The Use of Microscope in School Biology Teaching

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The study on the use of microscopes in biology teaching was conducted in 73 primary schools and 30 secondary schools in Split-Dalmatia County. The results showed that 94% of schools have at least one monocular light microscope, which is of primary importance for the teaching of biology. Out of the total number of schools, 97 schools are equipped with microscopes, while 6 schools have no microscopes. The most common types of microscopes used in teaching are monocular light microscopes (80%), followed by binocular optical microscopes (16%), digital microscopes (3%), and stereo-microscopes (1%). A total of 43% of teachers perform microscopy using the demonstration method, and 37% of teachers use practical work. Animal tissue and crosscut plant structure are the most frequent specimens used for microscopic examination in demonstration lessons, and plant cell preparations, protists, and sex cells are the most frequently used in practical lessons. In the course of the school year, 61% of teachers use the microscope occasionally in teaching biology, and 39% do so often. In terms of levels of satisfaction, using microscopy in teaching received an average rating of 3.73. Fifty-three percent of teachers gave the main reason for the infrequent use of microscopes in teaching as the lack of a sufficient number of microscopes for quality teaching; 30% cited the overly demanding biology curriculum; 11% space problems; and 6% the lack of microscopes, teacher’s lack of confidence in working with microscopes, and lack of preparation. The reason given by the teachers for the low level of engagement with microscopy is their concern that there is no guarantee that the amount of time and effort required to use microscopes in class will be justified.

Keywords: Teachers, microscopes, practical work, active learning, microscopy

1. Introduction

Over the past decade, in Croatia, as in other countries worldwide, a modern educational system has been developed aimed at achieving a synergy of functional and educational competences or learning outcomes. Teaching natural sciences should necessarily involve active learning, exploration, and discovery of the world in which we live with the constant presence of critical thinking. In passive learning, students acquire incomplete knowledge which is prone to degradation, and is ineffective and unacceptable in everyday life [1]. Therefore, it is necessary to use the methods of active learning and the skills of teachers to provide curricular and extracurricular activities for students [2–4]. For students, it is very important to incorporate the concepts of natural science firsthand, because it facilitates easier and faster adoption and experiential learning [5, 6].

It is also important that the teaching of natural sciences is shaped as active learning and observation of natural reality, so students can apply this knowledge in everyday life [7, 8]. Biology as a natural science, which is taught in primary and secondary schools, includes many materials not visible to the naked eye that are valuable for students to encounter firsthand and explore through discovery learning. Since this is of crucial importance for the understanding of cellular structure, organs, and microorganisms, it is essential that this microsphere is brought closer to the students and a microscope is used for this purpose. Microscopy is primarily defined as a visual method of learning; it is used as a demonstration method and for practical work.

The research on the use of microscopes in teaching biology was conducted in primary and secondary schools in Split-Dalmatia County. The aim of this research was to determine: (1) the availability of microscopes in schools; (2) the representation of the microscopic method in everyday teaching practice; (3) the diversity of microprocessors used in everyday teaching practice; (4) the attitude of the teacher regarding the microscopic method; and (5) the reasons for not using the microscope.

2. Experimental Details

The survey was conducted during the 2015–2016 school year using an anonymous survey (Supplementary Data) on a sample of 103 primary and secondary school teachers in Split-Dalmatia County: one teacher from each school completed a survey. The survey was designed to determine the basic microscopic options available to the school in question, and the teachers’ personal engagement and thinking about microscopy as a teaching method in the current teaching practice of biology and nature.

Each participant was given one copy of the survey leaflet and three A4 monochrome paper prints. The survey shown below is a colored original (Supplementary Data). Data collected through this study are computer-compiled and statistically processed in Microsoft Office Excel 2013™ and Microsoft Office Access 2013™ using a set of formula for comparing, integrating, copying, and analyzing data from which the enclosed results and graphs are derived.

3. Results and Discussion

There are many materials available for teaching biology and nature in primary and secondary schools, some of which can only be studied and observed by using a microscope. An appropriate number of microscopes should be available to schools and biology teachers for performing practical work and demonstration in biology teaching. A survey was conducted among 103 teachers, of primary and secondary schools in Split-Dalmatia County regarding the possession, maintenance, modernization, and practical application of microscopes in biology teaching. Seventy-three teachers are from primary schools, and 30 are from secondary schools, of which 25 are grammar school teachers and 5 are teachers at vocational schools. It has been established that
the vast majority of schools do possess microscopes, but, despite this, there are numerous qualitative problems.

By analyzing the microscopy equipment for teaching biology in schools, 97 schools (94%) possess microscopes, while 6 schools (6%) have no microscopes (Figure 1). Of the total number of usable microscopes used in schools, most are monoculars (80%), then binoculars (16%), digital microscopes (3%), and stereomicroscopes (1%) (Figure 2). Comparative statistics show that binoculars and digital microscopes are more prevalent in primary schools. A large number of monoculars, 114 of the total number of 342, were not valid, 5 binoculars were not in working order of the total number of 50, while 1 stereomicroscope of a total of 5 was not in working order. This also precludes the use of microscopy in biology teaching.

As for personal preferences in the choice of microscopes, most teachers opt for binoculars (42%) and digital microscopes (40%) as their ideal microscope. The least interest is in stereomicroscopes (2%) (Figure 3). It is also interesting to note that digital microscopes are largely selected by teachers who have a small number of monoculars as the only teaching microscopy tool. The stereomicroscope is the most successful tool for studying fine biological material and delicate structures in real time, color, and depth of presentation—such as insect organisms, anthers of flower, sporangia, crystals, trichomes, etc. Unlike monocular and binocular microscopic preparations, which are often abstract to students, the stereomicroscope provides a better understanding, integrity, and perception of tiny structures.

Analysis of the application of microscopy as a teaching method shows that the greatest uses are demonstration methods (43%) and practical work (37%). More than 80% of respondents confirmed the use of both methods in teaching students, i.e., in 6% of the same teachers were the most dominant demonstrations confirmed the use of both methods in teaching students, and practical work (37%). More than 80% of respondents confirmed the use of both methods in teaching students, i.e., in 6% of the same teachers were the most dominant demonstration methods compared to practical methods (Figure 4).

The data obtained by question 1 (d) “Please indicate the specimens you used for microscopic examination” show that the highest rated among 55 listed microscopy samples includes animal and plant tissues as well as vertebrates’ blood samples when using microscopes for demonstration and practical work in teaching biology. Among the listed preparations, fungi preparations are the least used (Figure 5). For the purpose of performing practical work, a smaller number of teachers apply micropreparations. The most commonly used preparations include plant and animal cells and protista (Protista), and fungi microscopic preparations are the least common (Figure 6). There is a proportional correlation between the number of available microscopes and the breadth of the purpose for which they are used with a variety of samples. The lowest rate of samples used for practical work in microscopy covered parasites, water samples, and hair dyes.

In terms of how frequently microscopy is used in teaching, it can be seen that microscopes are mostly used occasionally (“occasionally” means several times over the course of the school year) in 61% of biology classes. Microscopy is used often (“often” means in most classrooms over the course of the year) in 39% of biology classes. It should also be noted that, among the 103 respondents, there are no teachers who avoid using microscopes (Figure 7).

By analyzing the attitudes of teachers regarding the same method of microscopy in teaching, they have a positive Gaussian distribution. The most frequent assessment of their experiences by respondents is Satisfied — 4 (43%). This is followed by the ratings Neither satisfied nor dissatisfied — 3 (31%), Very satisfied — 5 (19%), and Not satisfied — 2 (6%). The least represented rating is Disappointed — 7 (1%) (Figure 8).

The main reason given for not using the microscope in the classroom is that there is an insufficient number of microscopes for quality microscopy (53%) and that the subject program is overloaded (30%) which does not leave enough time to focus on other teaching methods such as microscopy. Teachers are usually faced with problems such as lack of work space, storage space, and specialized classrooms (11%) or lack of confidence in using microscopes (6%), or too many students and a lack of samples. A lack of microscopy is more common among secondary school teachers (Figure 9).

All these data are obtained by the descriptive question 3: “If you could, what would you like to change in teaching biology/ science to improve overall learning experience of the subject?” which emphasizes the problem of breadth of material which negatively affects the variety of teaching and the motivation of students and leaves insufficient time for the development of functional and educational competences among students. There are no statistical differences in responses between the genders.

Research has shown that a large number of schools have a microscope (only 6% have none), but because of the large number of students in the classroom, it is difficult to achieve...
individual work in microscopy. The most common form of microscopy work is group work, so that many students are superficially familiar with the microscope and its capabilities. Additionally, educating teachers in the future and providing them with more up-to-date information on the application and acquisition of a microscope would greatly help them to rediscover the use of microscopes in practice, the benefits of which are numerous, and prepare them for the changes needed to implement microscopy in the classroom.

This study in the schools in Split-Dalmatia County is most likely a mapping of the situation in Croatian schools. Feedback on the use of microscopes in biology education will be gained by expanding the research project across Croatia.

4. Conclusions

A survey was conducted among 103 teachers, in 73 primary and 30 secondary schools (25 grammar schools and 5 vocational schools) in Split-Dalmatia County regarding the possession, maintenance, modernization, and practical application of microscopes in biology teaching. It has been established that the vast majority of schools possess microscopes, but, despite this, there are numerous qualitative problems.

By analyzing the equipping of schools, it was established that 94% of schools possess microscopes and that 6% do not. Thus, this 6% of schools are unable to engage in any practical microscopy work. In the schools included in the survey, the most represented type of microscope is the monocular microscope (80%), then the binocular microscope (16%), the digital microscope (3%), and the stereomicroscope (1%). Although monoculars are the most represented in schools today, 33.3% of them were not in working order which additionally precludes the application of microscopy as a teaching method in biology.

It was found that 42% of teachers would select binocular microscopes and 40% digital microscopes as their ideal microscope. The analysis of the application of microscopy as a teaching method shows that 43% of teachers use the demonstration method and 37% use practical work.

During the school year, of the 55 preparations used in biology teaching in demonstration and practical work, the most commonly used were plant and animal cells and tissues, the blood of vertebrates, and protists.

Most teachers (74%) rated their experiences with using microscopes as very good (4) or good (3).

The main reasons given for not using microscopes in the teaching of biology are as follows: an insufficient number of microscopes (53%), overloaded biology programme (30%), issues with space and storage, lack of specialized classrooms (11%), teacher uncertainty, too many students (6%), and lack of microscopic preparations (1%).

Too many students in the classroom make it difficult for an individual approach to microscopy.

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Figure 5. Representation of the most commonly used specimens for teaching demonstrations
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### Figure 6

Representation of the most commonly used specimens for the purpose of practical work.

### Figure 7

Frequency of using microscopes in teaching biology.

### Figure 8

Teachers’ satisfaction levels of microscope use in teaching biology.

### Figure 9

Main reasons for avoiding using microscopes in teaching biology.