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Making Accessories with 3D Printer, the New Methods for Vocational Education in Bandung

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ABSTRACT
Vocational High Schools (SMK) have technical and practical learning methods. The teachers always give simulations for students directly for the best education. Both must follow the trends of machine and technology innovation. Three-dimensional printing (3D printer) is increasingly being used by industry 5.0. Operational knowledge of this machine must be conveyed from an early age, including vocational students. This study aims to improve teacher and student's knowledge about 3D Printer in the new normal adaptation because of pandemic Covid-19. The learning method was online training with pre-test and ended with post-test for 15 participants. The training teaches how to make interior accessories (flower vases) by printing on 3D Printer. This study used T Paired Test Student analysis on the score of pre and post test. The 0,000 values T Test is significantly below from $p<0.05$. The mean score of pre test is 51 meanwhile the post test is 76 with maximum score 100. The results of this study showed that the online training can increase all trainees knowledge about 3D Printer. Also, the trainees could know about the slicing process of making interior accessories in 3D Printer software without any offline meeting.

Keywords: *Online training, 3D printing, Interior accesoris, Vocation education.*

1. INTRODUCTION

In the mid-1980s, the Three Dimensional Printer (3DP) was developed, along with the development of computer technology and control systems [1]. Currently this technology is known as Additive Manufacturing (AM). The term Additive Manufacturing was taken because this technology works to build three-dimensional objects by adding layer by layer of certain types of materials (plastic, metal, and ceramic). Currently 3DP is widely used in the manufacturing industry for the manufacture of prototypes, finished products in small quantities, customized products, high value products such as aircraft components and equipment related to the world of the health [2]. In the future, 3DP will be a technology capable of shifting old (conventional) technology in the world of design, sculpture and manufacture. Especially to form geometric shapes that are more complicated, asymmetrical, precise and more quick [2].

Then, on the economic side, the 3DP Market is predicted to grow rapidly [3]. The global 3DP potential market in 2025 is estimated to reach US$ 230-550 billion spread across several manufacture industry sectors. Among them are personal use (US$ 100-300 billion) for home production or just a hobby in the world of direct production for components of medical equipment and transportation (US$ 100-200 billion) and lastly in the production of molding for container casting, which is around US$ $30-50 billion [4]. In the data yearbook, information and reports on the creative economy in Indonesia, namely the Opus 2019 book [5] shows that the 8 trends of the creative economy in Indonesia are as follows:

Table 1 Trends in the Development of the Creative Economy in Indonesia.

No	Creative Economy Trends in Indonesia
1	Internet of Things (IoT)
2	Artificial Intelligence (AI)
3	3D Printing
4	Augmented Reality (AR)
5	Robots
6	Drones
7	Virtual Reality (VR)
8	Blockchain

(source: 2019 RI Creative Economy Agency)

The 3D Print sector is included as a pretty good economic growth forecast and will be widely used in the

future. In addition to the manufacturing industry sector, there are also various new business models in the creative industry sector as a result of the presence of 3DP technology. According to Beritaempat.com [6] some examples from the used of 3DP technology include:

1. Make Eyewear, which can print glasses and the required accessories.
2. Tecnologia Humana 3D, printing a replica of the baby's fetus in 3D after performing an ultrasound scanning for pregnant women.
3. Spuni, printing products for baby use, such as spoons that are adapted to the shape of the mouth.
4. Thinker Thing, the most advanced 3D printer startup business, which is scanning the concepts that are in our heads, which are captured into visual form using a computer, then printed to become replica.
5. Shapeways, print models or prototypes ordered from around the world through online channels.

3D Print technology has been widely used in the education, health, and aerospace industries [7]. This technology also offers the following benefits:

1. Fast and cost-effective experiment. Designs can be quickly and easily printed and tested. If needed, further works can be made at an affordable price point. This is especially useful for companies looking to build prototypes at home.
2. Business Tools. This technology can quickly print works and equipment products for machines or vehicles. Designers can also customize it to suit their needs.
3. Showing ideas. Sometimes, 2D illustrations are not enough to convey complex concepts. 3D printing allows ideas to be viewed in three dimensions and explored more deeply.
4. Promotes better health. 3D printing can be used to create prosthetic limbs, assist dentists, print knee and hip joint replacements, and much more.
5. Educate and explore. Schools use 3D Print to encourage children to design, test, and improve design concepts. 3D models can be created to explain aspects of the school curriculum.
6. Creating end-user products. 3D Print brings new possibilities to retailers, designers and more. Even metal products (such as jewelry) can be printed, and bespoke items made for customers.

Figure 1 The various types of 3D print machines. (Source: www.indoprinter3d.com).

The development of the design world invites every individual to think more creatively with the work they produce [8]. In interior design, which is a spatial planning study, always follow the development of creative accessories designs [9]. The design of these accessories can be used as a support for the desired layout. Some examples of these accessories designs can be in the form of flower vases, tissue covers, photo frame placemats, action figures, wall decorators, and so on. The inspiration and creation of these design ideas must be very possible to be created and developed together through shared learning media (workshops or training). Through the 3D Print machine approach, all the accessories design ideas can be made in real life [9].

Figure 2 Examples of product that can be made by yourself using 3D Print engine technology such as smartphone holders and action figures. (source:google.com).

Figure 3 Some examples of interior accessories that can be printed independently, such as flower vases and toy cars (diecast). *(source:google.com).*

One of the other benefits of being able to learn 3DP machines can be used to fill time by working alone when conditions are not as conducive as today. The existence of a Work From Home (WFH) and School From Home (SFH) policy allow teachers and vocational students to work independently in their respective homes [10]. The work can also be traded online to increase home income [11]. One of the changes that are likely to continue as a trend is the culture of learning and working from home which is no longer limited from a school or office building, but is an option to work from a remote location (remote working or teleworking) [12]. Moreover, for students and teachers in urban areas with high levels of traffic congestion, the implementation of this system can certainly ease the burden of transportation in seeking knowledge as well as create a balance between the rhythm of studying or working with personal life (work-life balance) [13].

The existence industrial revolution 4.0 forces technology, internet applications, design and prototyping to be mastered and developed by today's young Indonesian generation [14]. Vocational High Schools (SMK) as the front line in providing professional education services must also always be up to date in seeing opportunities for technological innovation. As a means of supporting multimedia, 3DP technology must be introduced to vocational students because it is one of the latest technological innovations [15]. Vocational students and teachers who already understand and are proficient in processing 3D software (such as 3Ds Max, Sketch Up, Blender, Solidworks, etc.) can develop their work in a tangible form. That is an object that can be seen, touched, and feel the texture. The results of the 3DP also strengthen the spatial power and design calculations of vocational students. This cause by turning the results of visual designs into scalable real forms, it will make the spatial performance of the right brain sharper in analyzing shapes, sizes, and texture patterns [16]. On the other hand, vocational students also have high learning motivation [15]. The students feel happy to understand more when invited to learn in practice.

According to a survey conducted by researchers, several state vocational schools in the city of Bandung have their own specializations. For example, SMKN 3 Bandung, which is located at Jalan Solontongan No. 10 RT. 03 RW. 06 Kel. Turangga Kec. Lengkong, Bandung, has a 3-dimensional-based department in the Multimedia department, SMKN 4 Bandung which is located at Jalan Kliningan No 6, Bandung has some technical expertise in electrical installations, media and electronics and there is also 3D animation. Then there is SMKN 6 Bandung which is located on Jalan Soekarno-Hatta (Riung Bandung Complex). There are several excellent majors such as wood construction engineering, building drawing engineering, mechanical engineering and light vehicle engineering. Then SMKN 9 Bandung, which is located on Jalan Soekarno-Hatta KM 10 RT 009 RW 006, Kel. Jatisari, Kec. Buah Batu, Bandung, also has a boutique fashion department and visual communication design.

Figure 4 In order from left to right is a symbol of SMKN 3 Bandung, SMKN 4 Bandung, SMKN 6 Bandung dan SMKN 9 Bandung. (source:google.com).

Some of the focus expertise belongs to these SMK will be even more innovative when new skills are added to support it, one of which is expertise in operating 3D Print machines. With these skills, three-dimensional spatial cognition can be developed by making printed model. Thus, in a pandemic condition like now, the problem faced by several vocational schools is how to provide work or activities to students and teachers so that they can continue to work. One of them is through expertise in using three-dimensional aplication [11].

2. METHODS

The training was conducted online due to the instruction study and work from home (WFH & SFH). The platforms used in this education method are the Zoom Meetings and Whatshapp Group. Activities take place every Saturday for two different days. Before starting the training, the presenters gave pre-test questions to test the trainees initial understanding of the 3DP machine. After that, participants were invited to get to know the theory, benefits and real form of the machine through the speaker's camera. The 15 participants which consist of students and teachers drom

SMKN 3, SMKN 4, SMKN 6, and SMKN 9 Bandung were also invited to learn about Ultimaker Cura software as an intermediary software for 3D model files so that they can be read by machines (slicing software). On the second day, participants were invited to see the print and coloring the 3D object, followed by the distribution of post-test questions to test how well the trainees understood after two days of training. The pre-test and post-test questions are the same two questions containing 20 task, namely:

Table 2. Table of Pre-Test and Post-Test questions

No	Questions
01	What do you know about 3D Print?
02	How does 3D Print work?
03	When did 3D Print technology start?
04	Why did the trend of using 3D Print start increase after going a difficult time?
05	Here are some of the advan-tages in using 3DP, except?
06	Disadvantages of 3D Print are as follows, except?
07	Mention the areas that can use the 3D Print application!
08	What do you know about the Additive printing system?
09	What do you know about the Subtractive printing system?
10	What does FDM stand for?
11	What printing materials are used in FDM machines?
12	The following are considerations in choosing the type of 3D Print that is suitable for us, except?
13	What type of 3D printing machine if we want the prints to be more flexible, strong and neat (uses resin)?
14	Which of the following is a 3D Print printing machine with metal (iron) material?
15	The following are 3D modeling software, except?
16	Zbrush, Rhinoceros, Fusion and Blender are types of software in making?
17	Mention software for slicing 3D objects so that they can be read by 3D Print!
18	What format should it be made in, so that our 3D model can be read by the 3D Print software language?
19	What does .STL format stand for?
20	What is the format of the machine reader slicing software preview result?

The scores from the pre-test and post-test questionnaires were then summed and analyzed using the Paired T-Test Student formula in SPSS software. Paired T-Test is a parametric test that can be used on two paired data. The purpose of this test is to see if there is a difference in the mean between two related samples. Because they are related, the data from the two samples must have the same amount or come from the same source. Paired T-Test is part of parametric analysis so the data must be normally distributed. To find out that the data used is normally distributed, a normality test must be carried out first [17]. The author conducted a normality test using Shapiro Wilk on SPSS. Normality test aims to determine whether the research data is normally distributed or not. Because, in parametric statistics the normal data distribution is an absolute requirement. After knowing that the results of the data are normally distributed, then the next step is to test the data using Paired T-Test analysis. The use of Paired T-Test because the researcher wants to test whether there is a difference in the value of understanding 20 questions above before and after the training.

3. DISCUSSION

The training activities were carried out over two different days, with the following rundown of events:

Table 3. The table of training event rundown

Day	Time	Activity
Saturday, 24th Oktober 2020	08.30-09.00 wib	Opening by MC, Singing Indonesia Raya, Mars Telkom University, Pre Test
	09.00-10.30 wib	Course 1-Introduction of 3D Printing Machine Technology
	10.30-10.45 wib	Ice breaking
	10.45-12.15 wib	Continuing Course 1
	12.15-13.15 wib	Break, pray and lunch at home
	13.15-15.00 wib	Practicing to install Ultimaker Cura software, insert 3D objects, and how to connect to 3DP machine
	15.00-16.00 wib	Free consultation session and closing of the first day activities
Saturday, 7th Nov 2020	08.30-08.45 wib	Registration and opening by MC
	08.45-10.30 wib	course 2-object coloring and product photography technique
	10.30-10.45 wib	Ice breaking
	10.45-12.15 wib	Product coloring and photoshoot mentoring session-1
	12.15-13.15 wib	Break, pray and lunch at home
	13.15-15.00 wib	Product coloring and photoshoot mentoring session-2
	15.00-16.00 wib	Free session, consultation, sharing and post test distribution
	16.00-selesai	Take picture for documentation, impressions message and closing

(Source: author)

Representatives from each SMKN register when filling out online pre-test and post-test questions, while the registered training participants are as follow (table 3):

Table 3. Table of the Number of Teachers and Students Participating in the Training When Filling Out the Pre-Test and Post-Test Questions

No	Name	Status	Asal SMKN
01	Mohamad Ismail	Teacher	SMKN 3 Bandung
02	Muhamad Dafa Maulidya	Student	SMKN 3 Bandung
03	Yurita Ayuningtias Priandini	Teacher	SMKN 3 Bandung
04	Mastria Br P	Teacher	SMKN 3 Bandung
05	Aristo Nidzar	Teacher	SMKN 3 Bandung
06	Raden Ridwan Nurmatullah	Teacher	SMKN 4 Bandung
07	Arif Syaripudin	Teacher	SMKN 4 Bandung
08	Dadan Hermawan	Teacher	SMKN 4 Bandung
09	Ridwan Gusnawan	Student	SMKN 4 Bandung
10	Tyas Purnamasari	Teacher	SMKN 6 Bandung
11	Wawan Sopian	Teacher	SMKN 6 Bandung
12	Asep Irwan Suherman	Teacher	SMKN 6 Bandung
13	Ariyodhani Muhammad	Student	SMKN 9 Bandung
14	Kartika Nursyabanita H.	Student	SMKN 9 Bandung
15	Sapaat Nurjabar S.M	Teacher	SMKN 9 Bandung

(Source: author)

In general, the activity event is divided into several important moments consisting of:

3.1. Provision of Basic Theory

The course for the activity was delivered by Telkom University lecturers through the share screen of the Zoom Meeting application. The material presented in this first session was about the history, theory and comparison of the use of 3DP machines with conventional machines such as CNC machines and laser cutting. The speakers also provided insight into the potential use and business of industrial engineering in the future. Where the 3DP machine can be used as an alternative in making toys, making new hobbies and alternative needs for items that are needed but difficult to find in public places. Another insight that was conveyed was regarding the types of 3D Printing machines, where there are types of 3D Printing made of plastic (3DP FDM type), liquid resin (SLA type), and iron powder (Binder Jetting).

Figure 5 Basic materials for the introduction and potential of the 3DP machine in the future. (*Source: author's material).*

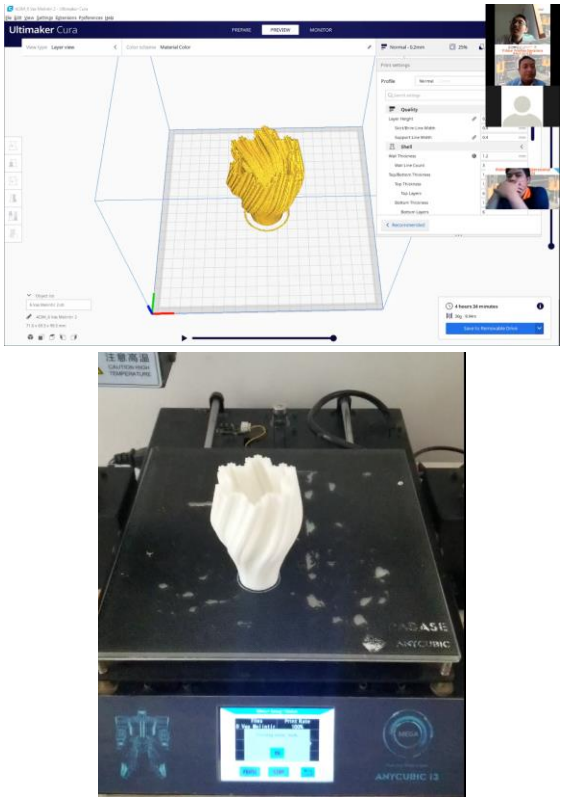
3.2. 3D Printing Machine Practice

The machine used during the training is a 3DP type plastic filament machine (FDM), namely the Anycubic i3 Mega machine. The presenters put a camera in front of the machine and in front of the screen as an illustration in operating, showing the printing process and showing the finished print.

(Source: author's documentation)

Figure 6 Placement of the camera in front of the screen and in front of the machine as an illustration of the process of sending and printing 3D models.

After setting the picture of the printing process, the presenters divided trainees into six groups. All participants were given a download link for the Ultimaker Cura slicing software and six 3D model files in the form of a 3D Flower Vase design. The presenters provide directions in opening 3D files, adjusting the scale and size, to managing printing technicalities. The practical exercise ends with the preview process of the Flower Vase which is ready to be printed on the machine. Participants were given homework for one week to conduct group discussions about setting up 3D files in the slicing software. After the 3D slicing results are obtained, the trainees send the preview file back to the presenter to be printed on the presenter's 3DP machine. The documentation process is carried out at the printing stage of each flower vase from 5% progress, 50% to 100% complete. All documentation files are sent via whatsapp group (WAG) so that all participants can see the printing process off all group.



(Source: author)

Figure 7 Unveiling of 3D models in Ultimaker Cura, and the result prints of model settings made by participants.

3.3. Delivery of 3D Printed Flower Vases for Each Group

After the printing process is complete, the flower vase prototype is sent back to the trainees for the finishing process. The finishing process is an activity which contain of coloring the prototype using acrylic paint and also photograph it. The delivery of prototype is addressed to the one of the group leader. At the group leader's house each trainees conducts a discussion for the finishing process and technique. After the coloring process is dry, it can be photographed with a white background to further strengthen the flower vase model.

(Source: doc. Author)

Figure 8 The delivery of 6 flower vases was also accompanied by acrylic paints and brushes for coloring materials for each participant.

After each group received the object and finishing tools, they were then required to document the coloring process until the process of shooting photography. Some of the trainees photos can be seen in the following documentation:

(Source: Author's documentation)

Figure 9 Documentation of the coloring process and evaluation of the results photographing flower vase printed objects that have been sent to participants at their respective homes.

3.4. Post Test, Take Picture for Documentation, Impressions Message and Closing Activity

On the second day, finally the entire series of course and practices could be carried out by the presenters and participants both during direct meetings and consultations through WAG. Trainees had a lot of discussions about the print and finishing that had been done. More discussion about the color selection process to the desire to deepen the knowledge of 3D Printing machines. Before the training event was closed, the MC and the presenters invited all trainees participants to work on the post test questions again, make an impressions message and ended with taking pictures together.

(Source: doc. Author)

Figure 11 Taking picture as an appreciation for all participants who participated in the all two-day training.

4. RESULTS

The scores results from the participants pre-test and post-test were then summarized and analyzed using SPSS software. The first analysis carried out a normality test using Shapiro Wilk on SPSS, the results of the normality test as followed figure 12:

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre Test	,161	15	,200*	,935	15	,321
Post Test	,233	15	,027	,910	15	,136

(Source: doc. Author)

Figure 12 The Results of the Normality.

Normality test aims to determine whether the research data is normally distributed or not. The basic for making normality decisions is to look at the results of Shapiro Wilk's Significance (Sig.) value from the table above. If the value of Sig. > 0.05 then the research data is normally distributed. And vice versa, if the value of Sig. <0.05 then the data values are not normally distributed, meaning that the results of the pre-test and post-test scores are not much different. From the data above, both the value of Sig. the results of the Pre Test and Post Test both showed 0.321 and 0.136, both of these values > 0.05 (more than the value of 0.05). So it can be concluded that the pre-test and post-test data are normally distributed. The value obtained from the participant's test is close to the ideal standard value. Ater normality test, it continue for the descriptive statistical analysis, as can be seen figure 11 below:

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Test	51,00	15	11,212	2,895
	Post Test	76,33	15	8,958	2,313

Figure 13 The statistical table of the average participant scores from the results of the Paired T-Test. (Source: doc. Author).

In the output of the analysis above, it can be seen the summary results of descriptive statistics from both pre-test and post-test samples. The descriptive statistics above contain the average value of the first test, which is 51, and the average value in the final test is 76.33 so that it can be seen that there is an increase in the average value of participants' understanding from before receiving training until after receiving the training. Then to show the results of the significant difference from the overall value of the pre-test and post-test data, it can be seen in the following figure 12:

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pre Test - Post Test	-25,3	11,25	2,906	-31,566	-19,101	-8,718	14	,000

Figure 14 Statistical table of the results of the Paired T-Test test to see the significant difference between the pre-test and post-test. (Source: doc. Author).

The basic for decision making is if the value of Sig. (2-tailed) < 0.05 then there is a significant difference between the results of the training in the pre-test and post-test, as well as the opposite if the data Sig. (2-tailed) > 0.05 then there is no significant difference, which means that there is no effect between being given training or not, because both do not provide understanding. However, from the results of the table above, it can be seen that the results of the Sig. (2-tailed) is 0.000 values < 0.05 (less than the value of 0.05), so it can be concluded that this 3D Printing machine operation training can provide significant understanding to the trainees participants.

5. CONCLUSION

Training on operation of 3D Printing machines for students and teachers at four Vocational High Schools (SMK) in Bandung turned out to have a positive impact on new understandings in the field of industrial product engineering. The training conducted by the Interior Design Lecturer at Telkom University Bandung can increase all trainees knowledge about 3D Printer. Also, the trainees could know about the slicing process of making interior accessories in 3D Printer software. It have a significant impact on the insight of technological innovation which is rapidly grow up in the era of revolution industry 5.0. The existence of Covid-19 pandemic that requires working and studying from home does not reduce the enthusiasm in spreading knowledge and experience to the younger generation. Through the Zoom Meeting and Whatsapp Group software with a few camera settings, we can send visual images of each training process for the trainees at home. They can interactively touch and coloring the 3D printed object (flower vase accessories decorating) after being sent to each group leader's house. The pre-test and post-test testing methods can effectively measure the significance difference of learning participants before and after receiving the training theory. The Paired T-Test method can also be used to test students' understanding in online education.

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