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Evaluation of Science Teacher Candidates' Level of Knowledge Regarding the Use of Microscopes

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Abstract
This evaluation was conducted with 43 second-year students, or teacher candidates, attending the science education program of an education faculty in a Turkish university. In this study, students were asked to complete a single open-ended and gap-filling questionnaire, and their answers were evaluated according to a five-point Likert-type rubric. The manuscript provides several examples of the students' answers. In this context, the aim of this study was to determine science teacher candidates' level of knowledge regarding the use of microscopes. Based on the study results, we determined that in general the science teacher candidates had a partially adequate or inadequate level of knowledge regarding the use of microscopes.
Keywords: knowledge of microscope use, science education, teacher candidate

Introduction

Evaluating the effect and contribution of biology laboratory courses on the development of teacher candidates is both necessary and important for devising effective and productive laboratory applications (Yeşilyurt, 2006). The benefits of laboratory activities include improved attitudes towards science and scientific applications; improved scientific thinking and understanding of science; the acquisition of science-related skills by students; and improved learning science subjects. This is owing to the opportunity to apply and experience abstract science subjects in tangible settings (Harman, 2012). Laboratory activities involve the use of a large variety of both simple and complex tools, items and materials used in daily life and those obtained from specific sources (Güler and Çobanoğlu, 1997). These tools, items and materials allow students to work, perform experiments and organize information in the same way as scientists, thus enabling them to become familiar with scientific applications (Jewitt, Kress, Ogborn and Tsatsarelis, 2001). One such tool is the microscope. Just as other technological tools, the microscopes that are found in most elementary schools (Akpınar and Turan, 2002; Demir, Böyük and Koç, 2011) facilitate the learning of subjects and concepts when used in education (Yavuz and Coşkun, 2008). Flick and Bell (2000) emphasized in their study the importance of the microscope as a tool that allows teachers to teach science and technology more effectively.

Students learn about materials and objects such as plants, batteries, light bulbs and microscopes by using and/or building them (Sivertsen, 1993). Being knowledgeable about the structure and characteristics of microscopes, and being able to identify the problems encountered during the use of microscopes, is an important and more effective way for teaching the proper use of these tools (Uzel, Dikmen, Yılmaz and Gül, 2011). In science education, and especially when teaching biology, allowing visualization and facilitating the understanding of the subject being studied, often requires the use of microscopes; consequently, it is necessary for the teachers to have a good knowledge of microscopes. In biology studies, microscopes are frequently the primary tools used in evaluation of biological materials. Since microscopes are fairly sensitive instruments, the effectiveness with which they can be used depends largely on their users' level of knowledge (Dökme, Doğan and Yılmaz, 2010). A previous study by Benzer and Demir (2014), evaluating the level of knowledge of science teacher candidates regarding the use of microscopes, emphasizes the importance of knowing the proper use of microscopes. In their study, Taşdelen and Güven (2012) report that science teacher candidates wish to see laboratories equipped in accordance with contemporary technological and scientific requirements, and prefer that laboratory observations be made directly through the use of microscopes. For all of these reasons, ensuring that science teacher candidates – the science teachers of the future – have adequate knowledge on microscopes is important for teaching them the proper use of this technology, as well as other laboratory tools and equipment. In this context, the aim of this study was to determine the technical knowledge of science teacher candidates regarding microscopes.

Methods

This study was conducted with 43 second-year students, or teacher candidates, attending the science education program of an education faculty in a Turkish university. As the aim of this study was to determine the level of knowledge of science teacher candidates regarding the use of microscopes, a screening model was used. Studies based on the screening model involve the description and evaluation of subjects/events relating to a particular topic or area of study (Sönmez and Alacapınar, 2011). Within the scope of this study, students were asked the following open-ended question: "*How would you evaluate a plant cell during an experiment by using a microscope? Describe step by step.*" The validity of this open-ended question was evaluated and confirmed by

two researchers, and the teacher candidates' answers were evaluated according to a 5-point Likert-type rubric.

Results

The study results are shown in Table 1 and Table 2. Table 1 shows the science teacher candidates' level of knowledge regarding the use microscopes, as determined based on the data obtained from their responses and the five-point rubric.

Table 1. The science teacher candidates' level of knowledge regarding the use of microscopes

Very Adequate	Adequate	Partially Adequate	Inadequate	Very Inadequate
0	9	14	19	1

As shown in the table above, the science teacher candidates generally had a partially adequate or inadequate level of knowledge regarding the use of microscopes.

Table 2. Certain examples of the teacher candidates' answers concerning the use of microscopes

A1- *As an example of a plant tissue, we take an onionskin. We carefully place the onion skin, without folding it between a glass slide and cover glass, and then put a drop of dyed water on it. We then place the glass slide and cover glass on the microscope. We first find the image of the onion skin with the aid of the coarse adjustment knob, and then clarify the image with by using the micro adjustment knob.*
A2- *I use an onion as a source of plant cells. I take a piece from the innermost section of the onion. I place the onion piece on the glass slide. I turn on the microscope, and adjust the level of light. I place the apparatus on the microscope's stage. I set the objective lens at x10 magnification. Then, I try to find the image by using the coarse adjustment knob. Once I find the image, I will increase its clarity by using the micro adjustment knob. I will then set the magnification of the image at x40. I will clarify the image once again with the micro adjustment knob. We can then repeat this procedure to find and clarify the image at x100 magnification*
A3- *As a source of plant cells, we can use an onion skin. We first separate the onion skin from the onion, and place the skin on a clean glass slide. We put a few drops of the necessary substance/stain, and place the cover glass on top of the glass slide. We complete the preparation of our slide, and then turn on the microscope. The slide will be held on the stage by the specimen holders. Using the revolver of the objective lens, we will adjust the magnification to the lowest level, and then find the image of the slide by using the coarse focus knob. By adjusting the specimen holders, we will bring the area of the slide to be evaluated/visualized to the section where light passes through the stage. Once we find the image while looking through the ocular lens, we will use the fine focus knob to make the image clearer. We can adjust the intensity of light, to decrease or increase the amount of illumination. If an image with higher magnification is required, the objective lens can be sequentially adjusted to x4, x10 and x40 to increase magnification.*

Table 2 provides three examples of the science teacher candidates' answers to the open-ended question. The examples in this table include an inadequate response, and partially adequate response, and an adequate response (in terms of the level of knowledge regarding the use of microscopes). An evaluation of all three answers reveals that none of these teacher candidates mentioned the use (or adjustment) of the condenser or diaphragm. In addition, the first teacher candidate failed to mention the adjustment of the objective lens, while the second students made inaccurate remarks concerning the objective lens.

Conclusion and Discussion

One of the most effective methods used in science education is laboratory activities, (Hofstein and Lunetta, 2004; Hofstein, Kipnis and Kind, 2008; İlhan, Sadi, Yıldırım and Bulut, 2009; Demirbaş and Pektaş, 2010; Dahar and Faize, 2011). The microscope is an important instrument used within the frame of science education and laboratory activities. Benzer and Demir (2014) described that the use of microscopes is important both for teachers and their students.

Zeren Özer, Güngör and Şimşekli (2011) previously demonstrated in their study that teacher candidates often experience problems with experiments requiring microscopes. Uzel et al. (2011) observed that while most science teacher candidates were able to identify the ocular lens, the stage, the fine adjustment and the coarse adjustment components on microscopes, they were generally unable to identify the condenser and the condenser adjustment. The results of our study indicated that science teacher candidates generally had a rather inadequate level of knowledge about microscopes, and that they had particular difficulties in identifying the name of the microscope, as well as the condenser and diaphragm components. Studies of Uzel et al. (2011) and Harman (2012) similarly determined that many teacher candidates had incomplete and incorrect knowledge about microscopes. Taşdelen and Güven (2012) noted that teacher candidates wanted to see a greater emphasis on experimental applications in their courses, and to perform observations using microscopes.

Ketelhut, Nelson, Clarke and Dede (2010) described that even virtual microscopes can give students/teacher candidates the impression of actually performing an experiment, of testing hypotheses, and carrying out tests in a manner similar to scientists. Flick and Bell (2000) emphasized in their study the

importance of the microscope as a tool that allows teachers to better teach science and technology. All of these studies emphasize that the use of microscopes has an indispensable place in science education. For this reason, it is both necessary and important for science teachers to have an adequate level of knowledge regarding the technical aspects and use of microscopes. This will allow science teachers to better assist students in studying the natural world within a laboratory setting, and in discovering certain structures, organisms and objects that cannot be seen with the naked eye. For these reasons, it is essential for science teacher candidates to have adequate knowledge regarding the use of microscopes.

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