THE SATISFACTION OF SOPHOMORE DENTAL STUDENTS WITH THE VIRTUAL MICROSCOPY PRACTICALS USED IN HISTOLOGY AND ANATOMICAL PATHOLOGY COURSE

Ríánsares Arriazu
CEU-San Pablo University, Histology Laboratory, Department of Basic Medical Sciences, School of Medicine (SPAIN)

Abstract

The visual aids for learning advanced over the last several decades. With the approach digital slice imaging, there is an opportunity to complement the way of teaching and learning histology. The aims of this study were:

1 To assess the opinion of sophomore dental students of the use of digital microscopy, in the Histology and Anatomical Pathology course, in comparison with light microscopy.

2 To compare the opinion of the students from “National” groups, who students are mainly from Spain, versus “International” group, who students are from different countries.

Practical classes were using the computer rooms as a Virtual Microscopy Laboratory. Every student had access to a desktop computer with the Leica SCN400 Image Viewer installed, and free access to the virtual drive hosted. Student satisfaction was assessed using 12 questions survey with three possible answers (Agree, Undecided, Disagree). First, we determined the percentage of students in agreement with a particular question of the study. Secondly, the Chi - square test was used to compare differences between groups. Statistical significance was defined as p<0.05.

The survey data indicated that students were satisfied with virtual microscopy. Students pointed out that Virtual microscopy is a useful tool and enhanced their learning of the material in this course. We only found significant differences between groups in three questions. In general, students consider virtual microscopy a significant improvement in the study of histology. As lecturers, we must adapt to new trends and integrate technological innovations into our courses as a means of information, training, knowledge and continuous learning, which could facilitate the teacher-student communication. Likewise, we have to consider the student profile.

Keywords: microscopy, virtual microscopy, dentistry.

1 INTRODUCTION

Histology is one of the morphological courses at medical schools. It constitutes a fundamental link between the visible and the submicroscopic dimension. For a long time, traditional light microscopy laboratory training, where the slides are presented via a camera connected to a microscope and explained by a lecturer, was basic in the practical histology teaching [1]. Over the last decade, advances in computer technologies have resulted in important changes in learning and teaching, particularly in disciplines such as Histology and Pathology [2]. These days, the implementation of Virtual Microscopy (VM) constitutes a new and potent tool in teaching sessions on morphological subjects. At present, curriculum using the VM is spreading at several Universities, even in some of them the use of traditional optical microscope has been completely replaced [3, 4, 5, 6].

The VM has four important steps: 1) histological slides selection, according to the quality of tissue preservation and histological staining; 2) image acquisition, scanning and converting the slides into high-resolution digital images; 3) storing the images electronically; and, 4) display the images.

The aims of this study were:

1 To assess the opinion of sophomore dental students of the use of digital microscopy, in the Histology and Anatomical Pathology course, in comparison with light microscopy.

2 To compare the opinion of the students from "National" groups, who students are mainly from Spain, versus "International" group, who students are from different countries.
2 METHODOLOGY

The digital slides were obtained by scanning glass slides available at the Histology Laboratory of the CEU-San Pablo University. All slides were digitized at a magnification of 40x using the slide scanner Leica SNC400. The following digitalization, the slides were stored in a virtual drive hosted at University's intranet.

The study started in 2015/16 in the Histology and Anatomical Pathology course at the School of Medicine, CEU-San Pablo University, Madrid, Spain. The course was delivered in the 2nd year from February to May and has 6 European Credit Transfer System credits (ECTS). It is taught in Spanish (two theoretical groups) and English (one theoretical group). "National" groups (Spanish language) consist of students mainly from Spain, but there are some students from Latin America and Italy, while "International" group (English language) is composed of students from Taiwan, UK, Kuwait, Italy, and Spain.

Every student had access to a desktop computer with the Leica SCN400 Image Viewer installed, and free access to the virtual drive hosted. Furthermore, all students had access to an open computer laboratory and the possibility to copy the image files and the Image Viewer to work at home. The practical session was done after completion of the traditional lectures about histology of the oral cavity; students were divided into ten groups of 10-12 students each due to the size of the computer laboratory.

For the VM activity, a document with the information about the objectives for each digitized sample is available to the students across the campus virtual in advance. During VM sessions, students have to capture different digitized slides and areas and point out a specific microscopic structure. For example, serous acini and duct system in parotid gland digitized sample.

![Image](Figure1.png)

*Figure 1. Leica SCN400 Image Viewer Screen (Parotid Gland).*

During two academic years (2015/16 and 2016/17), we evaluated the impact of this new didactic format and compared with the light microscope. For that purpose, at the end of the practice sessions, students were asked to complete a voluntary and anonymous survey. Respondents who indicated no prior experience with light microscopy were excluded, as well as students who retake the course or not answered all the questions. So, for all students surveyed was the first time using this method.

The student survey consisted of 12 questions (Table 1) from the paper of Farah CS and Maybury TS (2008) [7]. Each one with five possible answers: strongly agree, agree, undecided, disagree, and strongly disagree according to Likert scale [8]. The data show in this report are presented as the percentage in agreement (agree plus strongly agree), undecided, or non-agreement (disagree plus strongly disagree) with a particular statement.
Table 1. Questions of the survey with the number (code) used in the graphs (results).

<table>
<thead>
<tr>
<th>Nº (Code)</th>
<th>Question</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>I preferred the virtual microscope to the light microscope.</td>
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<td>I preferred the light microscope to the virtual microscope.</td>
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<td>3</td>
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<td>4</td>
<td>The maneuverable images studied with the virtual microscope were of sufficient resolution to allow identification of the required organs, tissues, and cells.</td>
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<td>5</td>
<td>The virtual microscope had sufficient magnification potential to allow me to examine the tissues and cells in great detail.</td>
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<td>6</td>
<td>Navigation of the images with the virtual microscope viewer was easier than that of the glass slides.</td>
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<td>The software viewing technology used in the virtual microscope was effective for the purposes of this course.</td>
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<td>Using the virtual microscope was more fun than using the light microscope.</td>
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<td>9</td>
<td>Using the virtual microscope during the scheduled laboratory class time helped me to understand the material.</td>
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<td>11</td>
<td>The virtual microscopy software allowed for a greater degree of collaboration with other students.</td>
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<tr>
<td>12</td>
<td>The virtual microscopy technology should be expanded to eliminate completely the need for light microscopy.</td>
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The Chi-square test was used to compare differences between groups ("National" and International"). Statistical significance was defined as p<0.05. Data was analyzed by SPSS version 20.

3 RESULTS

All second-year students (200) were surveyed voluntarily, of whom 184 were valid for the study. 16 surveys were excluded for the reasons described in "METHODOLOGY."

3.1 Student survey results

3.1.1 Overall student number in Histology and Anatomical Pathology ("National" and "International" groups together)

The results obtained in this report are presented as the percentage of students in agreement with a particular question of the survey. For the whole group (184 respondents) the results are shown in figure 2.
86.7% of the responders agreed that they prefer the virtual microscope and, only, the 16.8% preferred the light microscope. The questions related to increase and allow to learn about the content of the course, questions nº 3, 9, 10, and 11, were evaluated with 92.3%, 93%, 59.4%, and 81.12%, respectively. In relation to the VM technique (questions nº 4, 5, 6, and 7), 90.90% were agreed to the resolution of the samples, which permitted them to identify the different structures for the practical. 90.2% of the responders considered that the magnification potential was sufficient for examining the tissues and cells in detail. About if the navigation of the image with the VM viewer was easier than a light microscope, the 90.2% were agreed. 96.5% of the students were agreed that the software viewing technology used in the virtual microscope was effective for the purposes of this course. When we asked them if using the virtual microscope was more fun than using the light microscope (question nº 8) only the 60.13% of the responders were agreed. Finally, we wanted to know if our students think that the VM technology should be expanded to eliminate completely the need for light microscopy, the 40.56% were agreed with that.

Question nº 10 (Using the virtual microscope outside of scheduled laboratory class time helped me to understand the material) got a small percentage of agreement. When we asked our students (mainly students from "National" groups), some of them explained that they "did not hear about that possibility" or "we did not read the information in Campus Virtual where that possibility is explained."

3.1.2 "National" groups results

The percentages obtained in the survey for the "National" groups showed a similar pattern that we described above. The results are shown in figure 3.

87.23% of the students preferred the VM against the 22.34% of responders that chose the light microscope. For questions 3, 9, 10, and 11; 94.68% think VM positively enhanced my learning of the material in this course. The same percentage said that working with the VM during the scheduled laboratory class time helped them to understand the material. 53.19% considered that using the virtual microscope outside of scheduled laboratory class time helped me to understand the material. When we asked if the virtual microscopy software allowed for a greater degree of collaboration with other students, the 86.17% were agreed. About the resolution, magnification potential, navigation of the images, and the software viewing technology, the agreement was 94.68%, 90.42%, 89.36%, and 98.94%, respectively. The 58.51% of the responders considered VM more fun that conventional microscopy. At last, 45.74% of the students expressed their agreement with the disappearance of the light microscope.
In their free comments or suggestions, some students expressed that VM allows them to work easily and observe all structures without any problem. However, it is a good idea to use the light microscope in first year practical, because it is a traditional tool.

3.1.3 "International" group results

The percentages for survey statements from the "International" group are shown in figure 4. 85.71% of the international students preferred the VM instead of a light microscope. Overall the students’ responses were positive for the other questions. Briefly, 87.75% consisting of agreement with the statement "Using the virtual microscope positively enhanced my learning of the material in this course." The satisfaction with the statements about if the use of the VM during the scheduled laboratory class time (89.79% were agreed) or outside (71.43% agree) helped them to understand the material was higher than 70%. When we asked them if the VM software allowed for a greater degree of collaboration with other students, the 71.43% were agreed.

About the VM technique, 83.67% of the responders were agreed with question nº 4 (The maneuverable images studied with the virtual microscope were of sufficient resolution to allow identification of the required organs, tissues, and cells). 89.79% with statement nº 5 (The virtual microscope had sufficient magnification potential to allow me to examine the tissues and cells in great detail). 91.84% with question nº 6 (Navigation of the images with the virtual microscope viewer was easier than that of the glass slides). Moreover, 91.84% were agreed with statement nº 7 (The software viewing technology used in the virtual microscope was effective for the purposes of this course).

When we asked them if the use of the VM more fun than using the light microscope, 63.26% of the students were agreed with this statement. Finally, for the question "The virtual microscopy technology should be expanded to eliminate completely the need for light microscopy," the 30.61% agree with it.

The comments that they gave us were "Virtual much better, helped me understand much more effectively and efficiently", "it was interesting but too tiring", "I enjoy the class very much", "Virtual Microscopy should become the future", " Since everyone has the same sample, it allows efficient discussion between student. That is, common problem that we all have can be discussed easier, and there won’t be situations with one person having a better view of tissue sample than other people", "overall the lab helped a lot since we got to observe the samples ourselves and we learnt some techniques", and "Although the use of the virtual microscope has made it easier to observe the different structures in the various tissues, the light microscope allowed greater interaction with the professor and other students. In sum, the virtual microscope is a great advancement; I do not believe
that the traditional light microscope should be abandoned, however, as it gives histology it’s mysterious integrity”.

3.2 Comparison between groups according to the language of the course (English or Spanish)

Differences between groups were examined using Chi-square test for proportions. We compare the "National" group (course taught in Spanish and with students mainly from Spain) and "International" group (course taught in English and students from different countries, mainly from Taiwan). The level of statistical significance was set at $p < 0.05$, and it is shown in Table 2.

Only three questions (nº 2, 7, and 10) showed significant differences between groups There is a significant difference with the statement "I preferred the light microscope to the virtual microscope." The percentage of agreement was 6.12% for the course in English ("International" group) while 22.34% of the students that received the classes in Spanish ("National" group) preferred the light microscopy. It seems that Spanish students present a preference for light microscopy, although in "International" group there is 24.49% of undecided students.

Question nº 7, “The software viewing technology used in the virtual microscope was effective for the purposes of this course,” the satisfaction percentage for this question was higher in "National" group (98.93%) than "International" group” (91.83%). According to our observations, the foreign students are used to new technologies, while Spanish students used the computer, notebook, tablets, etc. mainly for taking notes. During the lectures with the "International" group were possible to observe some slides using VM as support to the explanation of the histology. The students were available the virtual atlas on their devices. However, "National" groups did not download the atlas and only observe the information that the lecturer showed during the class.

Finally, for the statement nº 10, "Using the virtual microscope outside of scheduled laboratory class time helped me to understand the material," the agreement was higher in "International" group (71.43%) than "National" group (53.19%). This difference could be because students for "International" groups review the material available in Campus Virtual in advance.
### Table 2. p values of Chi-square test. Each question is comparing between Spanish ("National" group) versus English ("International" group) language. *Significant level set at p<0.05

<table>
<thead>
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<th>Nº (Code)</th>
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<th>p value</th>
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<tr>
<td>1</td>
<td>I preferred the virtual microscope to the light microscope.</td>
<td>0.051</td>
</tr>
<tr>
<td>2</td>
<td>I preferred the light microscope to the virtual microscope.</td>
<td>0.011*</td>
</tr>
<tr>
<td>3</td>
<td>Using the virtual microscope positively enhanced my learning of the material in this course.</td>
<td>0.333</td>
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<tr>
<td>4</td>
<td>The maneuverable images studied with the virtual microscope were of sufficient resolution to allow identification of the required organs, tissues, and cells.</td>
<td>0.094</td>
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<tr>
<td>5</td>
<td>The virtual microscope had sufficient magnification potential to allow me to examine the tissues and cells in great detail.</td>
<td>0.238</td>
</tr>
<tr>
<td>6</td>
<td>Navigation of the images with the virtual microscope viewer was easier than that of the glass slides.</td>
<td>0.324</td>
</tr>
<tr>
<td>7</td>
<td>The software viewing technology used in the virtual microscope was effective for the purposes of this course.</td>
<td>0.028*</td>
</tr>
<tr>
<td>8</td>
<td>Using the virtual microscope was more fun than using the light microscope.</td>
<td>0.337</td>
</tr>
<tr>
<td>9</td>
<td>Using the virtual microscope during the scheduled laboratory class time helped me to understand the material.</td>
<td>0.554</td>
</tr>
<tr>
<td>10</td>
<td>Using the virtual microscope outside of scheduled laboratory class time helped me to understand the material.</td>
<td>0.033*</td>
</tr>
<tr>
<td>11</td>
<td>The virtual microscopy software allowed for a greater degree of collaboration with other students.</td>
<td>0.086</td>
</tr>
<tr>
<td>12</td>
<td>The virtual microscopy technology should be expanded to eliminate completely the need for light microscopy.</td>
<td>0.064</td>
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### 4 CONCLUSIONS

The modern technology attracts the attention of students. They have been designated as "Digital Natives" by Prensky (2001) [9] because they are "native speaker" of the digital language of computers, video games, and the internet. They have developed forms of thought, expression and relationship influenced by the dynamics of Information and Communication Technologies (ICTs). As teachers, we must adapt to new trends, integrating technological innovations to our subjects as a means of information, training, knowledge and continuous learning, which will facilitate teacher-student communication [10].

The anonymous survey showed that the students found VM useful, while a decreasing acceptance of the light microscope is plainly evident. Our results are in keeping with previous reports showing that the students' experience with VM is very positive [7, 11, 12].

As in the study of Farah CS and Maybury TS (2008) [7], the responses to learning, the resolution, and the magnification potential of VM, navigation window (and overall view of the specimen, Figure 1), and software showed the students' satisfaction. All these things are key points for student acceptance of this technique. Around 60% of the students considered "fun" the use of the VM.

The learning of our students improved during the VM laboratory class time. While we asked about the use of the VM outside of the scheduled laboratory session, there are discrepancies between "National" and "International" groups. For international students, the agreement with this statement was higher than for national students, because they use this tool more than the national students for reviewing the practicals. Nevertheless, when the question was about the collaborative work with other students, "National group" showed a higher (no significant) agreement that "International" group. In general, international students worked more independently during the laboratory sessions, while "National" groups tend to discuss between students.

Some students were agreed with the expansion of the VM and the elimination of the light microscopy, especially students from "National" groups. However, the percentage was inferior to 50%.
To sum up, the majority sophomore dental students (independently of their country of origin) preferred VM instead of light microscopy, due to the microscopic skills achieved by students with VM are comparable to the skills acquired with light microscopy. However, a small percentage of students preferred light microscopy, especially in "National" groups.

ACKNOWLEDGEMENTS
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REFERENCES
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