that the percentage of students who have design and product making by doing process and appropriate device ability is 47%. It is included in low category. The question item with this indicator is utilized to measure students' ability to make design so that they are able to produce a product by using correct device, material and steps as the knowledge they possess.

Based on the explanation of technology and engineering literacy of students for each previous indicator, it is known that students' ability on four indicators are included in low category and another indicator is included on moderate one. Based on the

interview with teacher of Natural Science of SMP N 6 Purworejo, in general, learning methods which are utilized are discussion and lecturing. Practical activities which involve technology and engineering are rarely performed so that relevant learning method to improve technology and engineering literacy of students are utilized.

The effort to increase technology and engineering literacy is required. A correct learning method can influence technology and engineering literacy of students. The research [12] indicates that natural science learning which is based on Science, Technology, Engineering, and Mathematics positively affect technology and engineering literacy of students. It means that by integrating the four knowledge, technology and engineering literacy of students will be increased. A learning which involves design and technique process should be attuned to improve students' critical thinking and problem solving skill. Besides, natural science learning by involving real experience on principles of technology will make students to literate in technology and engineering. According to [13], natural science learning uses STEM-PjBL approach that gives students a knowledge on science and real world. Through this learning, students can practice knowledge and technology in solving daily life problem.

## 4. CONCLUSION

Based on the preliminary research, it is known that most of technology and engineering literacy of students are included in moderate and poor category, which is 62.47% of total sample. Besides, technology and engineering literacy of students for each indicator are divided into three categories, which is moderate, low and very low. The increase of technology and engineering literacy can be done by using a learning method that involves science and principles of technology and engineering.

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