



# Arduino Tinkercad Simulator Training for Applied Physics MGMP Vocational Teachers in the Special Region of Yogyakarta

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**Abstract.** The purpose of the Tinkercad arduino simulator training for teachers of Applied Physics MGMP Vocational Schools in the Special Region of Yogyakarta (1) to create an Applied Physics project based on the Arduino UNO/Nano micro-controller simulator, (2) to train teachers to be able to recognize various Arduino UNO supporting devices that are useful in making physical projects, and (3) increasing the competence of applied physics teachers in the field of electronics physics. The method used is a workshop which is held online through a zoom meeting, due to the Covid 19 pandemic, which is still relatively crowded in Yogyakarta. This activity uses the Tinkercad simulator, an adequate simulator for learning to assemble and code circuits based on Arduino. There were 17 Applied Physics teachers spread across the Special Region of Yogyakarta who attended this zoom meeting, including teachers who had an electronic physics education background as well as teachers who did not have a background in electronics knowledge. The results of this activity indicate that most of the teachers of applied physics in the DIY region expect the continuation of this activity, considering that electronics skills are one of the competencies that must be mastered by teachers of the Applied Physics MGMP. The Tinkerpad simulator can replace Arduino-based electronics practicum to make simple physics projects, so that even in a pandemic atmosphere the practicum process can still be carried out.

**Keywords:** Training · Tinkercad Arduino · Applied Physical Projects · Teacher Competence

## 1 Introduction

Technological developments require every individual, from elementary to middle school students, teachers, students, academics, practitioners, as well as from the general public to be responsive and sensitive to the phenomena of change that occur. Alignment between theory and practice is important to be realized in the implementation of physics learning. The ideal implementation of physics learning is identical to mastering the concept of observation and experiment activities through practical activities. Learning experiences in formulating problems, proposing and testing hypotheses through experiments, designing and assembling experimental instruments, collecting, processing, and

developing data, as well as communicating experimental results orally and in writing, are believed to be able to develop inductive and deductive analysis skills [1, 2]. Physics practicum activities cannot be separated from observation and measurement activities. Applied Physics Practicums, such as microcontrollers, use many measuring instruments and electronic devices that have special characteristics and needs to master them. Some electronic devices that are often used in microcontroller practicums include: circuit boards, leds, various types of jumpers, resistors, switches, relays, liquid crystal displays (LCD), potentiometers, switches, USB cables, various sensors (temperature, color, ultrasonic sensors), infrared, odor, etc.), RFID, batteries, various modules, and others [3–5]. To master the use of these electronic tools, the teacher must really understand and master the material, because without careful mastery of the material it is impossible to achieve the previously designed learning objectives. Mastery of the Arduino microcontroller application for making applied physics projects is needed for teachers and students. Proficiency in making Arduino-based applied physics projects will be the gateway for the mastery of science and technology in today's society. Some projects that can be done using Arduino include: digital clock, traffic light, remote control, IoT, electronic data transfer, and other projects [6–9]. This expertise is also an opportunity for teachers and students in opening new jobs, considering that the application of microcontrollers is closely related to daily needs.

The Covid-19 pandemic, which is still unfinished, requires electronic simulator developers to work so that a simulator that can replace Arduino is made, namely Tinkercad. Many studies report the effectiveness of using Tinkercad to design Arduino and sensor-based projects [10–12]. In Indonesia, this simulator is also widely used for optimizing teaching and learning processes in microcontroller and microprocessor courses [13, 14]. In the world of 3D modeling, Tinkercad has established itself as a worthy introduction to computer-aided design (CAD). This application is a free and intuitive web-based CAD program that anyone can use. Arduino is an open-source electronic prototyping platform that also sells microcontrollers, and Tinkercad circuits allow anyone to virtually create and program Arduino projects without the need for physical hardware.

## 2 Activity Method

The Tinkercad Arduino training activity for teachers of the Yogyakarta Applied Physics MGMP Vocational High School was carried out online. This is because the Covid-19 pandemic in the Special Region of Yogyakarta is still high, and in accordance with the Instruction of the Governor of the Special Region of Yogyakarta number 6/Inst/2021 concerning the Extension of the Implementation of Restrictions on Micro-Based Community Activities in the Special Region of Yogyakarta, which is intended to control the spread of the Corona Virus Disease 2019 (Covid-19).

To increase the competence of the Applied Physics MGMP teachers to make physics projects, the following steps were carried out: 1) The teacher was given material knowledge about Arduino microcontrollers, and what advantages Arduino has if it was compared to ordinary microcontrollers, 2) The teacher was introduced to the C++ computer programming language because it supported Arduino programming, 3) The teacher was given an explanation how to run a C++ program on the Arduino IDE, 4) The teacher was

introduced to electronic devices, project support modules, electronic sensors and their respective uses, 5) The teacher was introduced to the Tinkercpad simulator and how to run it, 6) Teachers were guided on how to assemble electronic devices on a breadboard in Tinkercad, and 7) Teachers practiced independently making applied physics projects with real Arduino.

### **3 Result and Discussion**

#### **3.1 Activity Implementation**

The implementation of Arduino microcontroller training activities for Applied Physics MGMP teachers in the Special Region of Yogyakarta was held online from July to October 2021, and was attended by 17 (seventeen) teachers of Applied Physics MGMP Vocational High Schools throughout DIY. Activities are held once a month, namely on Friday, July 16; Monday, August 30; Tuesday, September 14, and Friday October 15, 2021. This training clearly was not able to make the teachers master the material completely, so teachers should have a motivation to learn independently.

The material presented in this training includes several essential things that are important to master before they can develop themselves at home. Some of the materials presented included: 1) Introduction to Arduino, including its types, 2) Introduction to supporting devices in building Arduino UNO-based circuits, 3) Introduction to the Tinkercad simulator as an alternative to implementing microcontroller practicums, 4) Assembling simple electronic circuits based on Arduino UNO R3 through the Tinkercad simulator, and 5) Create a simple physics project with Arduino UNO with Tinkercad.

#### **3.2 Result and Discussion**

Tinkercad arduino is a simulator that allows users to virtually develop an applied physics project. With this application, users can easily assemble supporting electronic devices available on the side and simply drag and drop on the circuit board. After the circuit is installed correctly, then the programming is done with C++ through the coding menu and run. Figure 1 provides a description of the virtual support tools on Tinkercad arduino. Figure 2 shows how to develop a simple physics project with the online simulator. Figures 3 and 4 show how instructor explain the simulator website and how to make source code to run the project.

Based on the implementation of this activity (PPM), it turns out that not all teachers at the Applied Physics MGMP have an educational background in electronics physics. Actually, this is one of the obstacles that must be solved so that teachers can still master this training material. The solution we took was to provide circuit materials and simple coding. Based on this condition, this PPM still needs to be followed up in the next year. This kind of training needs to be done repeatedly so that teachers can really improve their competence in physics projects related to electronics.

The enthusiasm and curiosity of the trainees is an important factor for achieving the objectives of this training. Although there are some teachers who do not have an educational background in electronics physics, their high enthusiasm is enough to make the

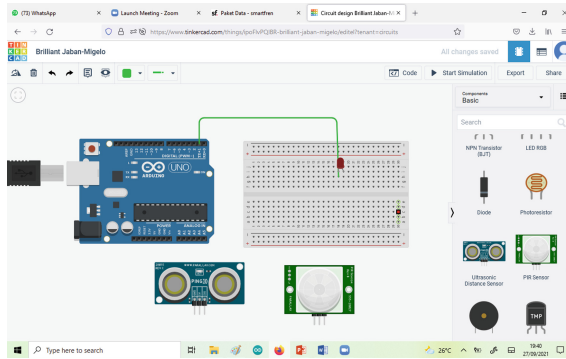


Fig. 1. Supporting devices on Tinkercad arduino

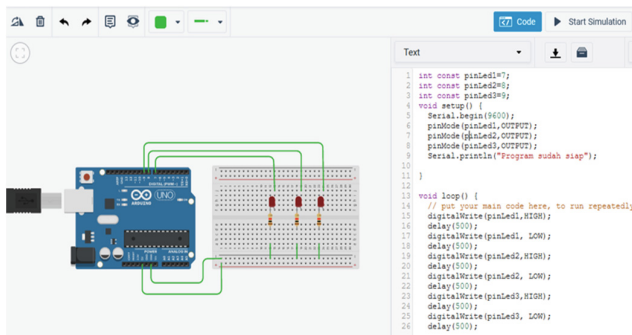


Fig. 2. Illustration of how to develop a simple physics project with Tinkercad arduino

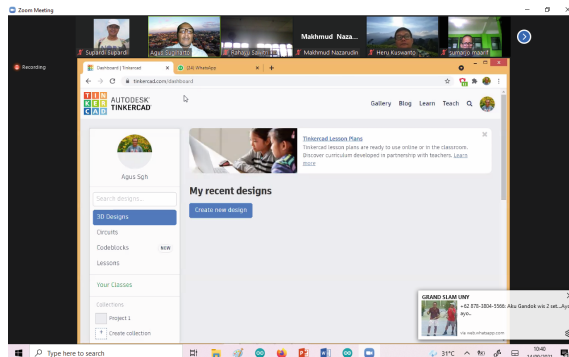
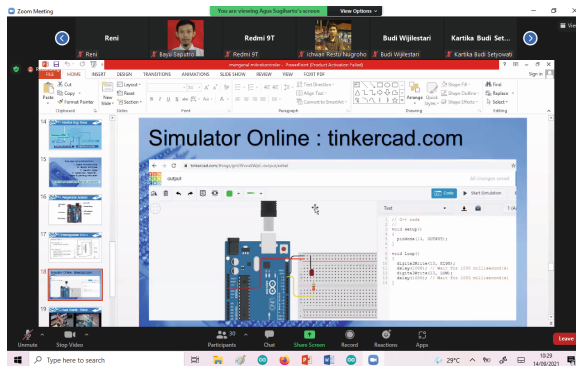


Fig. 3. The instructor’s explanation on how to login to the Tinkercad arduino simulator website

full day training run smoothly and full of intimacy. Support from institutions including LPPM UNY, Department of Physics Education FMIPA, and Applied Physics MGMP of LP Maarif Yogyakarta also greatly helped the implementation of the training. The



**Fig. 4.** The instructor gives an example of making computer code for the Tinkercad Arduino circuit.

department always hopes that the Department of Physics Education can be known by the public, one of which is through PPM activities. Likewise, the LPPM also hopes that the knowledge possessed by lecturers can be donated to the community to improve community competence in Physics.

According to the initial plan, this PPM will be conducted offline considering the material to be delivered through this training is related to small electronic devices. However, given the increasing condition of the COVID-19 pandemic, the training was carried out online. This is certainly one of the obstacles in delivering the material. Using the Tinkercad simulator, this problem can be overcome although it would be better if it was run offline.

## 4 Conclusion

Based on the results and discussion, we conclude that this PPM was going well even though there were several obstacles, including the teacher's lack of knowledge of physics material, especially in electrical circuits, and also coding. This PPM needed to be followed up so that teacher competence in mastering the tinkercad simulator increased. The simulator is just an application that runs without problems, the real competence that must be mastered is Arduino and its application in creating physics projects.

**Acknowledgment.** We would like to thank Yogyakarta State University for funding this Community Service through the 2021 UNY DIPA fund. We would also like to thank all the Community Service teams including our students who have helped carry out this activity.

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