Tinkercad Application Software to Optimize Teaching and Learning Process in Electronics and Microprocessors Subject

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Abstract—**The impact of the Covid-19 pandemic has hits many sectors, one of which is the educational sector. Lockdown policy has closed schools in most countries from natural teaching and learning process. This study aims to analyze students' experiences during the online learning process in electronics and microprocessors subject in Vocational High School (VHS) according to competency to implementing programming a microcontroller using Tinkercad software. The research method used is a qualitative approach. The results of this study that students able to properly implement programming a microcontroller both in theory and practice using Tinkercad software. Most students show a positive response, feel enthusiastic and motivated to develop their abilities, while a small number of students show a negative response, this is due to constraints both from internal and external factors. The conclusion obtained is that students can use Tinkercad software well to understand programming competency upon a microcontroller. Most of the students showed a positive response when using Tinkercad and the obstacles experienced by a small part of students related to internal and external factors.**

Keywords—COVID-19, VHS, online learning, tinkercad

I. INTRODUCTION

Currently, the world in era of the COVID-19 pandemic. In most countries, people are being asked to stay at home. Lockdown policy or area quarantine was carried out to reduce interactions between individuals which could make the spread of Covid-19 even more massive [1]. The impact of the Covid-19 pandemic has hit many sectors, one of which is the educational sector. Lockdown has closed schools in most countries. UNESCO estimates that more than 90% of the world's students are currently out of school due to the pandemic, with more than 1.5 billion students affected by the pandemic [2].

In Indonesia, all educational institutions are not allowed to carried out learning activities as usual, The government through the Ministry of Education and Culture has decided that educational institutions such as schools and universities to carry out teaching and learning activities online from home to avoid the massive spread of the COVID-19 disease [3]. One of the educational institutions that are experiencing the impact is vocational-based education such as Vocational High Schools (VHS) or SMK (Sekolah Menengah Kejuruan) in Indonesia.

VHS is a formal middle-level school whose learning process is focused on preparing human resources who have competency in knowledge, skills, and attitudes as skilled middle-level workers. However, at the time of the COVID-19 pandemic, efforts to prepare vocational postgraduate students who must have competence in the fields of knowledge, skills, and attitudes as skilled middle-level workers, facing obstacles [4]. Of course, as a substitute for face-to-face classes, online learning is needed that can be used by teachers and students easily in the application of the teaching and learning process. Current technology allows electronic learning (e-learning) to be done.

E-learning has become the curriculum for teaching methods during the COVID-19 pandemic. E-learning is defined as the use of information technology to improve the quality of education [5]. One type of e-learning is online learning. Online learning is a type of learning that can be conveyed by various electronic media, including the internet, interactive TV and satellite [6]. Online learning activities are more student-centered than teacher-centered. It is necessary to have learning media that is easy for students to use and is also able to train students' skills to meet vocational competencies [7].

Based on observations made by researchers while teaching at VHS Unggulan Terpadu PGII Bandung city, Indonesia, there are many obstacles faced in Electronics and Microprocessor subjects that are project-based or practicum, including the limited tools and materials owned by students and teachers. Therefore, the researcher decided to use an online web simulator that is available for free on the internet namely Tinkercad. Other researcher has done similar research. In that case, Tinkercad was used to analyze the experiences of elementary school students in Chile on programming and

electronic-computing competences, and these results indicate that elementary school students gave positive intentions to learn programming skills and related technologies [8]. And the another research Tinkercad used for 3D printing course for undergraduate students in Guatemala on computer programming competency using code block, and these result is that three factors were identified as the main drivers of positive student response: availability and accessibility of 3D printers, diversity of student group composition, and a sense of relaxed [9].

In this research, researcher have used Tinkercad to optimize the online learning process in the electronics and microprocessors subject in implementing programming a microcontroller competency. And to analyzing the experiences of students when online learning, with participants a students of VHS Unggulan Terpadu PGII Bandung city, Indonesia. Researchers hope that the results of this article can support the design and development of further online learning to be applied in vocational high schools, especially in subjects related to electronics [10].

II. METHODS

A. Research Methods

The research method of this study using a qualitative approach. Data collection based on the results of observation, interview upon student's and related documentation analysis. Data analysis using an interactive model of Miles and Huberman, The first stage in this model is data collection, then data reduction, data presentation, and finally conclusion [11].

B. Tinkercad Characterization and Features

Tinkercad is a free web-based software application or simulator that can be used without having to first download and installing it on a computer or smartphone. Tinkercad is a product of the Autodesk company, Tinkercad provides 3-dimensional design service features, simulation and design of simple electronic circuits and programming based on the Arduino R3 board [12]. Arduino was created in Italy to make it easier for students to learn computing and electronics at a low cost and open-hardware [13]. Arduino has many benefits to use in educational environment. The use of Arduino in learning can improve students' skills in learning the C / C++ programming language and electronic circuits [14].

Tinkercad supports and motivates the development of electronic learning with Arduino. Tinkercad considers proper design with the original hardware, There is a classification of various hardware components that can be added, and area code for learning to write programs [8]. Figure 1 shows an example of simple blue LED circuit designed in Tinkercad. While the LED circuit program code shown in figure 2.
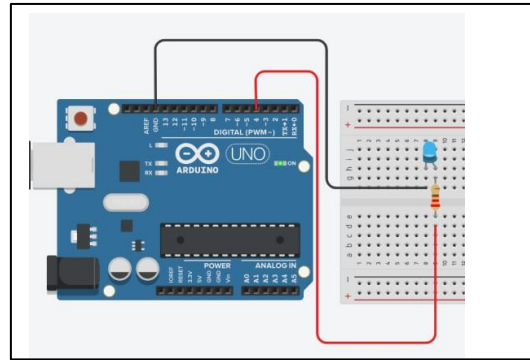

Fig. 1. Example of electronic circuits using Arduino in Tinkercad.

Fig. 2. Sample of code program of electronic circuits using Arduino in Tinkercad.

C. Competency Targets in Electronics and Microprocessor Subject

Based on the Lesson Plan that has been designed to achieve competency in implementing programming on the Arduino microcontroller, students must be able to make simple electronic circuits using Tinkercad, students must be able to make simple code programs in C / C ++ language using Tinkercad software. Table 1 show the targets of the competency in implementing microcontroller programming in electronics and microprocessors subject.

TABLE I.   COMPETENCY TARGETS

Competency	Indicator
Implementing the programming process on the microcontroller	• Understand the programming on the microcontroller • Making simple electronic circuits and programming on an Arduino microcontroller using Tinkercad

D. Learning Method and Participants

The learning method used is a Problem Based Learning. The participants in this study were 14 VHS (SMK) students. Eleven of them are males and three are females. Classes are given from March 24, 2020 to April 21, 2020.

E. Activity Plan

The class carried out for 2 hours per meeting. Learning activities of each meeting are shown in table 2.

TABLE II.   ACTIVITY PLAN

Meeting	Date	Activity
1	March 24, 2020	Introduce the use and features of the Tinkercad software
2	March 31, 2020	Students imitating the LED light circuit and programming using the Arduino board on the Tinkercad website
3	April 07, 2020	Students modifying the flip-flop LED light circuit and programming in Tinkercad
4	April 14, 2020	Students imitating the "Hello World" LCD Display circuit and programming on the Tinkercad website
5	April 21, 2020	Students modifying LCD Display through programming Tinkercad website

III. RESULTS AND DISCUSSION

This practice-based online learning can be done in various ways, such as autonomous learning, live streaming, and online exercise [15]. In this article, researcher combine autonomous learning with online exercises using the Tinkercad software. The results of this study were two aspects that were measured by the ability of students. The first aspect is to test whether students are able to do their assignments correctly. The second is to find out student responses when using Tinkercad software.

A. Student Work Results

A sample of student's work when create an electronic circuit of LED flip-flop light is shown in table 3. A sample from a work of student "AB" show that he is able to make a LED flip-flop circuit correctly and independently, and work sample from student "IM" shows that she is able to make a LED flip-flop circuit with a little help from the teacher. From the results of the documentation of student's work and the results of observation during the study, can be summarized as in table 4. Table 4 shows that students are able to accomplished the flip-flop LED circuit and its programming. Some student's are able to work independently, there are students who need a little help and a few students need intense help. to find out whether students have worked on the electronic circuit correctly, the teacher is guided by the lesson plans that have been made.

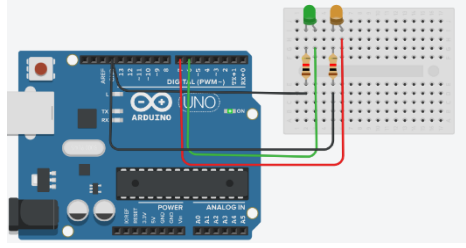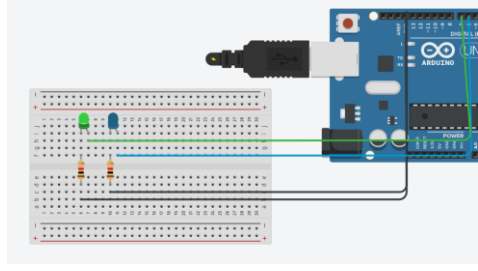TABLE III.   SAMPLE RESULTS OF LED FLIP-FLOP CIRCUIT HANDLED BY STUDENT'S

Students Name Initial	Results
AB	Note: a right LED flip-flop circuit
IM	Note: a right LED flip-flop circuit

TABLE IV.   SUMMARIZED RESULTS OF SSTUDENT'S PERFORMANCE ABOUT LED FLIP-FLOP CIRCUIT HANDLING

Students Name Initial	Results	Explanation
AB	Complete	Independently
HK	Complete	With a little help
IM	Complete	With a little help
KR	Complete	Independently
MI	Complete	With a little help
MRP	Complete	With a little help
MRF	Complete	With a little help
MF	Complete	Independently
MRS	Complete	With a little help
NSN	Complete	Independently
RN	Complete	With intense help
RS	Complete	Independently
YNA	Complete	With intense help
ZNA	Complete	With a little help

Table 5 shows a sample of student work when modifying the LCD Display circuit. A sample from a work of student "AB" show that he is able to make a LCD display circuit correctly and independently, and work sample from student "IM" shows that she is able to make a LCD display circuit with a little help from the teacher. From the results of the documentation student work and the results of observation during the study, it can be summarized as in table 6. Table 6 shows that most students are able to accomplished the LCD Display circuit and programming. Some students are able to work independently, but there are students who need a little

help, even a students need intense help, and a student unaccomplished the work. to find out whether students have worked on the electronic circuit correctly, the teacher is guided by the lesson plans that have been made and the teacher also practices electronic circuits using hardware to check the correctness of the circuit.

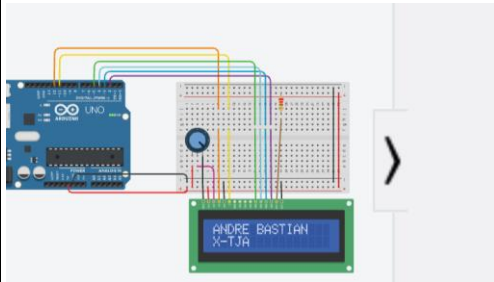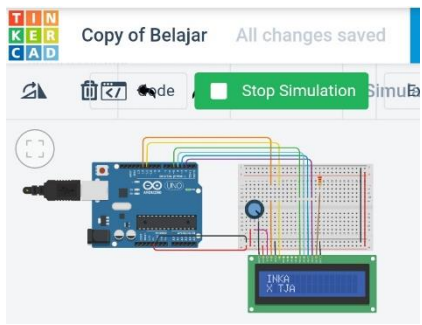TABLE V.   SAMPLE RESULTS OF LCD DISPLAY CIRCUIT HANDLED BY STUDENT'S

Students Name Initial	Results
AB	 Note: a right LCD Display circuit
IM	 Note: a right LCD Display circuit

TABLE VI.   SUMMARIZED RESULTS OF COMPLETING LCD DISPLAY CIRCUIT JOB

Students Name Initial	Results	Explanation
AB	Complete	Independently
HK	Complete	With a little help
IM	Complete	With a little help
KR	Complete	Independently
MI	Complete	With a little help
MRP	Complete	With a little help
MRF	Complete	With a little help
MF	Complete	With a little help
MRS	Complete	With a little help
NSN	Complete	Independently
RN	Complete	With intense help
RS	Complete	Independently
YNA	Uncomplete	Don't collect assignments
ZNA	Complete	With a little help

From the recap of student work results, it was found that almost student were able to complete the task of implementing microcontroller programming. Meaning that student have met the indicators of the competency target in the lesson plan.

B. Aspects of Student Response

Based on the results of data collection through observation and interviews to determine student response when using the Tinkercad software, it was found that most of the students' response when using Tinkercad gave positive responses, namely that students felt enthusiastic, interested and motivated by Tinkercad learning media, while a small of students described negative responses, namely feeling bored, indifferent and not interested due to problems when using Tinkercad. The summarized results of student response observations are shown in Table 7.

TABLE VII.   SUMMARIZED RESULTS OF STUDENT RESPONSES WHEN USING TINKERCAD

Students Name Initial	Response	
	Positive	*Negative*
AB	✓	
HK	✓	
IM	✓	
KR	✓	
MI	✓	
MRP	✓	
MRF	✓	
MF	✓	
MRS		✓
NSN	✓	
RN		✓
RS	✓	
YNA		✓
ZNA	✓	

IV. CONCLUSION AND RECOMMENDATION

Based on the results of research, it can be concluded that Tinkercad software application has good support and good contribution as a choice to overcome electronic skill competency need in limited COVID-19 teaching-learning circumstance in vocational education. Almost all students gave positive responses, enthusiastic, and motivated. while only a little part of students fails and not motivated in microcontroller programming using Tinkercad software teaching-learning.

The recommendation for teachers especially in vocational high school who will use Tinkercad is that they firstly must understand the features of the Tinkercad software. Furthermore, must be ready for competence in implementing microcontroller programming. Besides that, students must first understand the basics of simple electronic circuits and be familiar with the Arduino programming language.

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