PRE-SERVICE AND IN-SERVICE CHEMISTRY TEACHERS’ VIEWS ON TEACHING SPECTROMETRY IN SENIOR HIGH SCHOOL

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Abstract

Spectrophotometers are usually used in university laboratories and are rarely owned by high school laboratories. Meanwhile, teaching spectrometry in high schools can serve as a catalyst to attract students’ interest in chemistry. The purpose of this study was to investigate how the pre-service and in-service chemistry teachers’ views on teaching spectrometry in senior high school. Qualitative methods were used in this study. Data collection techniques used was questionnaires, interviews, and observations. A total of 39 pre-service and 4 in-service chemistry teachers were selected as the subjects in this study. The pre-service chemistry teachers used in this study were in the 2nd, 3rd and 4th year. Meanwhile, the in-service chemistry teachers used in this study were purposively selected from those who had completed their teacher professional training. The views of pre-service and in-service chemistry teachers on teaching spectrometry in the senior high school are highly depending on how they learn the subject when they were at university. Pre-service and in-service chemistry teachers think that making a simple spectrometry tool at the senior high school level is possible. The results of this study can be used as a reference for improving the quality of teaching in the chemistry teacher education program.

Keywords: Pre-service and in-service chemistry teacher, Teachers’ view, Spectrometry, Spectrophotometer.
Spectrophotometers are usually used in spectrometry learning and laboratory activities at universities. These tools are rarely owned by senior high school laboratories [1]. Spectrometry learning discusses about the basic principles of spectrometry, the function of spectrometry analysis for solving problems in everyday life and utilizing various spectrophotometer technologies. In Indonesia spectrometry has not been fully taught to pre-service and in-service chemistry teachers. Meanwhile, teaching spectrometry with various spectrophotometer instrument in high schools can serve as a catalyst to attract students’ interest in chemistry [2].

Researchers have developed various ways to teach spectrometry in high school. One of them is by making a simple spectrophotometer. Various kinds of simple spectrophotometers have been made, such as DVD spectrophotometer [3], flame spectrophotometer [4, 5], and visible light spectrophotometer [6, 7]. However, to teach students how to make a simple spectrophotometer, it requires experience, attitude, trust, and good knowledge and views from the teacher towards spectrometry.

The development of this spectrophotometer device is based on the same principle, namely the Lambert-Beer Law. The equation is presented as follows. [1, 8].

\[
A = ε.b.C
\]  

\(A\) is absorbance with molar absorptivity \((ε; \text{L/mol.cm})\); \(b\) (cm) is the path length of light in the sample, and \(C\) (mol/L) is the concentration. Then, when the correlation above involves light transmission \((T)\) and light intensity \((I)\), absorption \((A)\) is defined as follows [8-10]:

\[
A = -\log(T) = \log \frac{I}{I_0}
\]  

\(I\) is the intensity of light transmitted through the sample and \(I_0\) is the intensity of the light transmitted through the blank.

A spectrophotometer is a device that measures the level of absorbance of light in a certain wavelength range. This tool consists of three important elements, namely light sources, monochromators, and detectors. The light source and detector determine the wavelength limit and the sensitivity of the tool, while the monochromator separates the light produced by the light source into different small ranges, usually on a nanometre scale. Samples are placed between monochromator and detector using transparent containers called cuvettes. It is illuminated by certain wavelength ranges, and the intensity of light that is not absorbed by substances in the sample can be quantified by the detector [1]. The illustration of the basic principle of spectrophotometer showed in Fig. 1.

A simple spectrophotometer for chemical analysis and lab activity is one of the topics of research to answer current problems [8]. The development of this spectrophotometer is inseparable from three important parts of the spectrophotometer, such as the use of light sources in the form of green laser pointers [11], and LED [12, 13] also uses various kinds of detectors such as Arduino [8, 14] and digital camera [15, 16]. In addition, the types of spectrophotometer that were developed also varied such as UV-Vis [3, 17, 18], Flame photometer [4, 5] and spectrophotometer simulations using computer programs and augmented
The schematic of an optical spectrophotometer including a light source, monochromator, sample and detector show in Fig. 1.

Fig. 1. Schematic of an optical spectrophotometer [21].

Based on some previous studies, teaching spectrometry can be done with a simple spectrophotometer instrument that can be made by teachers and students [11]. Therefore, the purpose of this study was to investigate how the pre-service and in-service chemistry teachers’ views on teaching spectrometry using simple spectrophotometer in the senior high schools. The views and attitudes of the teacher will influence the way they conduct learning in the classroom [22]. This study is expected to provide an overview of the teachers’ views on spectrometry teaching opportunities in high schools. In addition, the results of this study are also expected to be a reference for teaching improvement for the chemistry teacher education program.

2. Method

Qualitative methods were used in this study. Data collection techniques used were questionnaires, interviews, and observations. A total of 39 pre-service and 4 in-service chemistry teachers were selected as the subjects in this study. The pre-service chemistry teachers used in this study were in the 2nd, 3rd and 4th year of one of the universities in Bandung. Meanwhile, the in-service chemistry teachers used in this study were purposively selected from those who had completed their teacher professional training.

The qualitative data obtained was analysed using three continuous flows of activities, namely: data reduction including data triangulation, data presentation, and conclusion drawing. Data reduction is used for selecting, centralizing or simplifying rough data that arises from each data collection technique. Data triangulation is used to check the validity of the data. This validity is obtained by comparing the results of interviews and questionnaires that have been conducted.

3. Results and Discussion

3.1. Experience of spectrometry learning

Most educational research focuses on improving student skills, educational curriculum and educational assessment. However few are paying attention to the role of the teacher in teaching, views and attitudes [23-25]. Teachers who have a negative view of science do not try to use inquiry-based teaching methods and usually transfer their negative beliefs to their students [26-28]. The views and attitudes of teachers during teaching were formed during their undergraduate study [22]. The results of the questionnaires shared with respondents can illustrate the
experiences they have learned about spectrometry learning. Table 1 contains questionnaire result data on experiences from 2nd, 3rd, and 4th year pre-service and In-service chemistry teachers on the spectrometry learning.

<table>
<thead>
<tr>
<th>No</th>
<th>Questions</th>
<th>2nd year</th>
<th>3rd year</th>
<th>4th year</th>
<th>In-service Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Did you get any experience in operating a spectrometry instrument?</td>
<td>We got instrument operation experience, but we did not practice with all instruments</td>
<td>We got instrument operation experience, but we did not practice with all instruments</td>
<td>We got instrument operation experience, but we did not practice with all instruments</td>
<td>We got instrument operation experience, but we did not practice with all instruments</td>
</tr>
<tr>
<td>2</td>
<td>Are there any assignments or projects given?</td>
<td>Yes, there are practical reports.</td>
<td>Yes, there are practical reports.</td>
<td>Yes, there are practical reports.</td>
<td>Yes, there are practical reports, papers and presentations</td>
</tr>
<tr>
<td>3</td>
<td>What experiences did you get in laboratory activities?</td>
<td>Experience of accuracy training.</td>
<td>Knowing how to operate the instrument.</td>
<td>Knowing how an analyst analyses a substance and how to read the results of the analysis.</td>
<td>Knowing the operating instructions, and detection mechanisms.</td>
</tr>
</tbody>
</table>

Based on Table 1, there is not much difference in experience that arises between 2nd, 3rd, 4th and In-service chemistry teachers. Differences that arise are only in the tasks given and interpretation of the experience they get. In-service Chemistry teachers interpret their experiences as a theoretical basis or detection mechanism for each spectrometry laboratory activity that they do, while the pre-service chemistry teachers define their practical experiences for instrument operation and analysis of results.

Spectrometry learning is not limited to teaching theory, but can be integrated by making simple spectrophotometer instruments using simple technology, such as Arduino-based spectrophotometers with white LEDs [8, 29], Home-made spectrophotometers [4, 10, 11], visible light spectrophotometers [6], and Low-cost quantitative absorption spectrophotometers [7].

The other research has explained how to engage students in making simple flame photometer [4]. Students create a simple flame photometer to measure sodium concentration in sports drinks. This learning generally uses many sophisticated instruments, whose inner parts may seem mysterious to students. However, this experiment gives students the opportunity to collect parts of the instrument used to measure and show that essentially all instruments depend on simple principles of physics and chemistry. These parts are then assembled into a home-made flame photometers instrument that has the same function as a flame photometer in the laboratory [4].
This method can be used by lecturers to provide experience in making and modifying spectrophotometers to pre-service and in-service chemistry teachers. Thus, they have enough experience and good views to teach spectrometry in high school.

3.2. The views of pre-service and in-service chemistry teachers on teaching spectrometry in senior high schools

Pre-service teacher belief is difficult to change [30]. Conception about the nature of knowledge and teaching was formed over many years through exposure to educational practices [30]. The term for this case was introduced by Bruner as "Folk Pedagogies" [30]. The term is used to describe an individual's developed beliefs about teaching and learning [30]. Table 2 contains a summary of the respondents' views and beliefs about teaching spectrometry at senior high schools.

Table 2. The views of pre-service and in-service chemistry teacher on teaching spectrometry.

<table>
<thead>
<tr>
<th>No</th>
<th>Aspects</th>
<th>2nd year</th>
<th>3rd year</th>
<th>4th year</th>
<th>In-service Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Are the subjects able to make simple spectrometry instruments?</td>
<td>No, they aren’t.</td>
<td>Yes, they are, it is difficult.</td>
<td>Yes, they are if they know the basic concept.</td>
<td>Yes, they are. The instruments can be simulated using animation and software</td>
</tr>
<tr>
<td>2</td>
<td>What is the spectrometry instrument that the subjects can make?</td>
<td>There are no instruments that can be made by the subjects.</td>
<td>UV-Vis</td>
<td>UV-Vis</td>
<td>UV-Vis</td>
</tr>
<tr>
<td>3</td>
<td>Is there any spectrometry-related topic in Chemistry for high school students?</td>
<td>Yes, there is. It is atomic structure.</td>
<td>Yes, there is. It is valence electron</td>
<td>Yes, there is. It is the qualitative analysis of element.</td>
<td>Yes, there are. They are the organic chemistry, determination of mass, and atomic structure.</td>
</tr>
<tr>
<td>4</td>
<td>Can the spectrometry be taught to high school students?</td>
<td>Yes, it can, but it is not deep.</td>
<td>Yes, it can with a simple explanation.</td>
<td>Yes, it can, but it is difficult because the limitations of the tools. Meanwhile chemical learning must be practiced directly.</td>
<td>Yes, it can, as an introduction, simply about its basic principles and functions.</td>
</tr>
<tr>
<td>5</td>
<td>How to teach spectrometry at the high school level?</td>
<td>With lectures</td>
<td>Only teaching the principle</td>
<td>Introducing a simple replica, the use of the tool, and how it works.</td>
<td>Teaching the types of samples tested, sample requirement, and detection mechanisms to read results</td>
</tr>
</tbody>
</table>
Table 2 shows the difference in perspectives between respondents. The 2nd year pre-service chemistry teachers consider it impossible to make a simple spectrophotometer that has the same function. Besides that, they view teaching spectrometry that can be done at the senior high school level only to the introduction of spectrometry instruments delivered by the lecture method. This negative view is influenced by their lack of experience in managing learning [31, 32]. Based on the applicable curriculum, pre-service teachers in the second year do not have real experience in teaching in the classroom.

The 3rd year pre-service chemistry teachers looked at being able to make a simple spectrophotometer but it is difficult to do. The tool that allows them to make a simple spectrophotometer of their version is UV-Vis. This tool was chosen because according to them it is the easiest tool to operate and understand. The UV-Vis instrument is the most developed spectrophotometer by the researcher [6, 7].

The 4th year pre-service chemistry teacher believes that it is possible to make a simple spectrometry tool. This tool can be made if they know the basic principles used. Just like most of the other respondents, they consider the UV-Vis the simplest instrument to make. To teach spectrometry at the senior high school level they argued to introduce a simple replica, also explained the uses and how it works.

The in-service chemistry teachers have other views on making simple instruments. They prefer to make animations or software or virtual labs that can simulate the spectrometry instrument. Thus, they can teach the types of samples tested, sample requirements, mechanisms and ways to analyse the results of the analysis. Alternative solutions from in-service teachers have been carried out by researchers by developing spectrophotometers based on augmented reality [20].

Due to the lack of a spectrophotometer in a senior high school laboratory, making simple spectrophotometer instruments can be a solution for pre-service and in-service chemistry teachers to teach spectrometry. Moreover, the research conducted by Lafratta proves that junior high school students are able to understand the function of spectrometry using homemade tools [4].

4. Conclusions

The views of pre-service and in-service chemistry teachers on teaching spectrometry in the senior high school are highly depending on how they learn the spectrometry when they were at the university. Pre-service and in-service chemistry teachers share the same view of the possibility of developing a simple spectrophotometer in high schools. They assume that the development of simple and inexpensive spectrophotometer instruments is the solution to the problem of spectrometry lab activity in high schools. Based on the results of this study, providing pre-service and in-service chemistry teachers with the skills to modify and make simple spectrophotometer instruments was important. Thus they have a good view of the potential of teaching spectrometry in high school.

Acknowledgment

The author would like to acknowledge the Lembaga Pengelola Dana Pendidikan (LPDP) and The Postgraduate School of Universitas Pendidikan Indonesia for supporting this research.
References


