Dental Students’ Evaluations of an Interactive Histology Software


Abstract: This study assessed dental students’ evaluations of a new Interactive Histology Software (IHS) developed by the authors and compared students’ assessment of the extent to which this new software, as well as other histology teaching methods, supported their learning. The IHS is a computer-based tool for histology learning that presents high-resolution images of histology basics as well as specific oral histologies at different magnifications and with text labels. Survey data were collected from 204 first-year dental students at the Universidad Austral de Chile. The survey consisted of questions for the respondents to evaluate the characteristics of the IHS and the contribution of various teaching methods to their histology learning. The response rate was 85 percent. Student evaluations were positive for the design, usability, and theoretical-practical integration of the IHS, and the students reported they would recommend the method to future students. The students continued to value traditional teaching methods for histological lab work and did not think this new technology would replace traditional methods. With respect to the contribution of each teaching method to students’ learning, no statistically significant differences (p>0.05) were found for an evaluation of IHS, light microscopy, and slide presentations. However, these student assessments were significantly more positive than the evaluations of other digital or printed materials. Overall, the students evaluated the IHS very positively in terms of method quality and contribution to their learning; they also evaluated use of light microscopy and teacher slide presentations positively.

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Histology teaching in the laboratory is traditionally performed with the aid of slide projection, use of monitors, or light microscopy. Recent studies have reported some limitations in the use of light microscopy; these include students not being exposed to some sectioned tissues or to all of the structures that should be identified during laboratory study.1,2 Some institutions have also reported difficulties in their being able to obtain fixed human tissues.3 In some instances, curricular reforms may result in a reduction of laboratory hours spent studying histological samples.1,2 Electronic media programs have been introduced to support student learning,3,4 these has given rise to the development of computer-based learning tools.2,5-10 These are defined as interactive applications in which practical histology basics are taught on-screen by combining digitalized images with text labels and theoretical information about the histological samples.11

Since the School of Dentistry of the Universidad Austral de Chile was founded in 2005, histology studies for first-year dental students have been taught with traditional teaching methods: the teacher presents histology slides to students, which they must identify and then view and analyze under the light microscope. A similar teaching method is used for other first-year courses such as cell biology and embryology. An Interactive Histology Software (IHS) entitled Atlas of General and Oral Histology (Atlas de Histología General y Estomatológica) was developed in 2006 to support the microscopy laboratory. The IHS presents high-resolution images of basic and stomatological topics included in the histology course at different magnifications and with text labels (see example in Figure 1). It also includes a quiz section that permits students to practice at their own pace. In 2007, this IHS was officially adopted as a teaching method for the histology course. Since its introduction, the IHS has been used with four cohorts of dental students.

Similar currently available computer-based tools for histology lab teaching are limited to static images or electronic book pages. The IHS is an enhanced version of a book, taking advantage of current technologies that embrace an interactive learning environment. The objectives of this study were to assess dental students’ evaluations of the IHS and to compare their evaluations of the extent to which this
Materials and Methods

This research was approved by the Board of Directors of the School of Dentistry, Universidad Austral de Chile. Approximately 360 dental students attend the school, with sixty new students entering each year. The IHS has been used by about 240 students from 2007 to 2010.

The IHS was developed as a complementary teaching method to provide an image database of histological samples and has been used for the histology course in the School of Dentistry. Photographs were taken of all samples used in the histology lab, in specific areas of learning. The samples included cells, groups of cells, and tissues at various magnifications, according to the structures mentioned in the laboratory guide used in the course. A digital camera (MicroPublisher 3.3 RTV, Olympus, Tokyo, Japan) attached to a light microscope (Olympus BX31, Olympus, Tokyo, Japan) was used to capture the images. These images were then imported into an image editor software (Photoshop CS2, Adobe, San Jose, CA, USA), where they were cleaned and text labels were added. The IHS interface was designed and developed using HyperText Markup Language (HTML) and was compiled in a Windows executable file. The basic interface has a start screen, from which the user chooses the topic and the tissue to analyze.

Materials for the basic histology topic include epithelium, connective tissue, cartilage, bone, nervous tissue, muscle, and blood. Materials for the oral histology topic include dental tissues, periodontal structures, oral mucosa, and salivary glands. For each tissue, multiple samples were taken using different stains, allowing the user to choose specific samples. For each sample, the user can choose through a horizontal scroll bar between different magnifications in some areas of the sample. The user is guided by an instruction guide that is displayed dynamically on the screen. This guide is the same as that for use of the light microscope.

For each image, the user interface (Figure 1) is divided into four main regions. The upper panel shows the title text and buttons for navigation of the software. The left panel presents the images in high resolution. The right panel has the labels, and the
responded, for a response rate of 85 percent. Fifty-four students were in the class of 2010, forty-eight in the class of 2009, fifty-two in the class of 2008, and fifty in the class of 2007.

The majority of students (96 percent) found the IHS easy to use (on a five-point scale with 1 being the most negative, the mean was 4.7), and 98 percent reported that the images presented were of good quality (mean=4.8). Ninety-four percent of the students reported that the IHS facilitated basic use of the microscope. However, 60 percent of the students reported that additional help was required from the teacher to localize specific structures. A total of 81 percent of the students said they would recommend the IHS to future students (Table 1).

A comparison of the students’ evaluations of the contribution the IHS made to their learning versus the contribution from using the light microscope or having slide presentations revealed no significant differences (Table 2). However, the contribution to learning with other digital and printed atlas learning aids was evaluated as significantly lower (p<0.05) than contribution from the IHS and other teaching methods.

Discussion

The use of technology in the classroom has enabled us to introduce course contents in different and novel ways. Histology lab teaching with computer-based tools has been widely described in the literature, with methods ranging from the use of image slides\textsuperscript{4-8,11,12,14,15} to virtual microscopes.\textsuperscript{2,3,13,16-20} All of these computer-based tools have significantly improved access to learning materials that enhance the self-directed mode of learning. Several studies\textsuperscript{4,7,12,15} have reported students’ evaluations of computer-based tools that are similar to the IHS. All evaluations have been positive. One difference between the IHS and other computer-based tools we have used in our research is that traditional methods display contents in a static way as a text page, while the IHS displays the contents dynamically.

Use of the IHS meets several objectives of computer-based teaching methods defined by Matheos et al.\textsuperscript{21} It is interactive, allows flexibility, supports individual learning paths, and encourages active and cooperative learning. The IHS has the additional advantage of being available for free download and can thus be used by dental students from around the world, especially by Spanish-speaking students.
evaluated the IHS as having a similar contribution to that of slide presentations and the use of the light microscope, but these were evaluated significantly better than printed books or an atlas. The tendency of students to prefer computer-based teaching methods may have contributed to the positive evaluation of the IHS. Moreover, the fact that histology course exams are carried out with light microscopy using the same histological samples as those presented in the IHS may explain the preference of students for these methods over the printed books and atlases.

Although the response rate was adequate, implementation of the survey was standardized, and the questionnaire was validated, this study is subject to the limitations of a research study performed with a closed-ended survey in which the student may not always be able to give an exact opinion. Personal opinions, learning experiences, and additional observations were ignored.

Students’ support of the replacement of traditional teaching methods with computer-based tools is the subject of much discussion. Our students did not support replacement of light microscopy methods with the IHS. A similar finding was reported by MacPherson and Brueckner\textsuperscript{14} and Rosenberg et al.,\textsuperscript{12} whose students were also in favor of computer-based tools but only as a complement to light microscopy. Introduction of technologies aimed at replacing traditional labs (e.g., virtual microscopy instead of light microscopy) has been reported as minimal by dental schools.\textsuperscript{1} In Chile, dental schools have not reported implementation of innovative teaching methods for histology learning nor replacement of light microscopy by other methods. Only one study\textsuperscript{22} reported

### Table 1. Dental students’ evaluations of the IHS

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Strongly Agree (5)</th>
<th>Agree (4)</th>
<th>Neutral (3)</th>
<th>Disagree (2)</th>
<th>Strongly Disagree (1)</th>
<th>Mean [SD]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The IHS was easy to use, and the content navigation was simple.</td>
<td>143 (70%)</td>
<td>53 (26%)</td>
<td>8 (4%)</td>
<td>0</td>
<td>0</td>
<td>4.6 [0.5]</td>
</tr>
<tr>
<td>2. The images included in the IHS were of good quality.</td>
<td>120 (59%)</td>
<td>80 (38%)</td>
<td>3 (2%)</td>
<td>1 (1%)</td>
<td>0</td>
<td>4.6 [0.5]</td>
</tr>
<tr>
<td>3. The IHS helped me to localize structures under the microscope.</td>
<td>133 (66%)</td>
<td>58 (28%)</td>
<td>11 (5%)</td>
<td>2 (1%)</td>
<td>0</td>
<td>4.6 [0.6]</td>
</tr>
<tr>
<td>4. I needed help from the teacher to localize some structures in the IHS</td>
<td>31 (15%)</td>
<td>91 (45%)</td>
<td>53 (26%)</td>
<td>26 (12%)</td>
<td>3 (2%)</td>
<td>3.6 [0.9]</td>
</tr>
<tr>
<td>5. The IHS contributed to the integration of theoretical and practical knowledge.</td>
<td>92 (45%)</td>
<td>83 (41%)</td>
<td>27 (13%)</td>
<td>2 (1%)</td>
<td>0</td>
<td>4.3 [0.7]</td>
</tr>
<tr>
<td>6. I recommend the use of the IHS to future students.</td>
<td>166 (80%)</td>
<td>34 (17%)</td>
<td>3 (2%)</td>
<td>1 (1%)</td>
<td>0</td>
<td>4.8 [0.5]</td>
</tr>
<tr>
<td>7. The IHS could replace the microscope.</td>
<td>15 (7%)</td>
<td>16 (8%)</td>
<td>21 (10%)</td>
<td>88 (43%)</td>
<td>64 (32%)</td>
<td>2.2 [1.1]</td>
</tr>
</tbody>
</table>

### Table 2. Students’ evaluations of the contribution of specified teaching methods to their learning, on a 1 to 10 scale with 1=lowest and 10=highest

<table>
<thead>
<tr>
<th>Teaching Method</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>IHS</td>
<td>204</td>
<td>8.57</td>
<td>1.4</td>
</tr>
<tr>
<td>Light microscope</td>
<td>204</td>
<td>8.43</td>
<td>1.4</td>
</tr>
<tr>
<td>Slide projection</td>
<td>204</td>
<td>7.96</td>
<td>1.7</td>
</tr>
<tr>
<td>Other digital or printed atlas</td>
<td>204</td>
<td>4.67*</td>
<td>2.8</td>
</tr>
</tbody>
</table>

*p<0.05

The present time, the IHS is available only in Spanish and for Windows OS. Mac and Linux versions will be developed in the near future although students can currently work with the IHS with any virtualization software.

This study found that our students evaluated the IHS as a useful teaching method for histology learning and gave high satisfaction ratings for navigation, quality of images, and integration of knowledge. These students would highly recommend the IHS to other students. Although most students reported that the IHS helped to localize structures when using the light microscope, they reported that they still required further assistance from teachers. Students thus considered that the IHS must not replace the physical presence of a teacher in the lab. This finding is consistent with the idea that the histology lab is not simply a place in which students observe histological samples under the microscope, but that it also provides an ambience in which they can share and discuss these observations with their fellow students and with teachers. Regarding the contribution to their learning, students evaluated the IHS as having a similar contribution to that of slide presentations and the use of the light microscope, but these were evaluated significantly better than printed books or an atlas. The tendency of students to prefer computer-based teaching methods may have contributed to the positive evaluation of the IHS. Moreover, the fact that histology course exams are carried out with light microscopy using the same histological samples as those presented in the IHS may explain the preference of students for these methods over the printed books and atlases.

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computer use of digitalized images in the histology lab. Our findings reinforce the idea that computer technologies aid rather than replace traditional teaching methods in the laboratory. Course administrators should take note of this fact when considering reducing teaching hours or replacing teachers in favor of technological teaching aids.

Our study reports the benefits of the IHS as perceived in student assessments and thus does not determine the effectiveness of the IHS as a teaching method. Several quantitative methods have been described for evaluating teaching methods in the histology lab, with student questionnaires being the most frequent. These permit us to evaluate student perceptions and opinions regardless of the real effectiveness of the teaching tool. Rosenberg et al.\textsuperscript{12} studied the effectiveness of a histology computer-based tool by comparing test scores of groups that used the software with a control group that did not. Further research is required to determine whether computer-based teaching aids may be effective in improving student grades.

Conclusions
The IHS was found to be evaluated very positively by dental students. The computer-based tools for histology laboratory teaching were evaluated with a similar rating to that for light microscopy methods. However, students were not in favor of replacing traditional teaching methods with computer-based tools. Other interactive and useful computer-based tools such as virtual microscopes may improve learning and productivity in the histology lab. Tools such as the IHS have been demonstrated to positively complement traditional teaching methods. These technologies can be implemented in several areas related to dental education, such as cellular biology, embryology, pathology, radiology, and any situation in which extensive use of images is required.

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