Implementation of Instructional Media Trainer Fiber Optic Sensor System on Sensor and Actuator Learning in SMKN 1 Katapang Bandung

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Abstract. Instructional media trainer of fiber optic sensor system is media that utilize optical fiber as props in the lessons sensors and actuators. The purpose of this research is the study of students learning outcomes on subjects sensor and actuator by use trainer fiber optic sensor system and student’s responds about media has used. The method used in this research is experimental design, with the pre-experimental design. This research was conducted in class XI technique electronics industry (TEI) 1 in SMKN 1 Katapang Bandung with 38 students. The research results show that there has been increasing study results students who demonstrated by the strengthening (the gain) study results students on the cognitive domain an average of 0.64 in the medium category. In the domain affective and in the domain psychomotor the average value on the good predicate. All of students gives a very positive responds about implementation of this media. From the results of this research can be stated that using fiber optic sensor system could improve student learning outcomes and students’s response is very positive to the media used. Thus we can conclude that fiber optic sensor system on the subjects of sensor and actuator can improve learning outcomes students and very use full to be used in vocational school.

1. Introduction
One of the productive subject that is needed to be mastered by the students of electrical engineering vocational high schoolers is sensors and actuator subject. The Sensors and Actuator subject cannot be conveyed only in theory without any media to prove the theory. Media usage in teaching could give a realistic experience and giving the foundation for the development to give a better study result using teaching media could boost students' motivation to be more active participating and giving more room to be more creative, innovative, and self-dependent [1].

After doing an observation in industrial electronics major in SMK Negeri 1 Katapang about sensor and actuator subject, researcher conclude that the teaching has not use teaching media or trainer in teaching the students, so the students still find it hard to understand the concept of the subject.

The Sensors and Actuator teaching only explaining the theory to the students without using any media to teach them, making them puzzled with the concept. After doing an interview with one of the teacher of Sensors and Actuator subject, it is revealed that the school doesn't have the teaching media for the subject.
Researcher have found out that without using the teaching media of Sensors and Actuator subject, SMKN 1 Katapang Bandung has not been able to implement the concept of working principles of sensors, which is very important in industrial electronics.

Based on the above finding, the researcher is interested in implementing fibre optic teaching media to help students understanding the material and helping them learning more skills in Sensors and Actuator. With that, the writer proposes a research named "Implementation of Instructional Media Trainer Fibber Optic Sensor System on Sensor and Actuator Learning In SMKN 1 Katapang Bandung"

2. Methods
This research is using experiment method. The experiment method is used to compare the result before and after experimental treatment [2]. The design of the experiment that will be used in this research is pre-experimental design. This design is chosen because the samples that is chosen are not random samples. And then the shape of the pre-experimental design that will be used is one-group pretest-posttest design. One group of pretest-posttest is chosen because this design will be used to compare the situation before and after the experimental treatment, so the result of the treatment could be observed effectively [3]. This research is done in two sessions.

This research is done in SMK Negeri 1 Katapang Bandung, located in Jl. Ceuri Terusan Kopo KM 13.5 Kabupaten Bandung. Sample that is used is 11th graders of industrial electrical engineering of SMKN 1 Katapang Bandung. The instrument used is tested first against the students of class XII TEI 1. The test instrument used in the research must be tested prior to a study [4]. The cognitive instruments performed should be tested first Testing of testing instrument performed to determine the validity, reliability, difficulty level, and the differentiator of the problem [5]. The validity test for the instrument used using Product Moment correlation formula from Preason [6]. In addition to the validity of the instrument also tested its reliability using the formula Kuder-Richardson 21 (K-R.20) [7]. Then the instrument also tested the level of difficulty and test of its power dissipation.

Observation instruments used include affective and psychomotor spheres. In the affective domain, the assessment includes Receiving with discipline, responding with enthusiasm, and Valuing with a sense of responsibility. While the psychomotor domain includes Skills and Problem Solving.

Students response are measured using questionnaires instrument that had been used in the Department of Electrical and Electronics, Neihu Vocational High School, Taipei, Taiwan to test the students’ response to the LED photometer application to detect enzyme coupling reactions [8]. Response test conducted using Likert scale with scale 1 to 5.

This research was conducted in three stages, namely the preparation stage, the implementation stage and the stage of processing and data analysis. At the preparatory stage, the researcher conducts literature study, studying the curriculum to know the purpose and basic competence to be achieved in the learning process, determining the research sample, preparing the lesson plan with the learning model of project based learning, preparing the research instrument, observation, conducted by interviewing with subject teachers, tested the test instrument, and analyzed the test results of the test instrument and then determined the feasible questions to be used to obtain the cognitive, affective, and psychomotor student learning outcomes. In the implementation stage, the researcher performs pretest test on the students, giving treatment that is by implementing the learning with the project based learning model on the students, observing the students on the affective and psychomotor aspects, doing the final test (posttest) on the students, and giving a questionnaire in the students to know the response of students to the learning media provided. In the final stages, the researcher analyzes the research data, draws conclusions, and reports.

Data analysis performed on the cognitive domain using the N-gain test. To see an improvement in concept understanding is calculated by the N-Gain \(<g>\) formula [9]. The data of the research should also be seen as normality test. Normally distributed data will show that the students' ability to spread evenly [10]. Test the normality of data using chi squared (x2). Hypothesis in this research is as follows:
Ho: Learning media of optical fiber sensor system cannot improve student learning outcomes on Sensor and Actuator subjects in Vocational High school if the average N-gain of cognitive learning achievement has scores less than moderate criteria.

Ha: Learning media of optical fiber sensor system can improve student learning outcomes on Sensor and Actuator subjects in Vocational High school if the average N-gain of cognitive learning achievement has score more than or equal to medium criterion.

The research hypothesis test is based on the data of student learning outcomes, namely the difference between pretest and posttest values. T-test is used for two independent samples with interval data types. To perform T-test conditions the data should be homogeneous and normal.

Student response test with Likert scale is classified into ordinal scale [11]. If the Likert scale is considered an ordinal scale, the average calculation and standard deviation are not correct [12]. Therefore, the Likert scale score calculation in this study did not use the average score or standard deviation. Likert scale data analysis step using median or mode for central tendency (central tendency) and data variation using frequency of score [13]. In this research, the first order to do to find the value of each statement mode. The mode value of each statement is searched for its frequency. The result of the mode and frequency values is shown in percentage [14].

3. Result and Discussion

3.1. Results of The Test Validity
The validity is validity of questions. The number of questions tested as many as 55 questions. The validity test was conducted on every questions with 5% of level of significance and degree of freedom (df) is \( df = n - 2 = 30 - 2 = 28 \), and obtained of \( t \) table is 1,701. When \( t > t \) table, then the question is valid. The result of the test validity represent that 33 questions is valid and 22 questions is invalid.

3.2. Result of The Test Reliability
The test of reliability was conducted to 33 questions valid. The reliability calculation was conducted using the Kuder-Richardson formula (K-R.20) at the 5% significance level and the degrees of freedom (df) = \( n - 2 \). The value of reliability is 0.878 and the questions are reliable.

3.3. Result of The Difficulty Test
The test of reliability was conducted to 33 questions valid. The result shows at the table 1.

| Criteria   | Number of Questions |
|------------|---------------------|
| Easy       | 10                  |
| Middle     | 17                  |
| Difficult  | 6                   |
| Total      | 33                  |

3.4. Result of The Test Discriminations Power
The test discriminations power was conducted to know level of ability students. The test discriminations power was conducted to 33 questions valid. The result shows at the table 2.

| Kriteria   | Number of Question |
|------------|-------------------|
| Excellent  | 15                |
| Good       | 9                 |
| Middle     | 9                 |
| Total      | 33                |
3.5. Result of Pretest and Posttest
Pretest and posttest result data gives an overview of students' initial ability before treatment and after treatment. The number of students given treatment as many as 38 people. The result of the mean pretest and posttest values of the students is shown in Figure 1.

![Figure 1. Average Pretest and Posttest Value Charts](image)

From the test results at the beginning of pretest is divided into three groups of students based on ability. The result of the mean score of the student group is shown in Figure 2.

![Figure 2. Average Pretest and Posttest Value Charts of each Criteria](image)

3.6. Result of The Test N-Gain
From the result of student's learning value was obtained N-gain test data of each student shown in Figure 3.

![Figure 3. Average N-gain Value Chart of each Criteria](image)

3.7. Result of Affective and Psychomotor
The result of the data test in the affective domain is shown in Figure 4.
The affective data test results of each student group shown in Figure 5.

The psychomotor data test results of each student group shown in Figure 7.
3.8. Result of The Test Data Normality

Data is said to be normal when $\chi^2_{\text{count}} < \chi^2_{\text{table}}$. The data normality test is performed on degrees of freedom (df) = k - 1 = 6 - 1 = 5 and with a significance level of 5% to obtain $\chi^2_{\text{table}}$ of 11.07. The results of normality data shown in Table 3.

| Data    | $\chi^2$ Count | $\chi^2$ Table | Criteria |
|---------|----------------|----------------|----------|
| Pretest | 7,11           | 11,07          | Normal   |
| Posttest| 10,25          |                |          |

From table 3, can be concluded that:

- The result of normality test of pretest shows that the average pretest data is normally distributed because $\chi^2_{\text{count}} (7,11) < \chi^2_{\text{table}} (11,07)$. This means that the average value of pretest is normally distributed.
- The result of normality test of posttest shows that the average posttest data is normally distributed because $\chi^2_{\text{count}} (10,25) < \chi^2_{\text{table}} (11,07)$. This means that the average value of posttest is normally distributed.

3.9. Result of The Test Hypothesis

Hypothesis test was conducted to find out whether the hypothesis proposed in this research accepted or rejected. Test the comparative hypothesis (in this case the right-hand test because $H_0$ sounds smaller or equal to ($\leq$) and $H_a$ sounds bigger ($>$).

$H_a$ accepted and $H_0$ rejected if $t_{\text{count}} > t_{\text{table}}$. Hypothesis testing was conducted on degrees of freedom (df) = $N_1 + N_2 - 2 = 38 + 38 - 2 = 74$, df 74 is between df 60 with significance level 5% obtained $t_{\text{table}} = 1.671$ and df 120 with significance level 5% obtained $t_{\text{table}} = 1.658$ and df. Difference df ($\Delta$df) = 60 and $t_{\text{table}}$ difference ($\Delta$t) = 0.013. From both of df on $t_{\text{table}}$, hence obtained $t_{\text{table}} = 1.668$. Result of hypothesis test is $t_{\text{count}} = 18,995$. Because $t_{\text{count}} (18,995) > t_{\text{table}} (1,668)$, $H_a$ is accepted and $H_0$ is rejected. So that instructional media trainer fiber optic sensor system can improve student learning outcomes on sensors and actuators learning in Vocational High School.

3.10. Result of Student Responses

Response data test was conducted to know attitude and student’s response to instructional media trainer of fiber optic sensor system. A list of student response statements is shown in Table 4.

| Symbol | Questions |
|--------|-----------|
| Q1.    | This implementation (the practice of measuring light sensors with fibre optic systems) enhances my understanding of light sensors in Sensors and Actuators learning |
| Q2.    | I learned something useful about fiber optic sensors |
| Q3.    | Through this implementation, I was build the light sensor circuit and evaluate its performance |
| Q4.    | From my experience with the implemented system, I gained more knowledge than I would have from just theory from textbook or whiteboard teaching. |
| Q5.    | I can practice the use and measurement of fiber optic systems as light sensors |
| Q6.    | This implementation encouraged me to integrate between software and hardware and assemble light sensor circuits |
| Q7.    | This implementation is very interesting |
| Q8.    | I like the concept of fibre optic sensor system |
| Q9.    | This implementation will inspire me to explore fibre optic sensor system further |
| Q10.   | I will recommend this implementation to other students. |
The result of the student's response to this instructional media is shown in Figure 8.

![Figure 8. The student's response](image)

Overall the students gave the response shown in Figure 9.

![Figure 9. Overall Student Attitude Response](image)

### 3.11. Discuss

Based on the result of research of Implementation of Instructional Media Trainer Optical Fiber Sensor System on Sensor and Actuator learning at SMK Negeri 1 Katapang Bandung in cognitive domain has increased learning outcomes with average N-gain of 0.64. Affective domain obtained an average value of 3.01 and psychomotor domain obtained an average value of 3.05.

In the group of students with low ability criteria had N-gain 0.74 greater than the high criteria had N-gain of 0.54 and the medium criteria N-gain is 0.65. This can be influenced by the affective value of each group criterion. Affective value of low ability criteria group is greater than 3.03 compared with high criterion group having affective value 3.01 and the medium criteria group affective value is 3.00. This is in accordance with the theory that the higher the use of instructional media and motivation, the higher the learning achievement obtained by the students, but if the use of instructional media and motivation is low then student achievement is low [15]. The motivation is the drive to achieve certain goals. The impulse may take the form of: enthusiasm, hope, and spirit [16].

In the cognitive domain as a whole the students had an improvement that was shown with an average value of N-gain of 0.64. In the affective domain there are 63.16% which has a value above the average class value and 36.84% has a value below the average class value. In the psychomotor domain 44.74% of total all student have value above the average class value and 55.26% student who have
psychomotor value below the average class value. This shows that in the psychomotor domain, the number of students who have above average value is less than in the affective domain.

In the affective and psychomotor domain have a good value that the average value of students above 3 or on the predicate B. In the psychomotor domain seen that 55.26% of students have values below the average grade. This shows that skills in practice and problem solving are minus.

There is a stimulation function in the implementation of instructional media trainer fiber optic sensor system. It is marked by 73.7% students give statement that implementation of instructional media trainer of fiber optic sensor system is very interesting on student response instrument with symbol of Q7. The instructional media of optical fiber sensor trainers can be mediated between teacher and student on sensor and actuator learning shown by 60.5% of students giving statements acquire more knowledge than just studying from textbooks and blackboards on statement with Q4 symbols. This instructional media also has an information function proven by a number of 60.5% of students giving a statement that the implementation of this media allows students to gain more knowledge (Q7), 68.4% of students can practice the use of sensors (Q5), and 57 , 9% of students learn something useful (Q2). Overall, 63.2% of students showed a very positive attitude response and 35% of students showed positive attitude response, also 1.1% of doubtful students and 0.8% of students who strongly disagree. Therefore, the implementation of Optical Fiber Sensor System on Sensor and Actuator Learning is beneficial in teaching bioelectronics in vocational high schools.

4. Conclusion

Based on the results of research, the implementation of Optical Fiber Sensor System on Sensor and Actuator Learning at SMKN 1 Katapang Bandung can improve students' cognitive learning outcomes with medium N-gain category. In the affective and psychomotor domain the average value of students has a good value. The attitude of students showed 63.2% of students gave very positive attitude response and 35% gave positive attitude response. So it can be concluded that the implementation of fiber optic sensor system on Sensor and Actuator learning can improve the learning outcomes of students of Industrial Electronics Engineering Department at SMK Negeri 1 Katapang Bandung. Also, the implementation of fiber optic sensor system on Sensor and Actuator learning is very useful in vocational high school.

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