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The Saudi Dental Journal

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## ORIGINAL ARTICLE

# Measuring dental students' preference: A comparison of light microscopy and virtual microscopy as teaching tools in oral histology and pathology

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Received 2 May 2015; revised 14 October 2015; accepted 11 November 2015

## KEYWORDS

Virtual microscopy;  
Light microscopy;  
Teaching;  
Students;  
Pathology;  
Dentistry

**Abstract** *Objectives:* Light microscopy used to be the traditional modality of teaching histology and pathology disciplines. Recent advances and innovations in the information technology field have revolutionized the use of hard- and software in medical education. An example of such an innovation is the so-called virtual microscopy. Many schools have started to adopt virtual microscopy as a new method aimed at enhancing student learning. Nonetheless, few reports have described the experiences of introducing virtual microscopy in dental education. We conducted this study to evaluate student perceptions of virtual microscopy use.

*Materials and methods:* A survey of 9 items with a five-point Likert scale was designed to assess student perceptions of different aspects of virtual microscopy use compared with light microscopy. Eighty-seven 2nd year dental students answered the survey for a response rate of 80%.

*Results:* The majority of the students (85.1%) reported positive feedback for the use of virtual slides as a method of learning. Students reported significantly higher scores in virtual microscopy compared with light microscopy ( $t$  test:  $t_{86} = 9.832$ ,  $P < 0.0001$ ); however, a few students reported some technical difficulties when using computers to view the virtual slides.

*Conclusions:* Although light microscopy is the classical tool of teaching histology and pathology, virtual microscopy is a highly preferred substitute. We believe that virtual microscopy is a valuable teaching tool that enhances student educational experiences.

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Peer review under responsibility of King Saud University.



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## 1. Introduction

Traditionally, histology and pathology education has been carried out using glass slides and light microscopy (LM). Light microscopy is the main and classical modality for medical education in the pathology laboratory (Hightower et al., 1999). Nevertheless, conventional microscopy is time consuming

and requires microscopy equipment and supplies (Kim et al., 2008). Additionally, LM requires several sectioned tissues that usually do not demonstrate all of the structures of interest (Blake et al., 2003; Bloodgood and Ogilvie, 2006).

More recently, many technological approaches have been utilized to enhance student learning experiences of histological sections. These approaches include the use of digitized images (Cotter, 2001), web-based animations (Brisbourne et al., 2002) and virtual microscopy (VM) (Hamilton et al., 2012). Since the beginning of the 21st century, there has been rapid technological advancement, particularly in the use of computers and the web, in medical education, including VM (Paulsen et al., 2010).

Virtual microscopy is a technology where microscopic glass slides are digitally reproduced and then viewed on a computer screen (Paulsen et al., 2010). As previously reported, there are numerous educational advantages for adopting VM. VM has been shown to enhance student learning experiences (Krippendorf and Lough, 2005). Another key benefit of VM is that an unlimited number of students can study slides at the same time (Krippendorf and Lough, 2005). Additionally, virtual slides can be digitally annotated where specific areas of diagnostic relevance can be labeled (Kolesnikov et al., 2001). These slides do not deteriorate and are easily duplicated, stored and managed (Kumar et al., 2006).

Therefore, several medical and training institutes have started integrating VM into their curriculum (Blake et al., 2003; Farah and Maybury, 2009; Kumar et al., 2006). A few reports have described their experiences in introducing VM in dental education (Farah and Maybury, 2009; Weaker and Herbert, 2009); however, there are no detailed comparisons between VM and LM concerning dental student preferences. In addition, there is a lack of literature regarding the perspectives of Saudi dental student use of virtual slides. The aim of this study was to compare the virtual microscope to the light microscope to assess student perceptions concerning the influence of virtual microscopy on their learning.

## 2. Materials and methods

The study survey and informed consent forms were reviewed and approved by the College of Dentistry Research Center, King Saud University. All students contributed to this study based upon confidential and voluntary participation.

King Saud University College of Dentistry has been applying VM technology in oral histology and pathology courses since the 2011–2012 academic year. Aperio's ScanScope System (Aperio Technologies, Aperio Technologies Inc., USA) has been used to scan slides and prepare the VM files. The students are loaned the CD-ROMs containing the virtual slides where they can view them through (Aperio's ImageScope) the viewer using their personal computers.

We asked second year dental students who used both VM and LM in oral histology and oral pathology to complete a survey. We designed the survey to assess student perceptions of different aspects of performance of VM compared with LM. A 9-item, five-point Likert scale was used for both microscopies as follows: 5 = Strongly Agree, 4 = Agree, 3 = Undecided, 2 = Disagree, and 1 = Strongly Disagree. The total score for each item was summed accordingly. The individual scores for the virtual and light microscopies were also calculated with a maximum possible score of 45 and a minimum

score of 9, where a higher score indicated greater preference. The statements are shown in Table 1 and 2. Two open-ended qualitative questions for each microscope type were also included. We requested that the students specify if they faced any additional technical problem using VM or LM. We also asked the students to state the reasons if they enjoyed learning with VM or LM. The computer program SPSS (Statistical Package for Social Science, version 21) was used for the data analysis. Paired two-tailed t-tests were used to detect the differences between the mean scores of responses for each of the 9 matched items (light vs. virtual) and the overall score. A critical P value of 0.05 was regarded as significant.

## 3. Results

The surveys were completed by 87 s year dental students (out of 109), including 48 males and 39 females, for an overall response rate of 80%. The normality of distribution was tested using the Kolmogorov–Smirnov test. The reliability of scale was measured by a reliability coefficient and Cronbach's  $\alpha$  = (0.766, 0.870) for VM and LM. The data shown in Table 1 and Table 2 are presented as the percentages of students in agreement or disagreement with a specific statement. The majority of students (85.1%) agreed or strongly agreed with the statement indicating that they preferred the virtual microscope to the light microscope. The data also indicated that the images provided by VM (87.2%) were of sufficient magnification to allow examination of the tissues in great detail compared with LM (44.8%). Eighty-five percent of the students disagreed or strongly disagreed with the statement indicating that they were able to use LM outside of scheduled times.

Table 3 shows the comparisons between the VM and LM scores using a paired two-tailed t-test. The students gave significantly higher scores to VM compared with LM ( $t$  test:  $t_{86} = 9.832$ ,  $P < 0.0001$ ). When the items were evaluated separately, all of the items showed a highly significant difference between the two microscopes, with VM being the more preferred option. One exception is item number nine, "I did not face any technical problems using virtual microscopes", which showed no significant difference.

Not all of the students offered written answers on the qualitative part of the survey; however, the comments were generally supportive of VM. Approximately 11 students commented that "they enjoyed learning with the virtual microscope because of its ease of use", whereas others stated that "because virtual microscopy can be used anywhere and anytime". Other comments included "because the microscope doesn't hurt my eyes and has less light exposure" and "because it saves me time". On the other hand, in response to "If you enjoyed learning with the light microscope, please answer why", very few students offered answers to this question. Answers included "the light microscope allowed me to directly examine a slide without technical issues" and "I like to work by hand and not computer". Regarding the technical problems faced by students, six students indicated that they experienced some difficulties with VM using Mac operating systems. One student offered, "VM files are large in size", and another wrote "Virtual slides sometimes freeze." A sample of student comments on LM included the following: "Orienting and adjusting the LM was difficult", "LM is heavy and slides are easily broken", "Adjustment of the fine object is challenging" and "I can't label the slide".

## 4. Discussion

Based on the formative assessment carried out in this study, our students accept VM as a preferred tool to facilitate learning.

Our students offered significantly higher ratings to the items of VM vs. LM, which is consistent with previous studies

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