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Fiber Optic Splicing Training with Mechanical Splicers and Fusion Splicers for Computer and Network Engineering Vocational School Students

AHMAD FAUZI[1] , GALURA MUHAMMAD SURANEGARA[2] , ENDAH SETYOWATI[3] , SUPRIH WIDODO[4]

[1, 2, 3]Telecommunication Systems Study Program, Universitas Pendidikan Indonesia, Indonesia
[4]Information Systems and Technology Education Study Program, Universitas Pendidikan Indonesia, Indonesia
Email: ahmad.fauzi@upi.edu

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ABSTRACT

Curriculum development is one of the challenges in the world of education. In vocational schools with Computer and Network Engineering Skills Competency (TKJ) in particular, these curriculum changes update the Basic Competencies taught. Several changes have been made, including those related to the core competency of fiber optic cable termination. The curriculum renewal means students must improve their core competencies in connecting fiber optic cables. Often, lessons related to fiber optic termination are only given theoretically. This is due to limited support for tools and materials for the fiber optics practicum. This activity will provide a workshop on connecting fiber optic cables to TKJ Skills Competency Vocational School students. As a result, the evaluation of the acceptance of activity materials obtained an average participant score of 88.74% in the very high category. Then, evaluating satisfaction with training activities, it was found that satisfaction with training methods was 94.35% (very high class); training instructors at 93.33% (very high category); and facilities and infrastructure amounting to 95.26% (very high type).

***Keywords**: Optical Fiber, TKJ, Vocational School, Workshop*

1. INTRODUCTION

Community service is a commitment to positively contribute to society through various activities to improve specific individuals' or groups' quality of life and abilities. One form of community service that is very relevant is through exercises to increase technological competence. In this case, connecting fiber optic cables. These activities are not only beneficial for the individuals involved but also have a positive impact on industrial and educational development in an area. **(Mustika, 2019)**

This community service activity began with attention to several problems at Maniis State Vocational School, Purwakarta, especially in learning about fiber optic networks. There are two main aspects for the background implementation of this activity. First, inadequate facilities and infrastructure for learning fiber optic networks: Maniis State Vocational School faces obstacles in providing adequate facilities and infrastructure for learning fiber optic networks. This can have an impact on students limited knowledge and skills in dealing with the latest technology in the fields of computer networks and telecommunications. Second, curriculum changes: Curriculum changes in the Computer and Network Engineering Skills Competency Vocational School have included fiber optic cable splicing skills as a basic competency in Broad-Based Network Technology (WAN) subjects **(Muhammad, 2018) (Muhammad, 2016).** With technology developing rapidly, SMK Negeri Maniis must ensure an understanding of skills essential to the growing job mark.

This comprehensive understanding aims to provide concrete solutions to the problems faced by Maniis State Vocational School, Purwakarta. The main objective of this activity is to increase students' competence in terminating fiber optic cables in rosettes using the Mechanical Splicer method so that they can confidently face challenges in the ever-growing world of work. In addition, to introduce students to fiber cable termination methods. Optics use a Fusion Splicer, a more advanced and efficient technique. To evaluate the practical process, provide students with an understanding of the importance of measuring power at fiber optic cable connections/terminations using the Mechanical Splicer methods **(Muhammad, 2018).**

By achieving these goals, it is hoped that Maniis State Vocational School students will have better skills in splicing fiber optic cables and be better prepared to face increasingly fierce competition in the world of work in the fiber optic network industry. Next, we will describe in more detail the implementation of this community service activity, the steps taken, and the expected impact.

2 . METHOD FOR IMPLEMENTING COMMUNITY SERVICE ACTIVITIES

The research was carried out using a quantitative method with a survey approach; according to **(Sugiyono, 2014),** the survey method is a quantitative research method used to obtain data that occurred in the past or currently regarding beliefs, opinions, characteristics, and behavior of variable relationships. Surveys are data collection techniques using questionnaires or interviews from samples **(Maidiana, 2021).** In carrying out community service activities, several stages of activities are undertaken. First, actions are preliminary or pre-activities intended for initial study and preparation for implementation. Second, activities, which are the implementation and implementation of plans that have been launched. Third, activities which are activity evaluation and reporting. All activities are evaluated by giving questionnaires to students as training participants.

2 .1 Literature review

This literature review will be an essential basis for describing community service to improve the competence of TKJ Vocational School students in connecting fiber optic cables, as well as evaluating and developing instruments to measure the results of these activities.

2.1.1 Basic Competency regarding Fiber Optic Cable Connection for Vocational School Students TKJ Skills Competency

A basic understanding of competency in connecting fiber optic cables is an essential foundation for students of the Computer and Network Engineering Skills Competency Vocational School (TKJ). Based on the regulation of the Director General of Basic Education, Ministry of Education and Culture number 464/2018, in the Wide Area Network (WAN) Technology subject, there are 12 Basic Competencies related to fiber optic network competencies as follows. (**Muhammad, 2018**)

a. KD 3.4. Understanding fiber optic networks
b. KD 4.4. Examining fiber optic networks
c. KD 3.5. Identify the types of fiber optic cables
d. KD 4.5. Find fiber optic cable
e. KD 3.6. Applying the function of fiber optic work tools
f. KD 4.6. Using the function of fiber optic work tools
g. KD 3.7. Evaluate fiber optic connections
h. KD 4.7. make a fiber optic connection
i. KD 3.8. evaluating passive fiber optic network devices
j. KD 4.8. configuring passive fiber optic network devices
k. KD 3.9. evaluate fiber optic network problems
l. KD 4.9. carry out fiber optic network repairs

a. Fiber Optic Cable Components

Fiber optic cables are used in various applications, such as single-mode, multi-mode, and wave cables. Optical fiber is a cable made of glass and shaped like a thread that functions as a data transmission medium by sending light signals at high speed from one place to another. Fiber optic cables have a stable connection and are not influenced by the current weather. This cable is better than copper, with a data transfer speed of up to 100 Mbps **(Farisan & Damayanti, 2020)**. The optical fiber structure is divided into 3 (three) parts, namely: core, cladding (skin), and coating (jacket). Figure 1 shows the construction of an optical fiber.

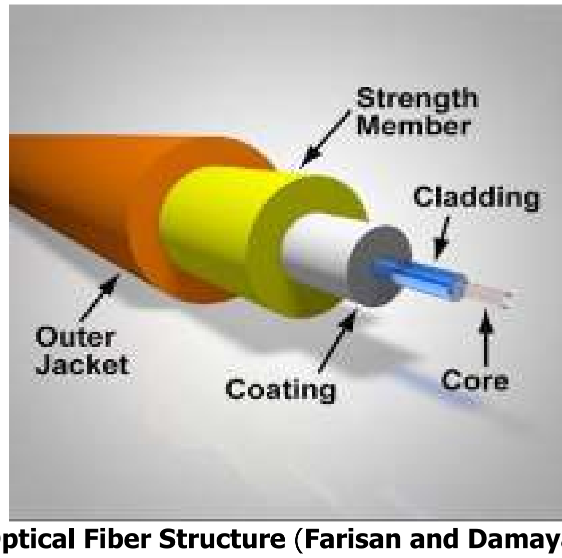

Figure 1. Optical Fiber Structure (**Farisan and Damayanti, 2020**)

The core part plays a role in transmitting light signals, and the cladding part acts as a mirror that reflects light so that optical signals can propagate to the other end. Apart from that, cladding also functions as a protector that covers the core. Apart from that, the Coating section plays a role in protecting the optical fiber from damage.

b. Main Components in Fiber Optic Networks

The Fiber To The Home (FTTH) architecture can be seen in Figure 2.

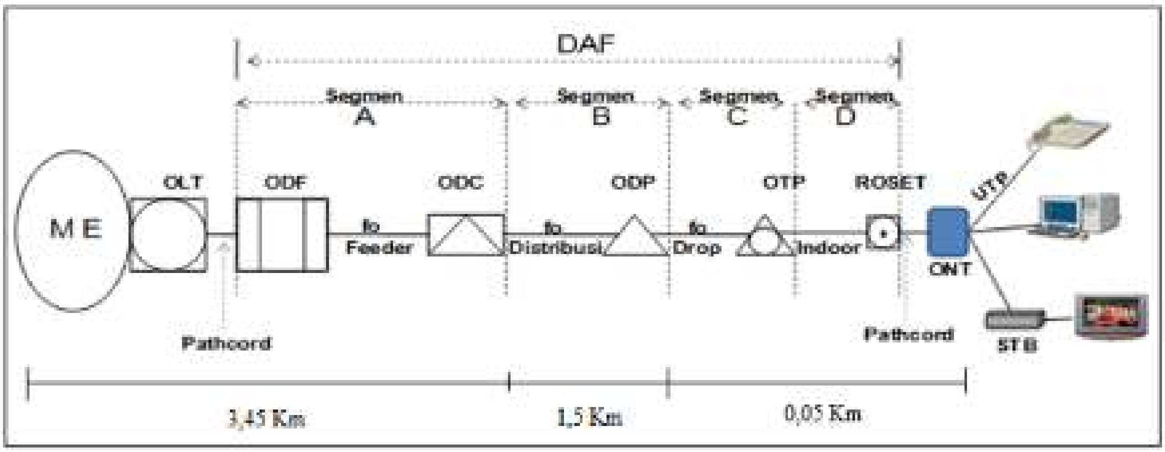

Figure 2. FTTH architecture (Dunggio et al., 2021) (Telkom Akses, 2017)

Figure 2 illustrates the components and interactions in a network infrastructure that combines optical, ethernet, and metropolitan network technology as follows:

1. ME (Metro Ethernet) is a Metropolitan-Area Network (MAN) based on the Ethernet standard with broader coverage.
2. OLT (Optical Line Terminal) is a central interface active device connecting one or more optical distribution networks.
3. In segment A, several components exist, such as the Optical Distribution Frame (ODF), feeder cables, and Optical Distribution Cabinet (ODC).
4. In segment B, there is an Optical Distribution Point (ODP) and distribution cables
5. In segment C, there are drop cables and Optical Termination Premises (OTP).
6. In segment D, there are indoor cables and rosettes.
7. ONT (Optical Network Terminal): ONT is a device located on the customer side and provides an interface for data, voice, and video.

c. Termination Technique

Techniques used in the fiber optic cable installation include mechanical termination (Mechanical Splicing) and termination using the Fusion Splicer method. Several tools and materials used in the fiber optic cable termination process include cable stripper, cable cleaver, fast connector, SC connector adapter, pigtail cable, and Fusion Splicer. **(Andrew Oliviero, 2014; Govind, 2002; Ivan P Kaminov, Tingye Li, 2008; Sahu, 2020)**

2.1.2 Mechanical Splicer Fiber Optic Cable Connection with Fast Connector

Splicing fiber optic cables using a Mechanical Splicer with a Fast Connector is a method that is often used in industry. Fast Connector allows connecting cables quickly and without the need for special equipment. This literature review will discuss the working principles of Mechanical Splicers and Fast Connectors, the installation process, and their advantages and disadvantages in practical applications. **(Andrew Oliviero, 2014)**

2.1.3 Fiber Optic Cable Splicing with Fusion Splicer

Fusion Splicer is a fiber optic cable splicing technique that uses heat to join two ends of the cable permanently. This method is often used in network installations that require highly reliable and low-loss connections. The literature review will cover the working principles of Fusion Splicers, the types of Fusion Splicers available, and practical steps in connecting fiber optic cables with Fusion Splicers. **(Andrew Oliviero, 2014)**

2.1.4 Evaluation of Power Measurements in Fiber Optic Cable Connections

Power measurement is a critical step in testing the effectiveness of a fiber optic cable connection. This article will discuss the principles of power measurement, the equipment used, and how to analyze measurement results. In addition, it is also important to understand the factors that can influence power measurement results, such as cable length, connection losses, and the light source used. **(Andrew Oliviero, 2014)**

2.2 Research Instruments and Activity Evaluation

Implementation of Community Service is at the Wireless and Transmission Laboratory at UPI Campus Purwakarta. The participants were divided into groups of 4 people. They were guided by laboratory assistance students in carrying out their activities as depicted in Figure 3.

Figure 3. Training of Fiber Optics Cable Splicing

In the context of community service activities, developing evaluation instruments is an important part. This article will outline the steps in designing a suitable evaluation instrument to measure the increase in student competency in connecting fiber optic cables. This instrument must consider students' technical knowledge, practical skills, and analytical abilities. Literature studies will help identify methods of validating evaluation instruments and approaches that are effective in measuring the results of this activity.

2.2.1 Fiber Optic Connection Evaluation Instrument by Measuring Connection Yield Power

This part shows how to design an assessment instrument to measure students understanding and skills in connecting fiber optic cables. Table 1 shows sample table of observation on fiber optic cable connection power values.

Table 1. Sample Table of Observation on Fiber Optic Cable Connection Power Values

Core Color	Calibration Power Value ($P_{Transmitted}$)	System Power Value ($P_{Received}$)	Losses
Blue	- 6.27 dBm	-8.74 dBm	2.47 dB

2.2.2 Indicators of Student Acceptance of Fiber Optic Connection Practice Material

This instrument measures students practical understanding skills regarding activities and equipment in splicing fiber optic cables using Mechanical Splicers and Fusion Splicers. After the training, a questionnaire was given again regarding students acceptance of the practical material as shown in figure 3.

Table 3. Indicators of Student Acceptance of Practical Training Materials

No	Indicator
K1	Students understanding of the characteristics of drop wire cables in Fiber Optic Networks
K2	Students understanding on how to use a cable stripper to strip Fiber Optic cables
K3	Students understanding of how to use a cable cleaver to cut fiber optic cables
K4	Students understanding of how to use fast connectors on Fiber Optic cable networks
K5	Students understanding of how to use a fusion splicer tool to connect Fiber Optic cables

2.2.3 Activity Implementation Evaluation Indicators

This instrument measures the implementation of students' practical activities in connecting fiber optic cables using Mechanical Splicers and Fusion Splicers. Data tracking through a questionnaire includes questions about training methods, instructors, facilities, infrastructure, and training follow-up **(Jayanti, 2018)**. After implementation, a questionnaire was given again regarding training methods with the following indicators (table 4).

Table 4. Indicators of Student Satisfaction After Training (Training Method)

No	Indicator
K1	Suitability of training materials to training objectives
K2	Delivery of training material that is interesting and discussed in depth
K3	The benefits of knowledge are provided in the training materials.
K4	The benefits of the skills are provided in the training materials.
K5	Students' understanding of the development of Fiber Optic Network learning
K6	Suitability of training methods to the topics discussed
K7	The suitability of the training time that I follow with the schedule that has been set
K8	The committee's responsiveness in helping training participants

After implementation, a questionnaire about the training instructor was given again with the following indicators (table 5).

Table 5. Indicators of Student Satisfaction After Training (Training Instructor)

No	Indicator
K1	Instructor interaction with participants
K2	Opportunity to ask questions from the instructor to the participants
K3	Delivery of training material that is clear and easy to understand
K4	Mastery of the material taught
K5	active encouragement of participants in training activities
K6	Use of language that is easy to understand
K7	Readiness of the instructor to help participants during the training

After implementation, a questionnaire was given again regarding training facilities and infrastructure with the following indicators (table 6).

Table 6. Indicators of Student Satisfaction After Training (Training Facilities and Infrastructure)

No	Indicator
K1	Completeness of the required practical equipment and supplies
K2	Completeness of the training module provided
K3	Cleanliness and comfort of the location where the training program is implemented
K4	Cleanliness and comfort of the training room
K5	Variations in initial consumption and during lunch breaks

3. RESULTS AND DISCUSSION

Based on observations and evaluation of implementation, the following results were obtained.

3.1 Fiber Optic Connection Results with Connection Yield Power Measurement

Table 7 is the result of splicing fiber optics by measuring the power output of a mechanical splicer connection.

Table 7. Example of Mechanical Splicer Fiber Optic Connection Results

Group No	Implementation date	Instructor	Loss Measurement Results (dB)
5	September 20, 2023	Alya N.	8.76
6	September 20, 2023	Delia F.	18.1
7	September 20, 2023	Najwa N.	22.63
8	September 20, 2023	Azzam M.	14.28

Table 8 is the result of splicing fiber optics by measuring the connection power using a fusion splicer.

Table 8. Example of Fiber Optic Splicing Results with Fusion Splicer

Group No	Implementation date	Instructor	Loss Measurement Results (dB)
5	September 20, 2023	Diana F.	1.7
6	September 20, 2023	Sarah A.	0.2
7	September 20, 2023	M. Dzikri	0.44
8	September 20, 2023	Abi A.	4.6

From examples of observations of Fiber Optic Network Connection Loss values carried out by students, it can be seen that connecting with a fusion splicer produces a smaller connection loss value than connecting using the mechanical splicer method.

3.2 Results of Evaluation of Student Understanding in Fiber Optic Splicing Practices

this evaluation, students' understanding of practical skills in connecting fiber optic cables using Mechanical Splicers and Fusion Splicers was obtained with the following results (table 9).

Table 9. Analysis of Student Acceptance Results for Training Materials

Results Description	Mark
Total score	599
Maximum value	25
Minimum Value	16
Average value	22.19
Standard Deviation	2.48
Grade Average Percentage	88.74
Category	Very High _ _

Based on the evaluation results data, the average evaluation value is 22.19 or 88.74% in the Very High category. The standard deviation value is 2.48, meaning the error percentage reached 11.18%.

3.3 Results of the Activity Implementation Evaluation Questionnaire

The first instrument measures student satisfaction with implementing student practical activities in connecting fiber optic cables using Mechanical Splicers and Fusion Splicers as seen in table 10.

Table 10. Student Satisfaction Questionnaire After Training (Training Method)

Results Description	Mark
Total score	1019
Maximum value	40
Minimum Value	32
Average value	37.74
Standard Deviation	2.93
Grade Average Percentage	94.35
Category	Very High _ _

Based on the evaluation results data, the average evaluation value is 37.74 or 94.35% in the Very High category. The standard deviation value is 2.93, meaning the error percentage reaches 7.76%. The second instrument was used to measure student satisfaction with the training instructor/student practice in splicing fiber optic cables using Mechanical and Fusion Splicers.

Table 11. Student Satisfaction Questionnaire After Training (Training Instructor)

Results Description	Mark
Total score	882
Maximum value	35
Minimum Value	27
Average value	32.67
Standard Deviation	2.67
Grade Average Percentage	93.33
Category	Very High _ _

Based on the evaluation results data in the table 11, the average evaluation value is 32.67 or 93.33% in the Very High category. The standard deviation value is 2.67, meaning the error percentage reached 8.17%. The third instrument was used to measure student satisfaction with the training/practice facilities and infrastructure for students in connecting fiber optic cables using Mechanical Splicers and Fusion Splicers as follows (table 12).

Table 12. Student Satisfaction Questionnaire After Training (Training Facilities and Infrastructure)

Results Description	Mark
Total score	643
Maximum value	25
Minimum Value	20
Average value	23.81
Standard Deviation	1.69
Grade Average Percentage	95.26
Category	Very High _ _

Based on the evaluation results data, the average evaluation value is 23.81 or 95.26% in the Very High category. The standard deviation value is 1.69, meaning the error percentage reaches 7.1%.

In comparison, the four calcifications or groups of indicators in the bar diagram are as seen in figure 4.

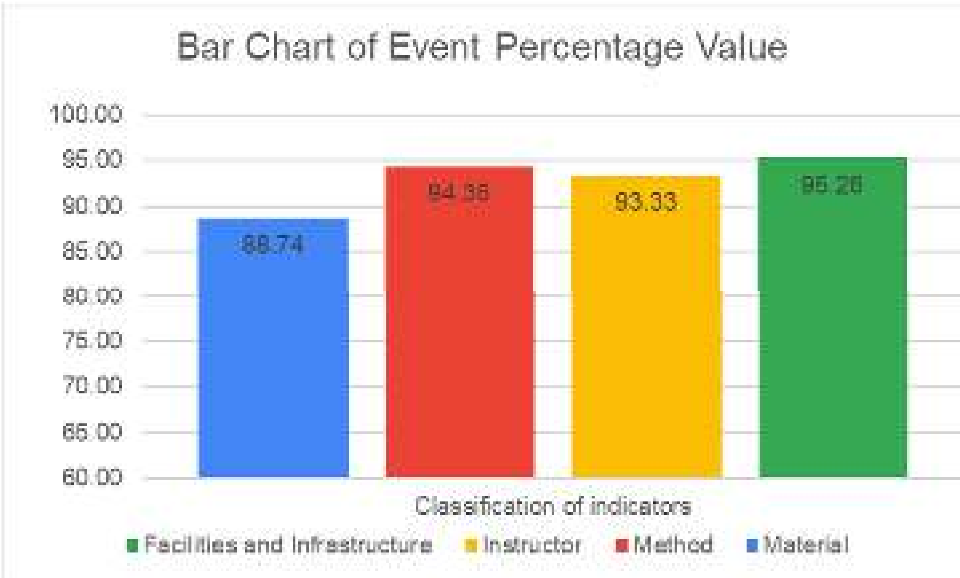

Figure 4. Bar Chart between Indicators

The diagram shows a comparison of the percentage values between indicator classifications. The assessment percentage is shown in the vertical direction, and in the horizontal order, the category of indicators includes materials, methods, instructors, and facilities and infrastructure. The highest value is Facilities and Infrastructure, namely 95.26%. The second highest value is the training method, worth 94.35%. The third value is the practical instructor, which is worth 93.33%. The fourth value is assessing the material presented, namely 88.74%. These four scores are in the very high category.

4. CONCLUSION

Based on the evaluation of the receipt of activity materials, the average participant score was 88.74% in the very high category. Then, evaluating satisfaction with training activities, it was found that satisfaction with training methods was 94.35% (very high class); training instructors at 93.33% (very high category); and facilities and infrastructure amounting to 95.26% (very high type).

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