

Use of virtual microscopy to promote Histology learning

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Virtual microscopy allows scan glass slides and create high resolution digital images that can be accessed on a computer screen mimicking a conventional microscope. Identification and interpretation of microscopic images are basic skills in histology that are learned and perfected in practical classes. In these classes each student has access to a light microscope and a series of glass samples for observation and identification for a limited time. We design an activity with the use of a virtual microscope as a complement to a classroom practice activity. With a microscopic scanner 3D Histech Panoramic Desk we digitized glass slides taken from those used during the practical sessions. Students are given access to the digitized images and provided a document with information about activities they have to perform. After conducting an anonymous survey for acceptance of this activity by students, is evident that students perceived as mostly positive activity. The virtual microscopy activity complements the microscopy laboratory class, allows the creation of teaching materials and promotes active and independent student work.

Keywords: virtual microscopy; histology; education

1. Introduction

Human Histology is a basic morphological discipline in the health science curricula. It can be describes as the study of human body cells and tissues and it is “fundamental not only in understanding the interdependence between normal form and function, but in the diagnosis of disease, understanding the disease process, medical research and clinical practice” [1]. In this discipline image is essential, understanding Histology requires the development of three-dimensional mental images of how cells are organized to form tissues and organs. Practical sessions are an important component in the teaching and learning of histology. In the practical sessions, performed in microscopy laboratories, every student use a light microscope to examine glass slides for a limited time.

In the late 1990s advances in computer technology have been made possible to develop virtual microscope (VM) [2]. VM could be defined as a computer system that allows the observation of microscopic samples in a computer screen similarly to a real microscope allowing to observe, navigate an annotate on virtual slides [3], or as “an electronic digital technology that takes an original glass slide, scans it at high resolution, which then makes it amenable for study, analysis and dissemination via computer and the www” [4]. Other term used is digital slide technology (DST) [5]. At present the use of VM is spreading, even in some universities has been completely replaced the use of traditional optical microscope [6, 7].

The convergence towards the European Higher Education Area (EHEA) brings changes in methodology. The students will play a central role, and the teacher’s role is to guide the student on his or her own learning. New teaching strategies are required to develop the abilities, skills and values in students. In Histology, a morphological discipline, a range of skills are needed to analyze specimens, localize objects and recognize structures [8]. These skills are acquired and perfect with practice, so it is important to create the conditions that promote this learning. By all of this we design a new learning activity beyond timetabling classes with the use of a VM, the goal is complement class-room practice activity, create new teaching materials, as well as promote active and independent student work.

2. Methods

For the activity we used 3D scanner Histech-Panoramic Desk that creates digitized slides that can be saved on a local computer connected to the scanner. It is a device that which take the glass slide and with a precise moving controlled by electronic systems and using a camera scans the whole slide or selected area and captured it and stored in the computer. Panoramic Desk can digitize one slide at once in brightfield in constant high quality. The scanner supports Carl Zeiss objectives, achieving up to 43x or 86x resolution, possesses magnifying lens and autofocus. One technical issue is the use of slides and coverslips not very thick. With the Panoramic scanner microscope we scanned histological samples selected from those used in practical sessions. The digitized slide can be opened with a free program “Panoramic Viewer” that can be downloaded to a computer with a user’s guide. This virtual microscope software lets you write annotations, mark areas of interest and capture image sections. When opening Panoramic Viewer you can see the virtual slides and move and change the magnification easily and fast using the mouse computer. With this system the students have the files with the virtual slides on their computers and can study and review them at any time as part of the study material.

The activity started in 2012/13 in two subjects of the Histology area at the Faculty of Medicine, University of Cádiz (UCA), one in the first year and second semester, the other in the second year and first semester of the Degree in Medicine. Currently for each laboratory session the students have a script in the virtual campus of each subject to achieve the objectives, list of histological samples to observe, text topic summary and representative commented images. For the activity with the VM, students are supplied with the virtual slides of each practical session and a document that indicates what to do on each of the digitized samples. Basically they have to capture different digitized slides areas and to point on it a particular microscopic structure. For example, in the digitized image of the submandibular gland, the students have to point serous-secreting component, mucous-secreting portions and a duct system. This VM activity is a complement to classroom practice activity and a practical work that students have to submit as a part of their final evaluation.

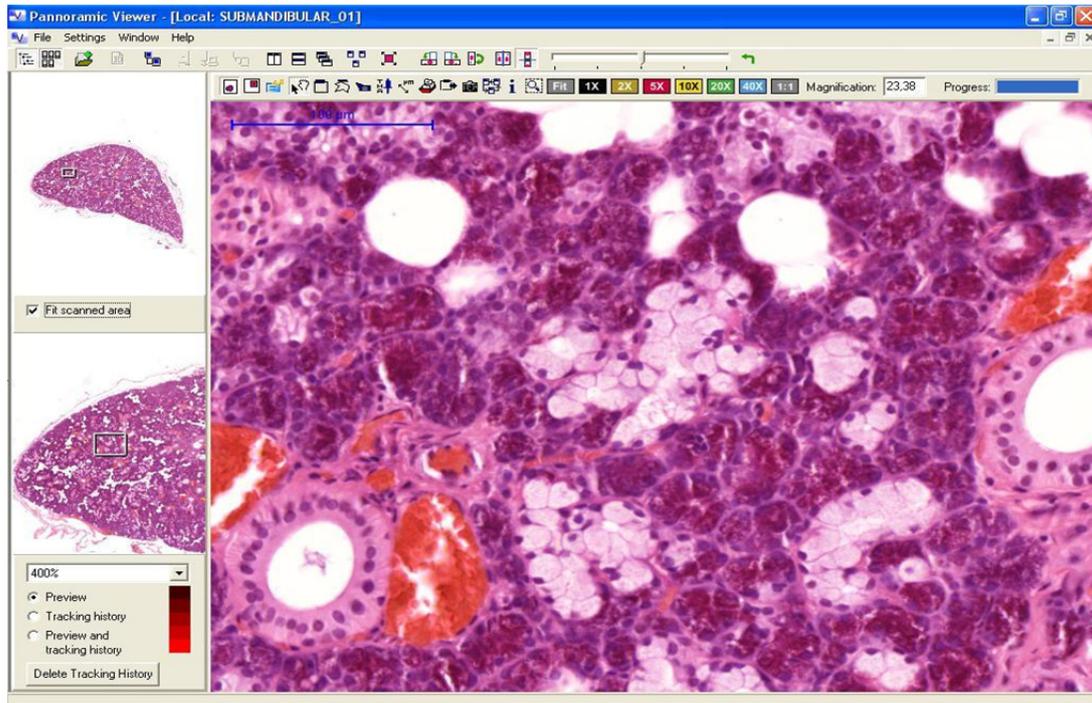


Fig. 1 Virtual microscope slide viewing screen (Submandibular gland).

To assess learning efficacy with the use of VM, student performance on histology practical exam was compared from one year prior to the VM activity. Additionally, at the end of the course, to assess the student perception with the activity an anonymous survey was delivered to the students. This survey contained 8 Likert 4-point scale questions, 4 short answer questions and a space for free comments and/or suggestions about the activity.

3. Results

Comparing students' practical evaluation scores for the 12/13 academic year to prior year (11/12) we observed how the grade for the histology practical exams went up from an average of 5.8 to 6.5 in the first course (Table 1) and 4.8 to 6.6 in the second (Table 2), increasing the number of A and B grades.

Table 1 Practical examination scores in the first year of the Degree in Medicine in the academic years 11/12 and 12/13.

First Year	Course 11/12	Course 12/13
Mean scores	5.8	6.5
Passed the practical examination	75%	79.8%
Grade of B	36.3%	46.9%
Grade of A	5.3%	16.9%

Table 2 Practical examination scores in the second year of the Degree in Medicine in the academic years 11/12 and 12/13.

Second Year	Course 11/12	Course 12/13
Mean scores	4.84	6.6
Passed the practical examination	57.6%	85.6%
Grade of B	34.7%	44.3%
Grade of A	4%	16.1%

303 students performed the survey to assess students' impressions of the VM activity. Overall the students' responses were positive. Briefly, 92% consisting of "strong agreement or agreement" with the statement "the VM facilitates the identification of microscopic structures" or 89% consisting of "strong agreement or agreement" with the statement "The activity with the VM facilitates the understanding and learning of the subject." 252 students reported that the use of the VM software was easy. 234 students appreciate the usefulness of the activity with a score of 7 or higher.

In their free comments or suggestions some students expressed that the VM program did not work on their Macs or problems with the download of the image files because the large size of a virtual slide. Others comments were "very useful", "facilitates recognition of structures", "use in other subjects", "reinforces our histological knowledge and useful for the practical evaluation", "suitable to implement what we learned".

During the 12/13 academic year we digitized and overall of 90 glass slides, elaborated the scripts works and reviewed about 320 students works.

4. Discussion

Histology is a morphological science in which the structure of the cells, tissues, and organs of the body are examined with a microscope [8]. Teaching and learning Histology is based on practical training traditionally acquired via optical microscopy with glass slides [9]. The technologic advance in the late 1990s, allowed the development of the VM that provides an alternative to the examination of glass slides using a light microscope [10]. The VM, as Kumar and Velan says [11], is a "quiet revolution" in learning and teaching especially in Histology and Pathology. The use of VM is progressively expanding in the histology and/or pathology programs [4, 6, 7, 9, 12, 13, 14]. VM have advantages versus traditional microscopy like accessibility (technology is available at any time anywhere so students may view the images outside of microscope laboratory), is easy to use (image is always in focus), capture of interest areas and annotations are possible [2, 4], also VM ease the maintaining costs of light microscopes and the numerous glass slides sets for practical classes [13].

Identification and interpretation of images are basic skills in Histology that are learned and perfected with practice [15], for it is useful to create situations that promote this learning. By all of this, we design an activity with the use of a VM. For this activity the students must download on their own computers a free program "Pannoramic Viewer" and the files containing the digitized samples images. Also, students are given a document that indicates what to do on each digitized samples. To perform the activity involves that students must carefully observed the images, remember what they saw with the light microscope in the practical sessions, consult information about the microscopic structure and later select, in the image, the desired area and make an annotation or a description. With all of this we propose the realization of a didactic activity that can be able to develop skills that are an inherit part of the discipline such as describe, identify, compare, classify, explain, define and interpret. It also encourages independent learning outside the microscopy laboratory allowing flexible time and space, as well the acquisition of competence like capacity for analysis and synthesis, problem solving, decision making and self-learning, following the guidelines of EHEA.

In the activity that we design we use the VM to supplement microscope laboratory instruction not as a substitute for it. The microscope is the most widely used scientific instrument [16]. We consider, like others [8, 17], that using the light microscope enhances histological knowledge through the acquisition of the microscope skills, without it students would not have been prepared to undertake laboratory courses as in pathology or microbiology, for example. We are agree with some people who think that "students have to know how to operate a light microscope or understand the limitation of the techniques involved" [16, 18] and "how to operate a regular light microscope is still a useful skill" [19]. Furthermore searching for the microscope structures under the microscope enhances learning [20].

A negative aspect of using a VM is the large amount of time spent in the selection and digitization of the glass slides. It is a long and hard work overtime that some authors estimate in three years [10], and as others pointed out "there are initial cost and time investment involved in digitizing" [21], "the acquisition and processing are still technically complex and time consuming" [2]. Another point to consider is the large size of the digitized images and sometimes students referred problems with downloading the images files, so the necessity of computer system with high RAM memory and storage device of high capacity.

In our experience, compared with one year prior to the use of VM we observed how the grade for the histology practical exams went up. Additionally students showed a positive perception about the activity with the VM and

majority of them are agreed or strongly agreed with the assumption that the activity facilitates the understanding of microscopic structures and the understanding and learning of the subject.

Summarizing, the VM activity complements the microscopy laboratory class, allows the creation of new teaching materials and promotes active and independent student work. We continue to use and expand this activity to other subjects of the histology area complementing traditionally practical classes.

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