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3D Printing Basic Knowledge and Skills Training for Teachers of SMAN 2 Palopo

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Abstract

Three-dimensional printing is a manufacturing process used to produce three-dimensional objects. It involves using a 3D printer with materials such as plastic, metal, and powder. In this community service initiative, a plastic 3D printer was chosen due to its practicality and effectiveness for laboratory settings. The training was conducted for teachers at SMAN 2 Palopo, with instructors from Cokroaminoto University, Palopo. The goal of the activity was to introduce and train SMAN 2 Palopo teachers on how to operate 3D printers. The training covered basic aspects such as using the 3D printer, setting up the equipment, designing, transferring design files to the printer, and printing the 3D models. The evaluation of the training was divided into four areas: understanding the concept, installation and operation, machine maintenance, and interest in further study. Participants' understanding improved by 1.7 points following the training. In terms of installation, usage, and maintenance skills, pretest scores were relatively low (1.8 and 2.1 points respectively) but increased significantly to 2.5 and 2.1 points after the training. Additionally, the pretest score for interest in 3D printing technology was 3.4 points and rose to 4.5 points after the training. The evaluation revealed that 3D printing technology is not widely known, especially in educational settings. The training aims to equip SMAN 2 Palopo teachers with knowledge and skills in 3D printing technology, which they can further teach to students through seminars, extracurricular activities, or incorporate into the curriculum.

Keywords: *3D Printing, Basic Knowledge, Teachers, Skills*

Introduction

3D printing is an innovative technology that is rapidly evolving, enabling the creation of products quickly, more easily, and with extremely high levels of detail (Ford et al., 2019; Huang et al., 2017; Song, 2018). This technology can transform virtual designs (from CAD software) into real objects with precise dimensions and shapes (KS et al., 2018; Leinonen et al., 2020). The printed designs are also highly accurate, efficient, and fast (HA et al., 2020; Asempapa et al., 2022). In the manufacturing sector, 3D printing has entered large-scale industries as a supporting technology. It allows for the creation of product models as prototypes for testing before proceeding to mass production (Schelly et al., 2015).

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Senior High Schools (SMA) serve as one of the partner institutions that bridge the process of transferring knowledge and technology from higher education to the community (Sullivan et al., 2017; Bonorden et al., 2020). This process can be carried out through various methods, including maintenance training to enhance teachers' skills in specific areas (ASLAN et al., 2022). The enhancement of SMA teachers' competencies is achieved by involving higher education institutions in various aspects such as PLC, Solidworks, digital teaching materials, and so on (Eslahi et al., 2020; Sharma et al., 2018). Through this training, it is hoped that teachers will expand their competencies and knowledge regarding technology, thereby making the process of transferring knowledge and technology more efficient (Concerned et al., 2022; Jamaldi et al., 2021; Mariyani et al., 2022).

Seminars and training on 3D printing usage have been widely conducted. Examples of such training include creating miniature transportation tools and electronic components in the Gunung Kidul area (BD et al., 2021) and manufacturing turbo jets for fishing boats in Bangka Belitung (Hasdiansyah et al., 2021). These training sessions focus on using 3D printing as a tool for producing real models that can enhance the well-being of the surrounding community (ŞİMŞİR et al., 2021). Senior High Schools (SMA) are seen as a potential target for 3D printing skills training (Alda et al., 2020). Countries like Taiwan and South Korea, which are global technology leaders, require secondary school students to master 3D printing technology (Syaifuddin et al., 2022). However, in Indonesia, only a small number of high school graduates are proficient in this technology.

This issue is due to the uneven distribution of knowledge and use of 3D printing devices among high school teachers (SS et al., 2022). One challenge teachers face is the difficulty in finding components or models needed for practical work at school. A solution to this problem is to create components independently using 3D printing (Santoso et al., 2021). Universitas Cokroaminoto Palopo, located at Jl. Lt. Gen Suprapto No.32, Sumber, Kec. Banjarsari, Palopo City, Central Java 57138, is a higher education institution with an engineering program that is expected to keep pace with technological developments, including 3D printing. Mastery of 3D printing technology relies heavily on the ability to use CAD and CAM software (RD et al., 2020). Therefore, to master 3D printing, one must be able to design with CAD and then operate 3D printing machines.

The issue faced by the teachers at SMAN 2 Palopo is a lack of understanding and skills in the installation, operation, and maintenance of 3D printing machines. This situation provides the basis for conducting 3D printing training at SMAN 2 Palopo as part of a community service program aimed at the school's teachers. The goal of this training is to enhance knowledge and skills in installing, operating, and maintaining 3D printing machines, so that this knowledge can be passed on to students (Cohen et al., 2018). The focus of this activity will be on improving the basic knowledge and 3D printing skills of the teachers at SMAN 2 Palopo.

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Method

Stages Implementation Training

Activity 3D Printing training conducted in a number of stages (Tang, 2022)

a. ***Partner Problem Identification:*** The interview process with relevant parties is used to determine the issues faced by SMAN 2 Palopo. In the context of 3D Printing Technology, the 3D printer planned for SMAN 2 Palopo will be used as a practical tool to support the learning process. However, not all teachers at SMAN 2 Palopo have the skills to install and use the 3D printer.

b. ***Establishing the Focus Objective:*** Based on the issues faced by the partner, the goal of this community service activity is to provide training on the installation and use of 3D printing machines. This training will include the process of converting image models into print-ready designs, techniques for printing with 3D machines, and machine maintenance.

c. ***Determining Targets and Participants:*** The target of this community service activity is the teachers at SMAN 2 Palopo. A total of 20 participants are involved in this activity. The instructors include 4 lecturers and 2 students from Cokroaminoto Palopo University.

d. ***Implementation of Activities:*** Briefly, the execution of the training is illustrated according to the flowchart shown in Figure 1.

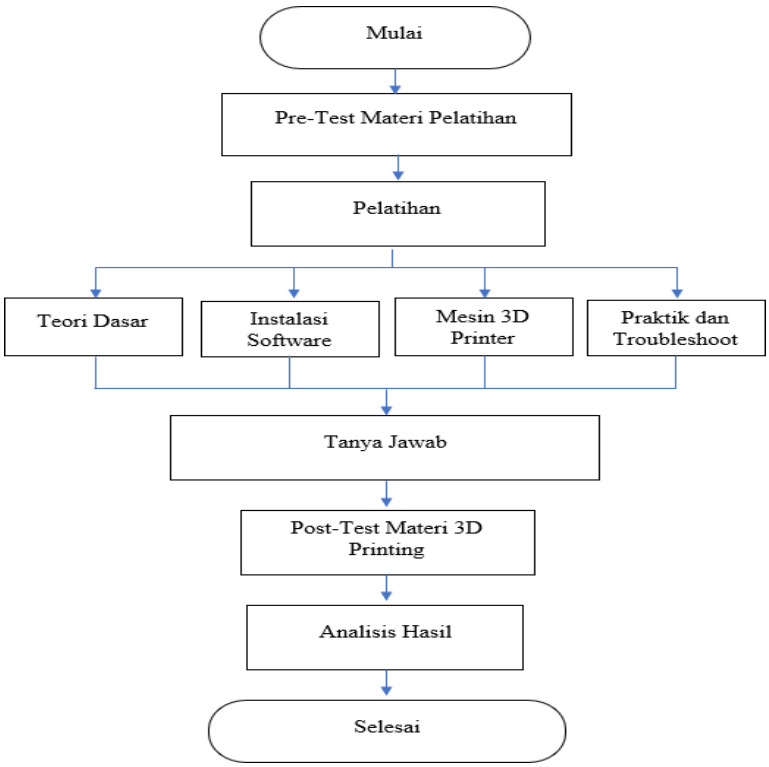

Figure 1. Flow chart activity 3D printing training

e. ***Schedule and Location of Implementation:*** The training was conducted for one day, from 08:00 AM to 04:00 PM, and took place in the practice room at Cokroaminoto Palopo University.

f. ***Activity Evaluation:*** The evaluation is conducted through pretests and posttests that participants are required to complete. This step aims to measure the progress of participants after they have attended the 3D printing training.

Material and Tool

The materials used in this training include: a) PLA filament 30 m x 1.75 mm white (1 roll), b) PLA filament 30 m x 1.75 mm green (1 roll), c) PLA filament blue 10 m x 1.75 mm (2 rolls), and d) PLA filament yellow 10 m x 1.75 mm (1 roll). The tools used in this training consist of: a) 1 unit of 3D printing machine with specifications (Type: 3 axes, Axis dimensions: 200 x 200 x 200 mm, Filament type: PLA plastic material), b) Projector, and c) Laptops and computers.

Results and Discussion

The training was conducted over one day. The activity began with administering a pretest to all participants to assess their understanding of the basic concepts of 3D printing (Levin et al., 2020). Following this, participants received an explanation about the fundamentals of 3D printing, the names and functions of the components of a 3D printer, and the use of software in the 3D printing process (Chen et al., 2018). Figure 2 shows the enthusiasm of the participants during the explanation of the basics of 3D printing.

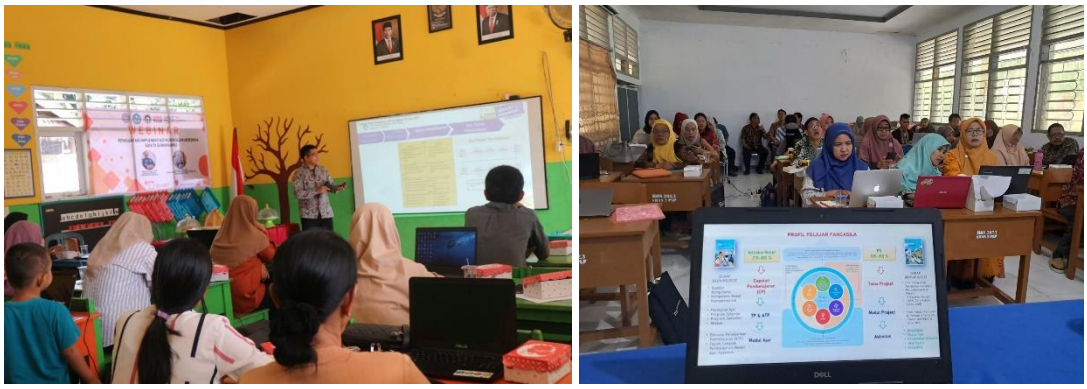

Figure 2. *Initial explanation of the concept of 3D printing to training participants*

The next activity involved demonstrating how to set up the 3D printing machine until it was ready for use. Following this, instructions were provided on how to create a simple 3D model and convert it into a ready-to-print 3D model using software. Most participants had prepared their own designs before the training began. Figure 3 shows the process of presenting the 3D model material.

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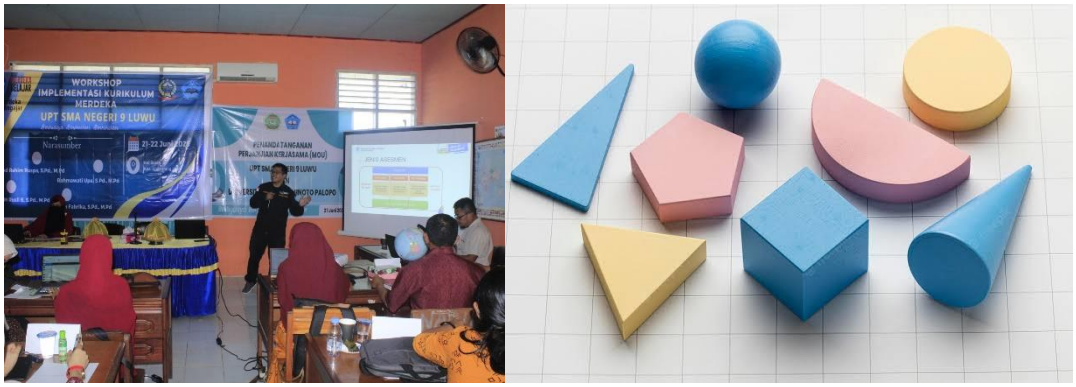

Figure 3. *Explanation of ready to print 3D design concepts*

After the participants successfully create print-ready 3D models, the next step is to print the 3D designs using a 3D printing machine. This machine uses PLA plastic filaments. Figure 4 illustrates the process of printing a 3D model with the 3D printing machine.

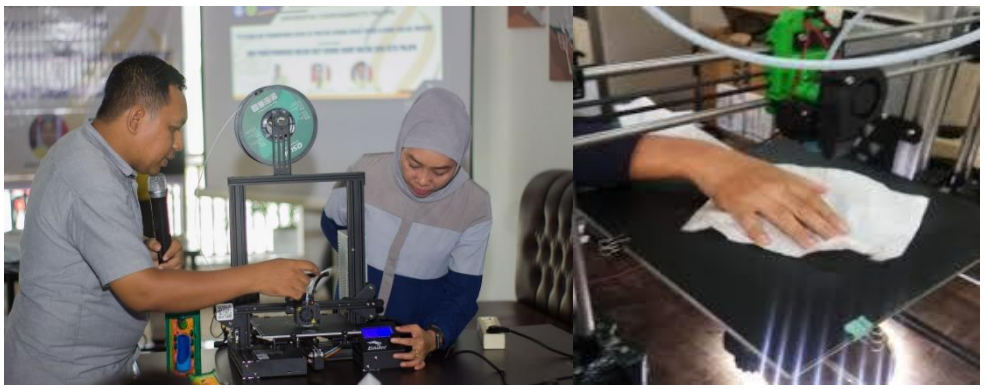

Figure 4. *Training participants print 3D models using a 3D printer machine*

Overall, the 3D model printing process went smoothly without any issues. All designs were printed successfully. However, some models required a longer printing time. The printing duration is influenced by the size of the design, mesh element size, and design details. Figure 5 shows several 3D designs that were printed by the training participants.

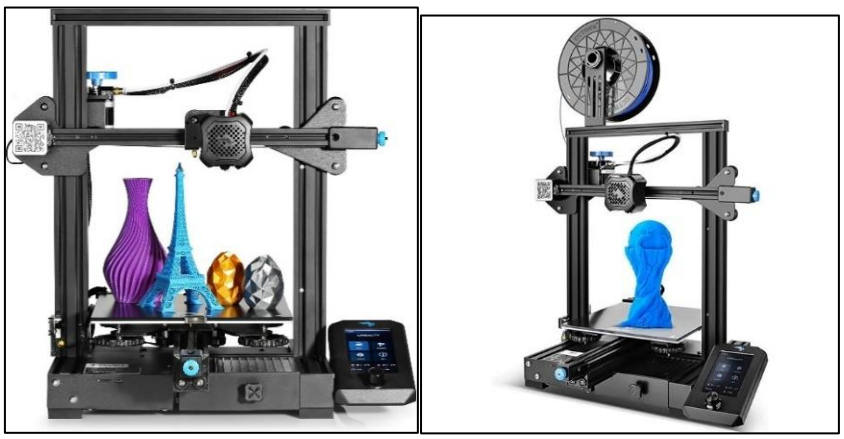

Figure 5. *Printing results 3D objects using 3D printer machine*

The final activity of the training process is the administration of a posttest for all participants. This posttest aims to assess the improvement in participants' abilities after the training. The improvement is observed by comparing the pretest and posttest results. Figure 6 illustrates the comparison of participants' abilities based on the average scores of 20 participants for both the pretest and posttest.

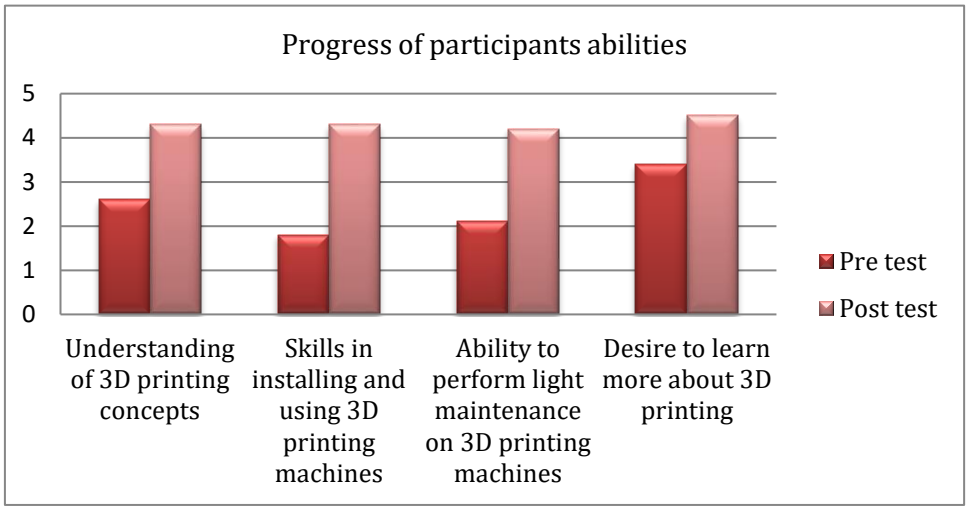

Figure 6. *Comparison chart results pretest and posttest participant training*

Based on Figure 6, the evaluation of skills in the four categories shows a significant improvement. This indicates that 3D printing technology is still relatively unknown among the public, particularly within educational institutions. Participants had a basic understanding of this technology from their experience with CNC machining, which is why the pretest scores for these skills were relatively high. After the training, participants' understanding increased by 1.7 points. They were taught that the working principles of 3D printing differ from CNC; 3D printing uses an additive principle, while CNC employs a subtractive principle. For skills in installation, usage, and maintenance of the machine, the pretest scores were quite low (1.8 and 2.1 points respectively) and improved significantly to 2.5 and 2.1 points after the training. Since SMAN 2 Palopo does not yet have a 3D printer, participants encountered a new experience in operating the machine during the training. This contributed to the low pretest scores in installation, usage, and maintenance skills. The novelty of 3D printing technology was quite engaging for participants, as reflected in the relatively high pretest score (3.4 points), which increased after the training.

The training covers a range of applications in 3D printing technology across various fields, broadening participants' perspectives. Increased knowledge about 3D printing technology enhances their understanding (Ballard et al., 2018). As part of the evaluation, participants were given the opportunity to complete a satisfaction questionnaire. The results from the online questionnaires completed by the participants reflect their level of satisfaction, which is summarized in Figure 7.

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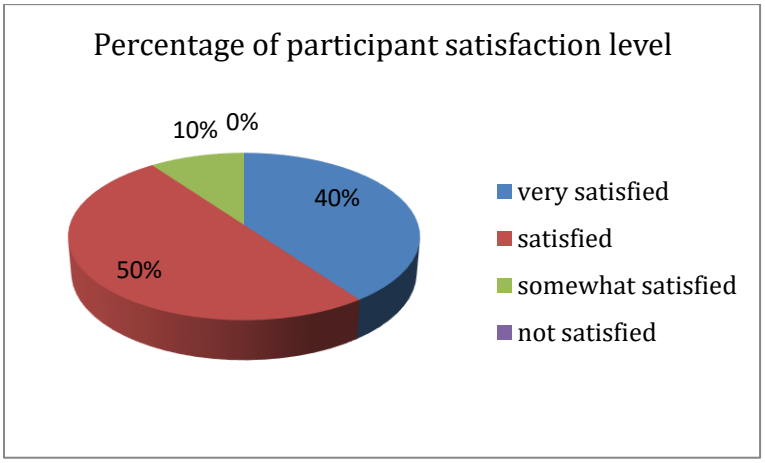

Figure 7. Level diagram satisfaction participant training

According to the participant satisfaction chart in Figure 7, 50% of participants reported being satisfied, 40% were very satisfied, and 10% felt somewhat satisfied. No participants reported feeling dissatisfied with the training. It is hoped that in future training sessions, over 80% of participants will be very satisfied, with no participants feeling dissatisfied. Feedback from participants will be used to improve the quality of future training. At the end of the activity, participants took a group photo. This training is expected to help teachers at SMAN 2 Palopo understand and effectively use 3D printing technology according to their level of knowledge (Wendt et al., 2019). These skills can then be taught to students through seminars, extracurricular activities, or integrated into the curriculum.

Conclusion

The 3D printing training organized by lecturers and representatives from Cokroaminoto Palopo University, along with teacher participants from SMAN 2 Palopo, proceeded smoothly. Based on data from pretest, posttest, and the results of 3D model printing by participants, it can be concluded that the training successfully improved participants' abilities and skills in installation, 3D model creation, and effective use of 3D printing machines. The entire training process was followed by participants from start to finish. Participants' understanding increased by 1.7 points after the training. In terms of skills related to installation, use, and maintenance of machines, participants' pretest scores were relatively low (1.8 and 2.1 points, respectively), but these scores significantly increased to 2.5 and 2.1 points after the training. Meanwhile, the pretest score for interest in learning about 3D printing technology was 3.4 points and rose to 4.5 points post-training. The evaluation results indicate that 3D printing technology is not yet well-known, particularly within educational institutions. With this training, it is hoped that teachers at SMAN 2 Palopo will be able to understand and master 3D printing technology according to their individual knowledge.

Acknowledgment

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