

Development and Validation of Performance Assessment Instrument in UV-Vis Spectrophotometry Practicum

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ABSTRACT

Performance assessment in the instrument laboratory had been required to identify the students' competency objectively. This research aimed to provide a performance assessment instrument in UV-Vis spectrophotometry practicum. The method was the development and validation through 4 stages: planning, development, validation, and evaluation. The validation results collected by the expert team described that among 17 valid assessments, the 14 were valued CVR 1, and the rest were invalid with value CVR 0.6 below the critical point (0.736). Meanwhile, the overall assessment validations were valid with value CVI 0.93. Based on questionnaires on several chemistry teacher instruments, they all agreed that performance assessment, which had been developed, was effective and feasible to use.

Keywords: Performance Assessment, Task and Rubric, UV-Vis Spectrophotometry

INTRODUCTION

Assessment is a series of teacher activities in determining competence achievement based on student learning outcomes during the learning process (Siswaningsih, W., & Kusumaningtyas, H. 2018). The importance of the assessment quality will facilitate the learning process, yet, the lack of assessment will decrease the learning quality (Novak et al. 2005). Assessment is expected to focus on the importance of acknowledging the students' weaknesses and strengths. The teacher's assessment can gradually provide useful feedback for the students, and therefore, they can learn how to monitor their performance (Perkins & Unger, 1999; Shepard, 2001).

Laboratory activities have a special and central role in the science curriculum and science teachers suggest involving the students in science laboratory activities because of the many benefits (Hofstein. 2004). Direct experience in the laboratory has long been recognized for the importance of these activities in science education and student work skills. Nevertheless, an accurate and informative assessment of students' laboratory skills is still a challenge for the teachers (Hofstein, 2004; Chen et al., 2013). Within practicum activities in the laboratory, the teachers have difficulty assessing student performance. These difficulties are caused by: (1) Lack of teacher knowledge in the assessment method of psychomotor aspects that are clear and detail, such as creating a proper assessment rubric following the students' competence. (2) The difficultness of a teacher assessing and observing all students in a classroom or a laboratory practicum, as in results, the practicum assessments are based on student report sheets, not based on their performance (Asiah, H. A et al. 2017; Nahadi et al. 2016, 2017; Susilaningsih et al. 2018; Wibowo, 2016).

The performance assessment is a part of the authentic assessment form, in which it involves teachers observing and considering the student competence based on a particular indicator in doing an activity, creating a product, and giving a presentation (Firman, 2018b; Mc.Millan, 2007; Mudrika, M et al. 2018; Nahadi et al. 2016). The performance assessment focuses on simulation and visualization (Palm T, 2008). The performance assessment is vital to be carried out in Vocational Schools because the graduates are expected to be ready to work and become entrepreneurs. As stated by the Directorate General of Primary and Secondary School, one of the vocational school students' competences majoring in analytical chemistry is to perform under the guidance with the quality and quantity measured in line with the performance competency standard. One of the competencies is using the instrument tools in analyzing the degree in the sample. The benefit of using instrument tools in industries is that it makes analysis faster, more precise, and efficient.

The performance assessment instruments can take the form of checklist and rating scales, and within the tasks, there are performance indicators shown by the students so that the skill can be accessed (Firman, 2018). Greenstein (2012) defines rubrics as guidelines in grading performance scores that need to be accessed and scoring criteria for each aspect of performance indicated by the students. Rubric scores are used to see student performance in a laboratory task (Chen et al. 2014). The advantages of the ranking scale rubric are the availability of performance quality ranks, not only relying on whether the assigned task is completed or not, and the direct teacher involvement in assessing. Therefore, the resulting scores can provide more detailed information and can be used as feedback to improve the skills (Firman, 2018b; Veale, C. G et al. 2020).

Some previous studies on the development of performance assessment instruments have been conducted. For instance, "Building a Visible Spectrophotometer Prototype" which analyzed an authentic performance project in instrumental analysis where the students design, build, and examine spectrophotometers which are made from simple components (Wilson & Wilson, 2016). Meanwhile, "Development and Validation of Performance Assessment in the Instrument Chemistry Modified Practicum Tools Project" investigated the development and validation of performance assessment instruments to measure the future chemistry teacher university students' creative thinking skills on project-based learning modification of visible light spectrophotometer and atomic absorbing spectrophotometer (Diawati et al. 2017). From the previous studies, there has been no study on the development and validation of performance assessment instrument in UV-Vis spectrophotometry practicum. Therefore, this study will explain the research on the development and validation of performance assessment instrument in UV-Vis spectrophotometry practicum.

RESEARCH METHOD

This study used the Development and Validation design, which referred to the development and validation conducted by Adams and Wieman (2011). This research design portrayed how the researchers developed the performance assessment instruments on the UV-Vis spectrophotometry practicum, which were used in 3rd-grade vocational school students majoring in analytical chemistry.

The research stages were as follows:

1. Planning Stage

This stage involved several instrument planning steps, namely: (a) Reviewing the 2013 Curriculum, which were Core Competencies (KI) and Basic Competencies (KD); (b) Determine the aims of performance assessment in UV-Vis spectrophotometry practicum.

2. Development Stage

This stage included the instrument development steps, namely: (a) Designing indicators of instrument chemistry quantitative analysis practicum skill; (b) Making a grid of performance assessment instrument; (c) Designing rubrics and task development. From this stage, the first draft of the performance assessment instrument was obtained at the UV-Vis spectrophotometry practicum.

3. Validation Stage

The validation test stage was content validity. The instrument draft was validated by an expert team that involves five members consisting of chemistry education lecturers and analytical chemistry lecturers. The validation results were obtained through CVR (Content Validity Ratio) analysis to determine the validity of each item and the CVI (Content Validity Index) to determine the overall validity. The minimum score of CVR for five expert teams with a significant level of one-tail tests, $\alpha = 0.05$ was 0,736 (Lawshe, 1975), and the acceptable CVI minimum standard score was $\geq 0,80$ (Davis,1992). If there were a wrong item, it would be revised or eliminated. The content validation design was a checklist form of the competency conformity with the performance aspects, performance aspects with indicators, and rubric indicators with scores.

4. Instrument Evaluation Stage

This stage was carried out by distributing valid assessment instruments and questionnaires via Google forms to 7 chemistry teacher instruments from several analytical chemistry vocational schools. The questionnaires were used to evaluate and obtain comments on performance assessment instruments. The questionnaire results were analyzed qualitatively descriptive.

RESULTS AND DISCUSSIONS

The analysis of the 2013 curriculum for analytical chemistry resulted in material data that would be analyzed in the group of subjects C3, namely chemical analysis instruments with the total of lesson periods 556 hours (@45 minutes). The Core Competency (KI) as a reference for making instruments was KI 4, a competency for the skill aspects with Basic Competence (KD) 4.9 carrying out spectrophotometric analysis. Meanwhile, 4.10 making a report on the results of the spectrophotometric analysis. Allocation of time for KD 4.9 and 4.10 learning was four times the practicum activities where each practicum was carried out during 4 hours of learning.

The purpose of evaluating the performance of the UV-VIS spectrophotometry practicum was to assess the student performance in the laboratory by using clear and detailed indicators so that the assessment was objective and described the students' abilities well. Performance assessment instruments developed in the form of tasks and rubrics. The rubric was a multi-purpose assessment guide for assessing student's products and performance and enhancing teaching, contributing to better assessment, and becoming an essential source of information for program improvement (Wolf, K & Stevens, E. 2007). Task and Rubric Development, which consisted of 17 tasks, were the development of competencies that students must

have in carrying out analysis with UV-Vis spectrophotometry. The task items can be seen in table 1.

Table 1: Item Performance Evaluation Tasks

| No | Indicators | Tasks |
|----|--|---|
| 1 | Making a sample solution to determine the concentration of the contained substance. | 1.1 Smooth the Sample (If the Sample is Solid) |
| | | 1.2 Weigh the Sample (If the Sample is Solid) |
| | | 1.3 Destructing the Sample (If the Sample is Solid) |
| | | 1.4 Pipette Samples (If the Sample is Liquid) |
| | | 1.5 Dissolve the Sample |
| 2 | Make a Standard and Blank Solution to Determine the Content of a Substance in a Sample | 2.1 Weigh Primary Standard Substances |
| | | 2.2 Making Parent Standard Solutions |
| | | 2.3 Make a Standard Series |
| | | 2.4 Limiting Pumpkin Measure |
| | | 2.5 Homogenize Standards / Samples |
| | | 2.6 Make Blanks |
| 3 | Measuring the Concentration of a Substance in a Sample | 3.1 Prepare the UV-Vis Spectrophotometer |
| | | 3.2 Preparing Cuvettes |
| | | 3.3 Fill the cuvettes |
| | | 3.4 Determine the maximum wavelength |
| | | 3.5 Make a calibration curve |
| | | 3.6 Determine sample concentration |

The developed instrument was then validated its contents to see the suitability of the contents of the tasks and rubrics by qualified experts. Content validation was carried out by 2 education expert lecturers and 3 analytical chemistry lecturers at Universitas Pendidikan Indonesia (UPI) through a validation sheet. Giving a score on each item using the CVR method. After all items gott a score, then the score was processed by the following formula:

$$CVR = \frac{n_0 \frac{N}{2}}{\frac{N}{2}}$$

Information:

n_0 = Number of respondents who said yes

N= Total number of respondents

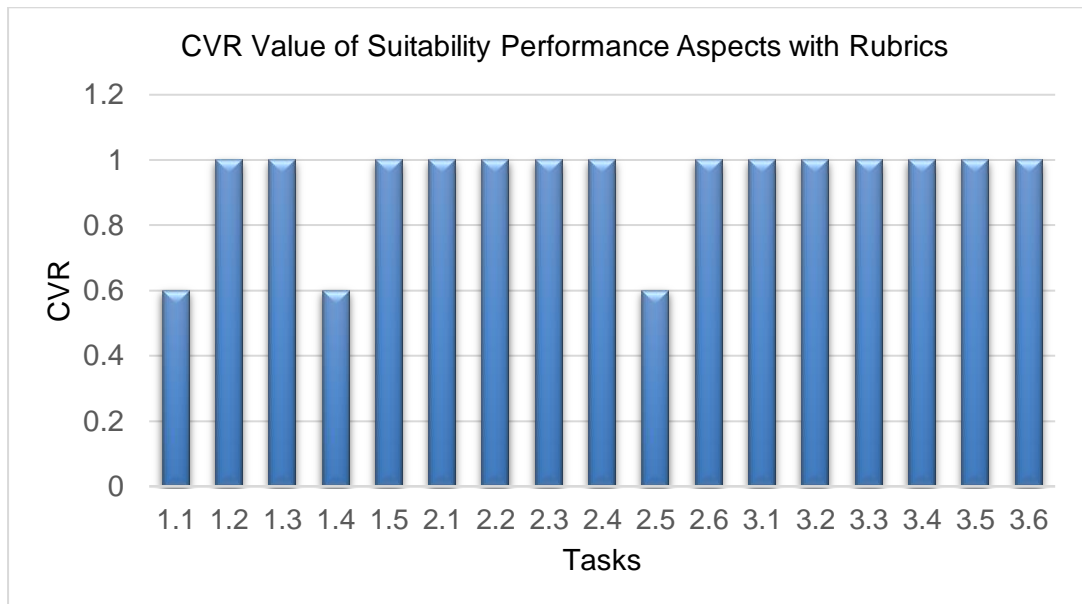


Figure 1. Graph of CVR Value of Suitability Performance Aspect with Rubric

The CVR calculation results for each task item developed were shown in Figure 1. According to Wilson et al. (2012) the critical value of CVR is a significant level of one-tail test, $\alpha = 0.05$ with the number of validators five persons are 0.736, as for the figure 1, it appears that 14 of the 17 tasks were valid with a CVR value of 1. The rests were invalid, with a CVR value below the critical value of 0.6.

The overall validity content could be seen through the CVI value. From the data of content validation results by the experts, the CVI value was calculated using the following formula:

$$CVI = \frac{CVR_t}{\text{The total number of questions}}$$

Overall, content validity referred to the minimum acceptable standard CVI value ≥ 0.80 (Davis, 1992). The CVI calculation results for the content validation data were 0.93, so the instruments developed as a whole fulfill the valid criteria.

The task that had not been valid was task 1.1 Smoothing the Sample (If the Sample is Solid); 1.4 Pipetted Samples (If the Sample is Liquid); and 2.5 Homogenizing Standards / Samples. In task 1.1, the expert validator questioned the refinement of the sample because the sample was not only solid but also liquid, which did not need to be smoothed. In task 1.4, the validator suggests an improvement to the rubric assessment of the piping task indicator, where it was not only to reduce the solution but also to the process of piping the sample to the targetted volume. In task 2.5, the validator suggested that in homogenizing the standard/sample, it should pay attention to a similar process until it was homogeneous, not limited to the amount of flipping the flask.

Following the suggestions of Ugwu and Anthonia, N (2014) and Wolf, K & Stevens, E. (2007), that instruments must be adopted by paying attention to the tools used, the performance to be assessed must be observable and measurable. The invalid tasks would then be improved as the suggestions from the expert validator. Some

descriptions of learning outcomes or performance indicators that were still vague would later be revised so that measurements can be done accurately.

Based on a questionnaire given via an online form to teachers who teach chemical instruments in several vocational high schools, the collected data is presented in the bar graph in Figure 2 below:

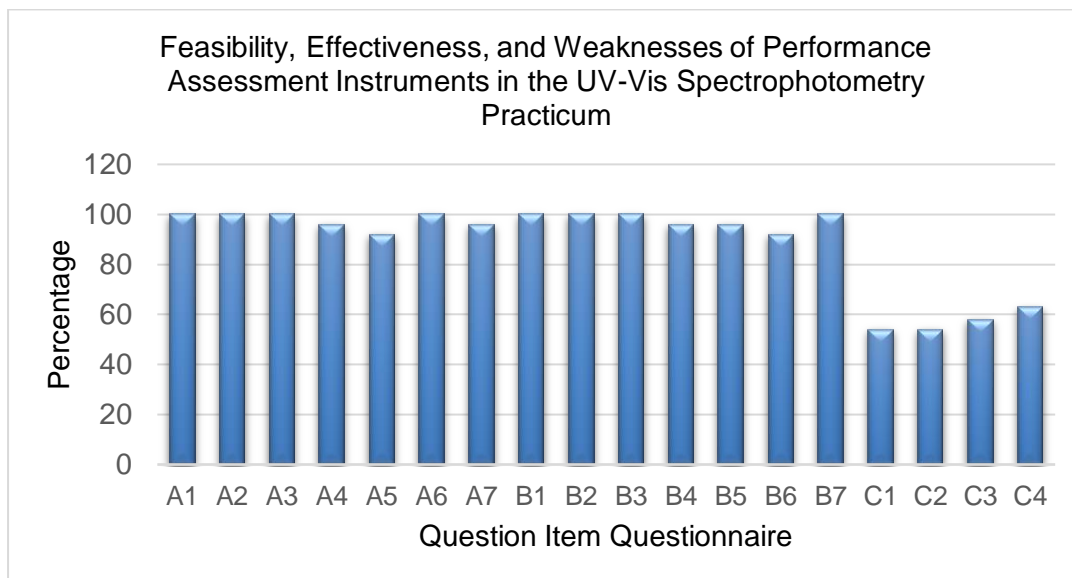


Figure 2. Feasibility, Effectiveness, and Weaknesses of Performance Assessment Instruments in the UV-Vis Spectrophotometry Practicum

In figure 2, the item questionnaire with code A1-A7 was a question about the suitability of instrument, code B1-B7 was a question about the effectiveness of the instrument, and C1-C4 was a question about the weakness of the instrument. The graph shows that the instrument was feasible with a percentage of 98% and effective with a percentage of 98%. Therefore, it can be inferred that the developed instrument was viable and effective for use in the performance evaluation of UV-Vis spectrophotometry because the assessment rubric was clear, detailed, and could assess students' abilities objectively. Meanwhile, the weakness of the instrument obtained a percentage of 57%, which meant that the instrument still had flaws. The weaknesses were the use in the field required many observers (teachers) in one class so that all aspects could be observed objectively in all students.

CONCLUSIONS

The developed instruments consisted of tasks and rubrics. The results of content validation by experts stated that 14 of the 17 developed tasks had fulfilled the valid criteria and showed the right consistency among experts with a CVR value of 1. At the same time, the rests were invalid, with a CVR value of 0.6. Overall, the developed instruments had met the validity requirements by meeting the CVI value of 0.93. Opinions from the potential instrument users, namely instrument chemistry teachers, stated that the instrument was feasible and effective in assessing student performance objectively. Nevertheless, more observers were needed so that the performance of all students could be observed.

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