

Transfer Technology of Laser Engraving Machine for Vocational School in Tegal District

Khairul Anuar bin Abd Wahid ^{1,*}, Muhammad Agus Shidiq ², Muhammad Fajar Sidik², Hadi Wibowo ², Galuh Renggani Wilis ², Irfan Santosa ²

¹ Mechanical Engineering Department Universiti Kuala Lumpur Malaysia

² Mechanical Engineering Department, Universitas Pancasakti Tegal

*Corresponding Author: khairulanuarabdwahid@unkkl.edu.my

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ABSTRACT

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Keywords

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Background: The problems and challenges that occur in Vocational High Schools (SMK) today are curriculum used is not aligned with the competencies, SMK graduates are not absorbed in the business world and the industrial world, the lack of quality products, competency test facilities, cooperation between companies, government agencies, the business world, and universities. Some of the weaknesses can be overcome through synergy between universities and vocational schools through Community Service activities, one of which is regarding CNC-based machines.

Contribution: The contribution of this program is that the Pancasakti University of Tegal, especially the Faculty of Computer Science Engineering in collaboration with SMK Negeri 1 Bumijawa, will carry out learning activities for laser engraving machine training to enhance students' knowledge and experience.

Method: The learning model used is theory and practice. The theory is given before practical learning or integrated during practice and at the last meeting an evaluation is held.

Results: Training activities through this community service program are divided into several activities, including socialization of the laser engraving training program, Implementation of Theory and practice regarding Laser Engraving Technology, Post-Training Evaluation.

Conclusion: The conclusion of this program states that the participants can increase their knowledge and understanding of laser engraving machine technology.

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INTRODUCTION

Learning is a business process carried out by someone to get new changes as a result of their own experience in interaction with their environment [1]. According to Sadirman [2] in general, there are three (3) learning objectives, namely: 1. To obtain knowledge, where the results of learning activities can be characterized by increasing one's thinking ability, 2. Instilling concepts and skills both physical and spiritual skills, 3. Shaping the mental attitude of students by instilling values to foster awareness within them. Whereas learning is a process of interaction between students and educators and learning resources in a learning environment where learning and learning theories include: Behaviorism Theory, Humanistic Theory, and Constructivism Theory [3]. Learning patterns, especially in Indonesia, are still relatively low compared to neighboring countries such as Malaysia because the quality of teaching staff is still minimal at the elementary, junior high, and high school/vocational school levels. Even in university institutions, the quality of lecturers in making scientific work is still minimal. Economic and technological progress in this era of globalization increasingly demands the availability of qualified and competent Human Resources (HR) in all business sectors, to be able to face increasingly fierce competition. This causes the need to increase the capacity of local human resources so that they are recognized as having competence in their respective fields. Based on a report from the Badan Pusat Statistik (BPS) Indonesia the number of open unemployment rates in Indonesia reached 7.24 million people [4]. Based on educational status, graduates of Vocational High Schools (SMK) are the most unemployed. The number reached 813,776 people or 11.24 percent of the total open unemployment rate [5].

The problems and challenges that occur in Vocational High Schools today are: [6]

1. The SMK curriculum used is not aligned with the competencies according to graduate users (link and match)
2. The number of SMK graduates who are not absorbed in the business world and the industrial world is quite high due to the low competence of graduates
3. The establishment of SMK expertise competencies tends to be based on "trendy"
4. The lack of productive teachers and the lack of quality productive vocational teachers
5. Lack of competency test facilities and SMK certification facilities
6. Lack of cooperation between companies, government agencies, the business world, and universities in implementing dual-system education

Some of the weaknesses above can be overcome through synergy between universities and vocational schools through Community Service activities, one of which is regarding CNC-based machines. The development of industrial technology can assist the manufacturing industry in producing products that are quality. One tool that can help produce quality products is a CNC machine [7]. System application numerical control as a controller is considered capable produce products with high-quality accuracy. CNC Machine (Computer Numerical Control) combines a numeric system with control computers to drive machine tools fully [8], [9], [10]. The study examines the effect of pulse frequency, beam speed, and layer thickness on the surface roughness of engraved materials. The experimental results showed that the surface roughness of the laser-engraved material was highly dependent on the process parameters used. The researchers found that increasing the pulse frequency and decreasing the beam speed resulted in a smoother surface finish. In contrast, increasing the layer thickness resulted in a rougher surface finish [11] the use of laser engraving in microfabrication, including the benefits of high precision, flexibility, and versatility, as well as its applications in the fabrication of microfluidic devices and other microstructures [12]. Several previous studies have explained

the working principles, advantages, and accuracy of a CNC-based machine the basis of this research will be used as the basis for socializing CNC-based machines to the public.

Several applications of learning models are carried out by university institutions to schools or groups in the community through community service programs including CNC machining practice training for Jakarta Vocational School teachers [13] where the output of this activity is providing training and CNC machining practice to teachers at Jakarta Vocational School, starting from good CNC machining techniques, to CNC machine maintenance management. Then the empowerment of UKM groups of silver/silver craftsmen to increase their production was also carried out by [14] where activities included: socialization of activities to the provision of materials and training to the manufacture of products for the target group. CNC router training was also carried out [15] for the BUMDES target group in Heubeulisuk Village, Majalengka Regency, and Small Industry Groups in Tegal City [16], Karang Taruna organization (katar) in Cilobak, Pondok Labu, Jakarta [17], where training activities included: training on using the CNC Router, preparation of cutting tools, making models through CAD, to the execution/feeding of the workpiece. Another learning model is creating an innovation village through composites in Bangsri village and Pesantunan village, Brebes Regency [18], where activities include soft and hard programs.

From several community service programs carried out by university institutions through their lecturers to target community/school groups, it is proven that the learning and learning process is not only carried out within the scope of the class/room but can be carried out together with the community. SMK Negeri 1 Bumijawa Tegal Regency is located in a rural or mountainous area with a geographical location of 2.26.466 South Latitude consisting of 6 concentrations of expertise namely: Light Vehicle Engineering, Electrical Installation Engineering, Motorcycle Engineering, Industrial Automation Engineering, Computer Network Engineering, and Communication Design Visual [19].

The purpose of this program is to introduce CNC laser engraving machines. The urgency of this program is that the Pancasakti University of Tegal, especially the Faculty of Computer Science Engineering in collaboration with SMK Negeri 1 Bumijawa, will carry out learning activities for laser engraving machine training to enhance students' knowledge and experience. The selection of themes regarding laser engraving machine training activities is to introduce and train students of SMK Negeri 1 Bumijawa to be able to operate CNC (computer numerical control) based laser engraving machines. The choice of SMK Negeri 1 Bumijawa as the target location for Community Service Program activities was because the university institution wanted coordination and communication to be established between the school and the university institution in the hope that students from SMK Negeri 1 Bumijawa after graduating could continue their studies at Pancasakti University in Tegal.

METHOD

The method of this service activity refers to several methods carried out by Salam [20], and Widodo [21], where the orientation of the participants is students and teachers of SMK, but in this activity the group of participants were students of SMK Negeri 1 Bumijawa. The laser engraving machine training is planned for 8 hours of learning for SMK Negeri 1 Bumijawa students, especially the scientific concentration of Industrial Automation Engineering. Implementation in theory and practice of how to operate a laser engraving machine from preparation to the machining stage. The learning model used is theory and practice. The theory

[22] is given before practical learning [23] or integrated during practice and at the last meeting an evaluation [24] is held. The theory given includes:

1. Development of Digital Factory Manufacturing Industry 4.0 on CNC Machines [25].
2. Engraving Machine Design [26], [27].
3. Operation and troubleshooting of Engraving Machines [28], [29], [30].

The implementation of the training is made in a community service flowchart as shown in Figure 1 below:

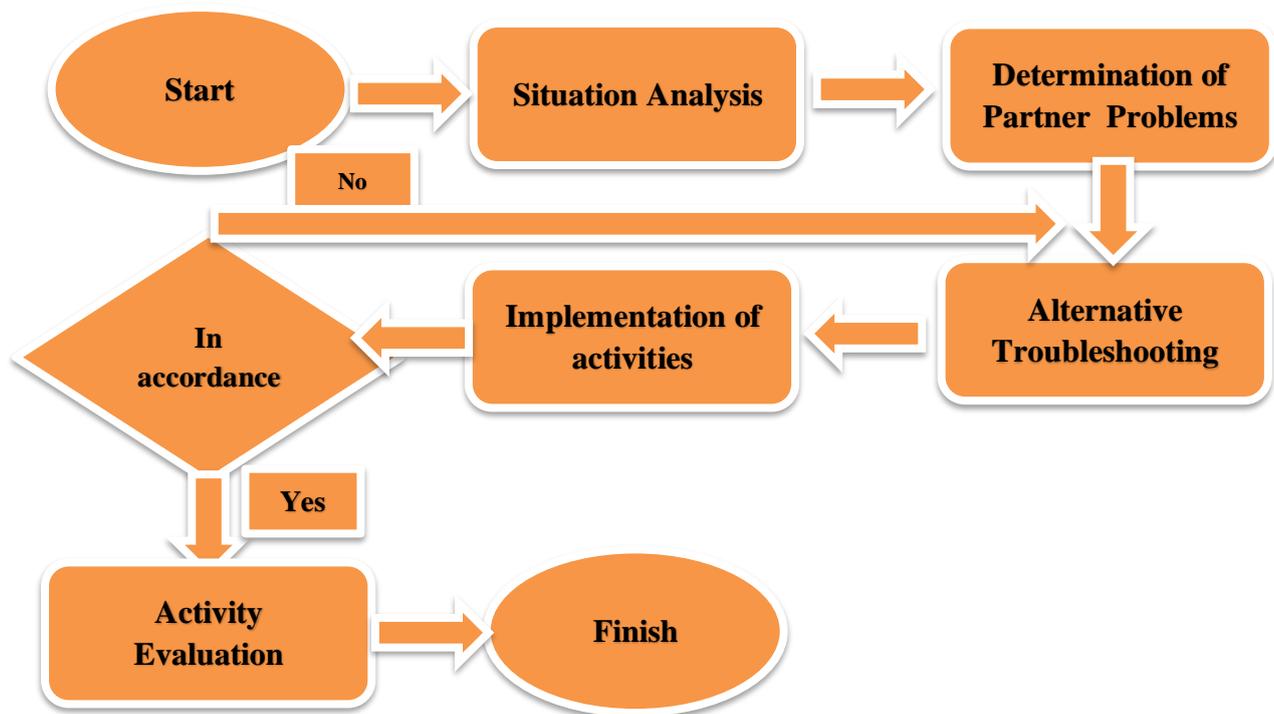


Figure 1. Community service program flow chart

The explanation of the flow chart is:

1. Start Coordination between teams and the responsibilities of each team.
2. Situation Analysis: The team came to the Head of SMK Negeri 1 Bumijawa to explain the community service program.
3. Determining Partner Problems: Determining problems based on interviews with the Principal of SMK Negeri 1 Bumijawa and seeing potential resources from the University
4. Alternative Problem Solving through Community Service Programs by applying theory and practice to students.
5. Implementation of activities at SMK Negeri 1 Bumijawa with target students with a learning duration of 8 hours.
6. Is it acceptable: In this section, students are given learning through theory and practice. Yes, if students can rate and make simple products, and No, then theory and practice will be repeated for students.
7. Activity Evaluation: At the end of the activity students are given questions and answers online (using Google Forms).
8. Finish: End of Program

RESULTS AND DISCUSSION

Training activities through this community service program are divided into several activities, including:

1. Socialization of the laser engraving training program.

At this stage, the community service team, represented by the team leader, coordinated and communicated intensively with the Head Master SMK Negeri 1 Bumijawa starting from designing the lessons that the team would convey to the participants until the laser engraving machine practice stage (Figure 2). Coordination and communication are needed so that the team can prepare the material to be delivered so that it is on target according to what the participants want.



Figure 2. The team leader coordinates with the Headmaster of SMK Negeri 1 Bumijawa.

2. Implementation of Theory and Practice Regarding Laser Engraving Technology.

The presentation of the theory regarding laser engraving technology made by students of the Faculty of Engineering and Computer Science at the Pancasakti University of Tegal (Figure 3) was delivered by the team to 30 student participants from SMK Negeri 1 Bumijawa (Figure 4). Theories regarding the development of laser engraving machine technology, the need for tools, cost, and materials for making laser engraving machines (Table.1), how laser engraving machines work, image setup to the operational maintenance of laser engraving machines.

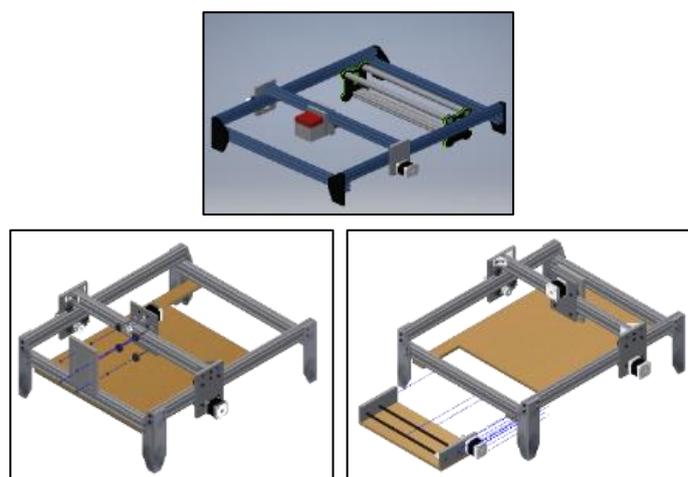


Figure 3. Design of a laser engraving machine frame.



Figure 4. The enthusiasm of participants in the laser engraving machine training at SMK Negeri 1 Bumijawa.

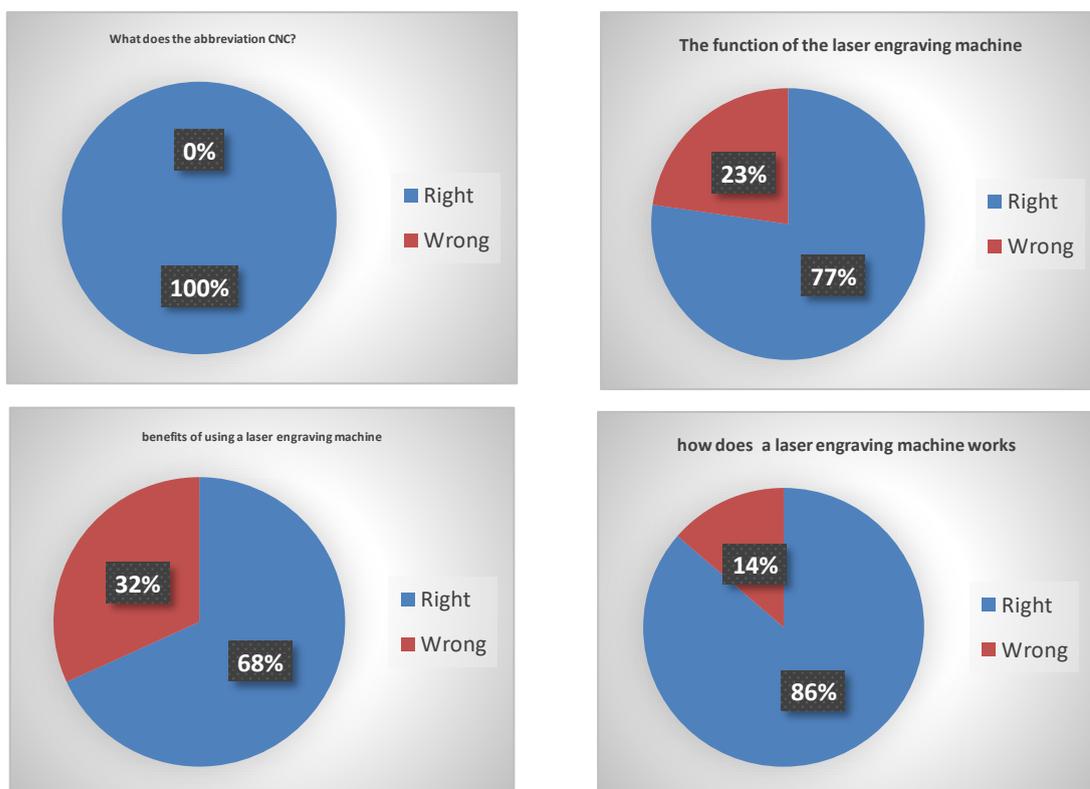


Figure 5. Graph of participants' responses to training activities.

Table 1. List of tools and materials for making laser engraving machines.

No	Tools and Materials	Amount/units	Spesification/Justification	Price
1	Ring	9	Size: 10x5x1 mm	Rp. 900
2	Bolts and nuts	8	Size: M5	Rp. 8.000
3	Double Tee Nuts	6	As Unlock	Rp. 16.500
4	Set Screw	6	M5 - 4mm	Rp. 6.000
5	Aluminum Spacers	16	6mm	Rp. 40.000
6	Bolts t L Low Profile	8	M5- 30mm	Rp. 8.800
7	Bolts L Low Profile	4	M5- 40mm	Rp. 12.000
8	Drop In Tee Nuts	8	Nuts alumunium Profil	Rp. 12.000
9	Solid V Wheel Kits	12		Rp. 60.000
10	Tee Nuts - M5	18	Lock nut	Rp. 27.000
11	Black Angle Corner Connectors	8	Elbow	Rp. 24.000
12	L-Bracket - Single	8	Connection lock	Rp. 120.000
13	Cable Ties	30	Ties	Rp. 6.000
14	Bolts L Low Profile	4	M5- 20mm	Rp. 4.000
15	Bolts Button Head	7	M3 - 8mm	Rp. 7.000
16	Bolts L Low Profile	8	M5 - 10mm	Rp. 8.000
17	Bolts Button Head	12	M3 - 10mm	Rp. 12.000
18	Bolts L Low Profile	8	M5 - 15mm	Rp. 8.000
19	Bolts L Low Profile	20	M5 - 8mm	Rp. 20.000
20	GT2-2M Timing Pulley	3	16 Gigi	Rp. 129.000
21	Bolts Button Head	1	M3 - 12mm	Rp. 1.000
22	Bolts and nuts	4	M3	Rp. 4.000
23	Tee Nuts	1	M3	Rp. 2.000
24	Akrilik	1	set	Rp. 300.000
25	Xtension Connectors - 2 Pin (Male & Female)	1	Cable extension 2 connector	Rp. 10.000
26	Xtension Connectors - 3 Pin (Male & Female)	1	Cable extension 3 connector	Rp. 10.000
27	Xtension Limit Switch	2	Switch	Rp. 12.000
28	GT2 Timing Belt	3	4 Feet 50cm	Rp. 110.000
29	V-Slot Linear Rail	3	20x40 - 1000mm	Rp. 360.000
30	Stepper Motor	3	NEMA 17	Rp. 450.000
31	Power Supply	1	12V 10A	Rp. 150.000
32	Arduino Nano	1	GRBL CNC Controller	Rp. 200.000
33	Diode Laser	1	5500mw	Rp. 1.470.000
34	Grinding cut	1	Used to cut off	Rp. 500.000
35	Hand grill	1	Used to drill	Rp. 190.000
36	L Keys	1 Seat	To tighten bolts	Rp.55.000
		Amount		Rp. 4.353.200

3. Post-Training Evaluation

The evaluation stage of the community service program regarding laser engraving machine training is to provide a questionnaire containing questions about laser engraving machine technology to see the participants' responses and knowledge of the training activities. The questions asked and the participants' responses can be seen in Figure 5.

Figure 5, can be seen that the participant's response to this activity was very good and they were able to understand the material and practice using the laser engraving machine that was instructed by the team. The evaluation contains multiple choice questions, several questions are done online using Google Forms. The evaluation contained questions about what CNC stands for, and 30 participants answered correctly. The percentage reaches 100%. The next question is about the function of the CNC laser engraving machine, the percentage of the answers given is 77% and 23%. The third question regarding the advantages of using a CNC laser engraving machine for the industrial world, the percentage of correct and incorrect answers for the students was 68% and 32%. The percentage of this answer is quite low because laser engraving technology is a new technology where students do not yet know the application of using a CNC laser engraving machine for the industrial world. For the last question regarding the workings of a CNC laser engraving machine, the students could answer correctly and incorrectly reaching 86% and 14%. This proves that students can understand how machines work.

Likewise, the answers to the level of participant satisfaction with this training activity can be seen in Table 2. When seen from the participant satisfaction level Table 2, the response of the participants in this laser engraving machine training activity was very enthusiastic and could add to their understanding, knowledge, and insights about this laser engraving machine. Even though 2 participants responded that they did not benefit and also did not understand the material presented by the team. But overall the conclusion is that the participants can accept this laser engraving machine training learning activity well and the enthusiasm is high.

Table 2. The level of satisfaction of the training participants

Participant response	Respondent Name
from this activity, I understand more about laser engraving machines	Ahda Farda Sabila
Nice and easy to understand	Sabrina Silviana
Become more familiar with the use of laser engraving machines	Muhammad Muflihul Azki
Be more prepared during visits to schools	Dimas
enough insight	Kuslia Sari
because the time is very short I do not understand	Sakila Oktaviani
From this activity, I can understand laser machines	Muhammad Mahfudin
Exciting	Laelatul Fitri
More interested in delivery	Alfian
Beneficial	Sri Mulyani
Very happy	Khamdani
Easy to understand and easy operation	Prasetyo Adi Nugroho
I don't understand	Alisa Nafa Safira
Good	Diva Rahmawati

exciting	Laelatul Fitri
Excellent	Abisar
can't understand	Diva Safira
We get input about laser engraving materials	Utha
Very interesting	Anas abi hamzah
Good to add insight	Kevin
Good	Utha Qutratu Aenur Zamzam
Enthusiasm to learn machine engraving	Sabila Andini

Table 3. Comparison of community service activities with the previous :

Community service	target students	Activity Target	Outcome
[31]	40 students	SMK Penerbangan	Students can open entrepreneurship
[32]	20 person	residents of the Cisaat village	Character education
[33]	25 person	residents of the Bandar Setia village	increase in entrepreneurship Increase student knowledge and collaboration between institutions
Present study	30 student	SMK Negeri 1 Bumijaw	

CONCLUSION

Learning activities through this community service program aim to transfer knowledge from the teaching team to students as participants regarding the operation of laser engraving machines. The learning is divided into several activities, including program socialization, delivery of material, and evaluation of training participants. From the socialization activities, a program is a form of team communication with the target in the hope of synchronizing the training material with the target, in this case, SMK Negeri 1 Bumijawa, Tegal Regency. Then the delivery of material includes the development of laser engraving machine technology, the need for tools and materials to make an engraving laser machine, how the laser engraving machine works, and the operational maintenance of the laser engraving machine.

The last activity is an evaluation, where this evaluation activity is expected to be able to understand the level of understanding and participants' responses to this laser engraving machine training activity and the conclusion states that participants can increase their knowledge and understanding of the laser engraving machine. Some problems found in this program, namely the number of students who enthusiastically participate, but the number of CNC laser engraving machines is only 3 units, so students only practice simple fields to operate. So that in the future it is necessary to carry out activities like this again to introduce more products that can be made using a CNC laser engraving machine to students, and it is hoped that this article can be used as a reference in community service programs in Indonesia.

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