Developing Electric Lighting Installation Practice Performance Instruments in Vocational High Schools

A F Husna and H Sofyan

1,2 Technological and Vocational Education Department, Universitas Negeri Yogyakarta, Indonesia.

E-mail: amelia.fauziah.husna@gmail.com

Abstract. The aim of this study is to develop a performance assessment of electrical lighting installation in Vocational High Schools. The assessment tools were developed by using Designing Assessment Tools Model from Western Australia. The research passed through four steps: (1) clarifying the evidence requirements, (2) choosing the most appropriate assessment methods, (3) designing and developing the assessment tools, and (4) trialling and refining the tools. The method of assessment used was observation. This tool was used by teachers to assess students’ performance. The result of this research were 9 items of performance assessment that be used in vocational high school

1. Introduction

Assessment instruments are an important factor in the process of learning vocational education. Most of the teachers in Yogyakarta have not a standardized performance assessment of electric lighting installation practices. The teachers do not have the time to design a performance assessment [1]. This is not in accordance with Indonesian government regulations about national education standards. Assessment of learning education is measured through three aspects: attitudes, knowledge, and skills [2]. One of the most important aspects of vocational education is the aspect of skills. Vocational education students' skills are assessed based on practical performance. Assessment of skills aspects consists of five steps: (1) compiling an assessment plan, (2) developing an assessment instrument, (3) carrying out an assessment, (4) utilizing the assessment results, and (5) reporting the assessment results [2]. One of the skills assessed in electrical engineering installation students is the performance of lighting installation practices. This is important, to develop an instrument for evaluating the performance of electrical lighting installation practices.

Performance assessments are a good fit for experiential learning environments [1], for example, electrical lighting installation practices. Performance assessment is used to find out how well a person's performance responds to a situation [3]. Performance assessment relates to skills. Individual skills can be measured from simulation, interaction in trying something, or skills in improving a situation in the work environment. The keys of the test are to make the test situation and environment resemble real work.

There are three dimensions of problem solving performance in vocational high school students: analytic problem solving, constructive problem solving, and evaluation [4][5]. Analytical problem solving consists of analyzing the causes of problems and finding alternative solutions. Constructive
problem solving consists of problem specifications and performance processes. Evaluation consists of product quality and work quality.

Electricity requires efficient and trained personnel because it has a high level of risk of workplace accidents [6]. Occupational health and safety in the electricity sector needs special attention. Installation of electricity requires personal protective equipment in accordance with the workplace. Personal protective equipment commonly used in electrical workers includes safety helmets, safety goggles, ear protectors, wearpacks, masks, gloves and safety shoes [7]. Competencies that need to be learned by students are understanding the electrical work diagram, knowing various types of cables, knowing various types of wiring networks, knowing the principles of security of electrical devices and installations, understanding the order of inspection and testing of electrical devices and installations, knowing the terms of electric lighting, and knowing various types of lighting electricity [8]. Installation of an electric lighting installation must be good and right because it will affect the quality of the lighting itself. The quality of electric lighting is divided into three classes, namely good, bad, and indifferent [9].

The skills of installing electrical lighting installations that students need to learn include connecting cables to distribution boards, installing electrical installations and lights, installing kWh meters, disconnecting the network, and connecting the installation circuit to the distribution board [10]. This ability also needs to be supported by the ability of students to be able to use and develop skills related to the equipment of the measurement, both measuring instrument and hand tools [11]. The correct installation is then checked and tested to determine its performance and security. Installation of electrical installations must be ensured safe and free from the danger of electric current [12].

2. Methodology

The assessment tools were developed by using Designing Assessment Tools Model from Western Australia. The research passed through four steps: (1) clarifying the evidence requirements, (2) choosing the most appropriate assessment methods, (3) designing and developing the assessment tools, and (4) trialling and refining the tools.

The learning assessment required was an assessment of the performance of electrical lighting installation practices. The assessment method used was an observation sheet based on the evidence requirements. Assessment was designed and developed based on theories and syllabus. Instruments developed with 16 items based on three indicators. There were two trials in this study. There were limited trials and extensive trials

3. Result and Discussion

The instrument was developed based on three main indicators, namely analytic problem solving, constructive problem solving, and product evaluation. Analytical problem solving had 5 items. Constructive problem solving had 6 items. Product evaluation had 5 items. The subjects of the limited trial were 24 grade XI students of the electrical power installation department of vocational high schools in Yogyakarta. The following table 1 were the results of limited trials.

| No | Indicators   | Number of item | ICC Scores | Results        |
|----|--------------|----------------|------------|----------------|
| 1  | Constructive | 1              | 0.956      | Used           |
|    | Problem      | 2              | 1.000      | Eliminated     |
| 1  | Solving      | 6              | 0.757      | Used           |
The reliabilities of the performance measurement instrument for electrical lighting installation practices were measured using the Intraclass Correlation Coefficient (ICC). The calculations of the reliability of the instrument using the ICC were carried out by more than one observers. Items that had an ICC score ≥ 0.6 were maintained because it included items that had reliability in the medium category. Items number 5 and 12 were eliminated because they had reliability of less than 0.6, while items number 2 and 16 were eliminated because they did not have variation in the second measurement of rater.

Based on the results of the ICC score, there were 12 items remaining. Analytical problem solving had 4 items remaining. Constructive problem solving had 5 items remaining. Product evaluation had 3 items remaining. The items were tested using a trial extending to 190 students. The following items used for extensive trials were listed in table 2.

### Table 2. extensive trial results

| No | Indicators                  | Number of item | ICC Scores | Results |
|----|-----------------------------|----------------|-----------|---------|
| 1  | Constructive Problem Solving| 1              | 0.956     |         |
|    |                             | 4              | 0.757     |         |
|    |                             | 5              | 0.771     |         |
|    |                             | 6              | 0.675     |         |
|    |                             | 7              | 0.600     |         |
|    |                             | 2              | 0.882     |         |
| 2  | Analytic Problem Solving    | 3              | 0.661     | Used    |
|    |                             | 10             | 0.935     | Used    |
|    |                             | 11             | 0.707     | Used    |
| 3  | Product Evaluation          | 9              | 0.707     |         |
|    |                             | 12             | 0.921     |         |
|    |                             | 16             | 1.000     | Eliminated |

The remaining items in table 2 were calculated using confirmatory factor analysis. There were two prerequisite factors for confirmatory factor analysis, normality test and multicollinearity test. The following results of the normality test are found in table 3.
The normality assumption test according to the table III showed that the Z kurtosis multivariate normality was 1.061. This value was smaller than the critical value z for a significant level of 5%, which was 1.96. This showed that there was no skewness and kurtosis. So, the results were accepted. Data on the performance variables of electric lighting installation practices complied with the standard of assumptions of multivariate normality.

Multicollinearity tests were performed using a correlation matrix between items. The results of correlation showed a minimum score of 0.050 and a maximum score of 0.666. The test results showed that all of the correlation values between items were less than 0.9. These results proved that the performance of electrical lighting installation practices had no correlation between items. So that a confirmatory analysis test could be done using maximum likelihood.

The initial calculation of confirmatory factor analysis on the work of electric lighting installation practices showed that the CFI value was 0.646 and RMSEA was 0.144. These results had not fit the criteria. For this reason, it was necessary to improve the measurement model. The following results of the improvement of the measuring model were in figure I.

![Figure 1. Measurement Model of Electrical Lighting Installation Practices Performance](image-url)

Figure 1 indicated that there were some items that were eliminated because they had a loading factor less than 0.3 [13]. These items were numbers 5, 7 and 9.

The path diagram of the results of the second order confirmatory factor analysis of the performance of electric lighting installation practices showed the correlation between measurement errors a1 and a2, a1 and e2, a2 and e1, a3 and a4, and a3 and e1. Testing the overall model match hypothesis with research data stated that the CFI value was 0.921 and RMSEA was 0.098 [14].

Table 3. extensive trial results

| Indicator                  | Skewness | Z_{skewness} | Kurtosis | Z_{kurtosis} |
|----------------------------|----------|--------------|----------|--------------|
| Constructive Problem Solving | 0.034    | 0.189        | -0.828   | -2.330       |
| Analytic Problem Solving   | 0.023    | 0.129        | -1.100   | -3.095       |
| Product Evaluation         | 1.467    | -8.254       | 2.363    | 6.647        |
| Multivariate               |          |              | 0.843    | 1.061        |
Table 4. loading factors of electric lighting installation practices performance

| Relation | λ  | t_{value} | P  |
|----------|----|-----------|----|
| K01      | 0.40 | 3.34 | *** |
| K04      | 0.55 | 3.71 | *** |
| K06      | 0.76 | 3.96 | *** |
| A02      | 0.36 | 4.05 | *** |
| A03      | 0.30 |      |    |
| A10      | 0.74 | 3.85 | *** |
| A11      | 0.79 | 3.91 | *** |
| E12      | 0.48 | 3.89 | *** |
| E08      | 0.53 | 3.68 | *** |

Table 4 showed the value of loading factors (λ) more than 0.3. The t value was between 1.96 for a significant level of 5%. These results indicated that the variable model of electrical lighting installation performance theoretically matched the empirical data, so that the model could be accepted.

Based on these results, there were 9 items that could be used. The items consisted of 3 items of constructive problem solving indicators, 4 items of analytical problem solving indicators, and 2 items of product evaluation indicator. The following item numbers and indicators were listed in the following table 5.

Table 5. extensive trial results

| Indicators        | Number of item |
|-------------------|----------------|
| Constructive Problem | 1              |
| Solving           | 4              |
| Analytic Problem  | 3              |
| Solving           | 7              |
| Product Evaluation| 9              |

The items used in the final results of this study were in table 6.

Table 6. Items of observation sheet of electric lighting installation practices performance

| No | Items                                                                 |
|----|-----------------------------------------------------------------------|
| 1  | Preparation and identification of tools according to requirements.   |
| 2  | Planning work diagrams and electrical systems.                       |
| 3  | Understanding of work diagrams and electrical systems.              |
| 4  | Using of hand tools.                                                 |
| 5  | Installing cables in accordance with work requirements.             |
| 6  | Using of electrical measuring devices.                               |
| 7  | Troubleshooting the circuit                                         |
| 8  | Repairing of troubles according to requirements.                    |
| 9  | Installation of strong and neat lighting components.                |

These items can be used in assessing the performance of electrical lighting installation practices.
4. Conclusion

The development of this practice performance assessment instrument consisted of four stages: (1) clarifying the evidence requirements, (2) choosing the most appropriate assessment methods, (3) designing and developing the assessment tools, and (4) trialling and refining the tools. The items developed consisted of 16 items from three indicators: constructive problem solving, analytical problem solving, and product evaluation. Initial testing was carried out with limited trials. The results of limited trials indicated that there were 4 items eliminated. Items repaired and tested with extensive trials. The results of this trial showed that there were 3 items eliminated. The final result showed there were 9 items according to empirical validity and could be used. These items were used to assess the performance of electrical lighting installation practices for vocational high school students.

Acknowledgments

The authors wish to thank all who have helped materialize this study. The universities and stakeholders were who support the successful of this study, especially teachers and students who helped in data collection of this study.

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