Performance parameters of standard salt concentration sensitivity and linearity in Refractometers and Genesys 30 Spectrometer UV-Vis

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Abstract. The performance parameters of the sensitivity and linearity of the UV-vis Refractometer and Spectrometer in the standard salt solution test are very simple to do on a simple and inexpensive sample basis. The accuracy of measuring instruments is very important, and the process of checking measuring instruments through trials of salt content is one of the techniques in this study to determine the performance parameters of science laboratory equipment, especially in the use of refractometers and Genesys 30 spectrometer UV-vis. Both of these instruments are available in the Laboratory of the Faculty of Mathematics and Natural Sciences with different specifications in order to select an instrument that has high accuracy based on the characterization of the performance parameters of the Science laboratory equipment with indicators of higher sensitivity and linearity. The output of this research is to provide tool recommendations with high accuracy. Experimental results on samples of five different concentrations of salt solutions showed that the sensitivity and linearity of the spectrometer UV-vis were higher than those of the refractometer, so it can be concluded that to test the concentration of salt content in certain samples, it is better to use a spectrometer UV-vis.

1 Introduction

The Science Laboratory is a place for students and lecturers to research and solve science problems. In the Science Laboratory, students and lecturers carry out investigations by observing natural objects (natural phenomena) and/or experiments for research development to strengthen scientific understanding of sciences. A science laboratory is an academic support unit in an educational institution, in the form of a closed or open room, permanent or mobile in nature, managed systematically for testing, calibration, and/or production activities on a limited scale, using equipment and materials based on certain scientific methods, in the framework of implementing education, research, and community service.

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The role of science laboratories is urgently needed to support course achievements including Utilizing Science and Technology to teach how to use laboratory equipment, and tracing information related to laboratory equipment and managerial functions in the laboratory, being able to master theoretical concepts (Facts, Concepts, Principles, Theories) in the field of Science laboratory management related to managerial, administrative, occupational security and safety functions, preparation of SOPs, and preparation of solutions, as well as being able to formulate several procedural problem solving alternatives in the laboratory associated with a scientific approach, to: plan, manage, and evaluate the implementation of the natural science laboratory which is the responsibility, make appropriate decisions based on analysis of information and data and communicate to the public in accordance with applicable regulations, and be responsible for work carried out as a form of self-learning and be able to provide reporting on work results related to activities in the science laboratory [1]

The existence of an adequate science laboratory in terms of the availability of practical tools has an important role in supporting the strengthening of the knowledge of students and lecturers, especially at the Universitas Negeri Surabaya (UNESA) Faculty of Mathematics and Natural Sciences (FMNS). Supporting capacity for strengthening science can be achieved through practical activities in laboratories that support both subject knowledge and research development carried out by students and lecturers. The equipment used for practical courses and research activities must have good feasibility and accuracy [2][3]. That's why checking the accuracy of measuring instruments is very important, and the process of checking this measuring instrument is commonly known as calibration. Calibration is a process of checking the accuracy of a measuring instrument by comparing a traceable standard with national and international standards and certified materials or materials. The performance parameters of practicum tools include the accuracy of the tools, the sensitivity of the tools, and the linearity of the results of data analysis, as well as the level of accuracy obtained in measuring variables.

In the description of the background above, the researcher as Head of the FMNS Science Laboratory took the initiative to improve the performance parameters of the tool to characterize the performance parameters of the UNESA Science laboratory equipment, including determining the accuracy, sensitivity, and linearity of the Science practicum tools in the Physics, Biology, Chemistry, and Science. Determining the performance of the tool aims to be able to find out the accuracy of the tools used in the FMNS Science laboratory which includes 4 majors, and to produce good data analysis and conclusions for the achievements of course practicum activities at FMNS as well as lecturer and student research. As for the sample tools that will be tested for tool performance parameters are Refractometers and Genesys 30 spectrometers UV-vis by testing the standard salt content [4].

Knowing the characteristics of measuring instruments is important so that the overall measurement work (preparation, implementation, and analysis) can be relied upon for its success [5]. One will not be able to design measurements properly without knowing the meaning of the characteristics of the measuring instrument. Accuracy is defined as a measure of how far the measurement results are close to the actual price. Accuracy measures are often expressed in two ways, on the basis of differences or errors (errors) against the actual price. Sensitivity is the ratio between changes in output to changes in input. On a linear measuring instrument, the sensitivity is fixed [6]. In some cases, a high sensitivity value also indicates the superiority of the measuring instrument in question [7]. Measuring instruments that are too sensitive are very expensive, while not necessarily useful for the intended purpose.

The salt content test is one of the techniques in this study to determine the performance parameters of science laboratory equipment, especially in the use of refractometers and Genesys 30 spectrometers UV-vis. The two tools are in 4 scientific clusters in the Faculty of
Mathematics and Natural Sciences with different specifications in order to choose a tool that has high accuracy based on the characterization of the performance parameters of the science laboratory equipment, namely the sensitivity and linearity of the two tools.

2 Method

The method used in this study was the experimental method of testing standard salt content samples with varying concentrations as a performance tool on a Refractometer and UV-Vis Spectrometer.

A refractometer is a tool that can be used to measure the level/concentration of dissolved materials. For example, sugar, protein, salt, and so on. The working principle of a refractometer, as the name implies, is to use the refraction of light. There are several types of refractometers, including Abbe refractometers, Brix refractometers, and Salt refractometers [8]. Salt Refractometer is a refractometer used to measure salt content in parts per thousand or ppt and specific gravity or percent salinity (salt content) depending on the model. Salt refractometers can be used to measure the salt concentration of water or brine. Hand salt refractometer for 0-28% NaCl.

The working principle of UV-Vis spectroscopy is when there is a light source in the form of UV-vis light (monochromatic) that is passed through a medium (a colored solution) which is a sample, some of the light is absorbed, reflected and some is transmitted. The absorbed light will cause electrons to be excited from the ground state to a state that has a higher energy. This light absorption does not occur in all structures. However, it only occurs in conjugated systems that have phi bonds or chromophore groups, auxochrome groups (groups that have a large vibration due to the presence of lone pairs of electrons) for example -OH, -NH₂, and others. Because it has a large vibration, if it is bound to the chromophore group, it will cause a shift in absorption towards a longer wavelength and increase the intensity of the absorption peak. Meanwhile, light that is not absorbed or transmitted will appear as a transmittance value. Thus, the results of UV-Vis spectroscopy measurements will be presented in the form of absorption or transmittance spectra.

3 Results and Discussion

Research data on standard salt solution trials with varying concentrations were tested on a refractometer sample by obtaining the refractive index variable from each variation in standard salt solution concentration [9]. The next step is to test samples of varying concentrations of standard salt solution on a UV-Vis spectrometer with the output variable absorbance of each variable salt solution concentration [10]. The values of refractive index and absorbance from variations in the concentration of salt solutions are shown in Table 1.

<table>
<thead>
<tr>
<th>No</th>
<th>Concentration (M)</th>
<th>Refractive Index</th>
<th>Absorbances</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1</td>
<td>1.004</td>
<td>0.031</td>
</tr>
<tr>
<td>2</td>
<td>0.2</td>
<td>1.01</td>
<td>0.066</td>
</tr>
<tr>
<td>3</td>
<td>0.3</td>
<td>1.014</td>
<td>0.098</td>
</tr>
<tr>
<td>4</td>
<td>0.4</td>
<td>1.016</td>
<td>0.100</td>
</tr>
<tr>
<td>5</td>
<td>0.5</td>
<td>1.02</td>
<td>0.113</td>
</tr>
<tr>
<td>6</td>
<td>0.6</td>
<td>1.026</td>
<td>0.127</td>
</tr>
<tr>
<td>7</td>
<td>0.7</td>
<td>1.03</td>
<td>0.145</td>
</tr>
</tbody>
</table>
Figure 1. shows that the index of refraction appears to increase linearly with increasing concentration of salt solution.

![Graph of Refractive Index vs Concentration]

**Fig. 1.** The graph of the refractive index appears to increase linearly with increasing concentration of salt solution.

The results of the detection analysis showed that the refractive index showed a linear increase with increasing concentration of salt solution with a sensitivity of 0.0414 and a linearity of 96.71%. Figure 2. shows that the absorbance appears to increase linearly with increasing concentration of salt solution.

![Graph of Absorbance vs Concentration]

**Fig. 2.** The absorbance graph appears to increase linearly with increasing concentration of salt solution.

The results of the detection analysis showed that the absorbance value showed a linear increase with increasing concentration of cholesterol solution with a sensitivity of 0.171 and a linearity of 97.57%.

### 4 Conclusion

The results of the analysis of the performance parameters of the refractometer and UV-vis spectrometer using standard salt concentration variations showed that the sensitivity and linearity of the UV-vis spectrometer were higher and more accurate than the refractometer.

### Acknowledgment

Thanks to DAPT-EQUITY Program, Lembaga Pengelola Dana Pendidikan (LPDP), Ministry of Finance, Indonesia for supporting this publication.
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