Effect of Supplemental Online Resources on Undergraduate Animal Science Laboratory Instruction

J. Bing, S. Pratt-Phillips[1] and C.E. Farin
North Carolina State University
Raleigh, NC

Abstract

The objective of this study was to determine if supplemental online resource (SOR) availability in a distance education (DistEd) format could enhance student learning. Students (n=137) in an undergraduate animal science laboratory course completed an anatomy pretest and pre-survey to assess their experience with, and attitudes towards, SOR. Supplemental Online Resource modules were made available for randomly selected laboratories. Two laboratory practical exams were administered and included questions from labs for which SOR was made available as well as labs that had no SOR. Questions from the pre-test were included in the exams and used to generate "posttest" scores. Student learning and performance was evaluated using a hierarchical design that included test scores, SOR availability and their interactions. Results are presented as mean±SEM. Posttest scores (87±2%) were higher (P<0.0001) than pretest scores (34±2%), indicative of student learning. On Laboratory Practical 1, students scored higher (P=0.0012) on questions from laboratories with SOR compared with laboratories without SOR (80±1% and 75±1%, resp.). In contrast, on Laboratory Practical 2, there was no effect of SOR supplementation on student scores (83±1% and 83±1%, for SOR and no SOR, resp.). A majority of students (93/137, 68%) surveyed indicated that SOR was at least somewhat useful for improving their grade.

Key Words: anatomy, online, supplemental online resources, undergraduate

Introduction

Through the use of computers, instructors have been able to design and create programs and materials suited to students' learning needs (Holt et al., 2001). These types of programs and materials have been referred to as computer assisted learning (Holt et al., 2001), computer assisted instruction (Schittek et al., 2001), web-based materials (Granger et al., 2006) or supplemental online resources (SOR). The use of SOR may enhance the learning opportunities for topics that may not be taught or expressed as well with traditional methods (Schittek et al., 2001). Supplemental Online Resources may also enhance student learning by allowing students to learn at their own pace, as well as permit interactions between the student and content or learning material (Schittek et al., 2001).

Mahmud et al. (2011) conducted a quasi-experimental study showing dissection videos to first-year undergraduate medical students and analyzed their test score performances. It was concluded that while the videos did not significantly improve the students' final examination scores, the majority of the students preferred regular use of the videos to assist with studying and review. Those results were also true for first-year students who used instructional anatomy videos as a supplement to their gross anatomy course (Saxena et al., 2008). Students found that the videos were a useful preparatory tool that had the capability to enhance student anatomy performance if used (Saxena et al., 2008)

In evaluating the use of SORs in the form of practice quizzes within the Animal Science discipline, Grizzle et al. (2008) examined whether or not exam grades were influenced by the number of times a practice quiz file was accessed and used in preparation for taking an examination in an undergraduate reproductive physiology course. While the use of the practice quiz files did not influence exam grades, the authors concluded that the use of online resources offered students a means of review after the lecture and traditional dissection laboratories were completed (Grizzle et al., 2008).

The purpose of this study was to determine the effectiveness of SOR on student learning in an undergraduate domestic animal anatomy laboratory. The hypothesis was that student learning would be enhanced when using the available SOR material compared to learning without the availability of SOR.

[1]To whom correspondence should be addressed: Department of Animal Science, Polk Hall 259, Box 7621, NCSU Campus, Raleigh, NC 27695; Email: Shannon_Pratt@ncsu.edu

Materials and Methods

Approval was obtained from the University's Institutional Review Board, and all participants provided written informed consent prior to the start of the study. No identifying information was used in the data analysis, and participation in data collection was entirely voluntary.

Anatomy of Domestic Animals (ANS 206) is a required course for all students in the Department of Animal Science at North Carolina State University. Students who register for this lab meet once a week for two hours. In each laboratory lesson, students were introduced to the gross anatomy of a major organ system, using one or more of the domestic animal species as examples for study.

The present investigation was conducted in the fall and spring semesters of 2009-2010. In fall 2009, 72 students were enrolled in ANS 206, with 68 females and four males. Seventy-eight percent of the students were sophomores, 4% were freshman and 18% were juniors and seniors. In spring 2010, 65 students were enrolled in ANS 206, with 54 females and 11 males. Thirty-five percent were freshman, 35% were sophomores and 29% were juniors and seniors.

Individual laboratory lessons were organized in a manner similar to that reported by Bing et al. (2011). In the present study, all laboratories were in face-to-face format, but alternating laboratories had SOR available to students. In order that each laboratory content topic had SOR material made available over the two semesters in which the study was conducted, the presentation style (SOR, No SOR) was switched between the fall and spring semesters. For example, if Laboratory 1 had a SOR module made available in the fall, then there was no SOR module made available for Laboratory 1 in the following spring (Table 1).

Each laboratory began with an introductory presentation made by the instructor, which was followed by students viewing models and performing specimen dissections. After each laboratory lesson, students were given assignments (some to be worked on individually and others designed for groups) and/or quizzes to be completed by the following week. The quizzes each week were presented in one of two formats: self-testing video quizzes that could be attempted multiple times to help students review the information presented in the laboratory and graded quizzes prepared and administered using the Blackboard Vista online learning system (Blackboard, Washington, D.C.).

Table 1. Availability of SOR Materials for Laboratory Lessons in Fall 2009 and Spring 2010

Laboratory	Laboratory Topics	Availability of SOR materials	
		Fall 2009	Spring 2010
L1- Body Water and Diffusion	body water, osmosis, and diffusion	SOR	No SOR
L2- Brain and Senses	structures and functions of the sheep brain and cow eye	No SOR	SOR
L3- Bone and Joints	comparative skeletal anatomy-horse, goat, dog, cat and rabbit	SOR	No SOR
L4- Cardiovascular System	external and internal cardiac anatomy of the sheep; describe blood flow	No SOR	SOR
L5- Muscles	skeletal muscles of the horse	No SOR	SOR
Lab Practical 1 Covered Labs 1-5			
L6- Respiratory Physiology	anatomy of the respiratory system (sheep); inspiration and expiration	SOR	No SOR
L7- Blood	principal components of blood; explain procedures for blood sampling in pigs	No SOR	SOR
L8- Endocrinology/ Blood Typing	major endocrine glands and tissues of the body; identification and function of major hormones produced	No SOR	SOR
L9- Urinary System	external and internal features and functions of the sheep and cow kidney	SOR	No SOR
L10- Digestive System	anatomy and function of the digestive system; comparative anatomy of ruminants and nonruminants	No SOR	SOR
Lab Practical 2 Covered labs 6-10			

SOR- supplemental online resources

The SOR modules were created using Blackboard Vista and Adobe Dreamweaver (Adobe Systems, San Jose, CA). Each SOR module had an introductory web page presenting the overview and objectives of the laboratory lesson, recorded video demonstrations of specimen dissections with narration, animation, captions, and video demonstrations from various commercial sites that could be accessed by web link. Students were allowed to return to the SOR material throughout the semester for further clarification of laboratory objectives as well as to review for their laboratory practical examinations during the course of the semester.

A pre-survey was administered on the first day of class and was used to collect demographics, information on prior knowledge or experience with SOR material and students' opinions regarding SOR material. A pretest consisting of 10 questions was also administered on the first day of class and was used to determine how much prior knowledge students had about anatomy. A post-survey, given on the last day of the semester, was used to collect general feedback on the course and gather opinions as to whether or not the SOR material provided during the semester was useful.

Two practical examinations were given

during the course. Laboratory Practical 1 was given mid-semester and covered material from laboratory lessons 1-5. Laboratory Practical 2 was given at the end of the semester and covered material from laboratory lessons 6-10. The examinations were given in-person and consisted of material from the covered laboratory lessons, regardless of whether SOR was made available to those lessons or not. The practical examination consisted of identification stations where students had to name the structures presented or identify their function and a short answer section that consisted of definitions or explanations. The 10 questions included in the pretest were also included in the appropriate Laboratory Practical examination. Performances on these 10 questions were considered the students' "posttest" scores.

Tracking data was obtained from Blackboard Vista, over the entire semester. This Blackboard feature allowed the course instructor to track the number of sessions a student logged into, the number of files viewed by the student, as well as the amount of time spent online viewing the SOR material. The tracking data was broken down and analyzed by each section of the semester associated with each Laboratory Practical examination.

All statistical analyses were conducted using SAS (SAS Inst. Inc., Cary, NC). Paired t-tests were performed on pretest and posttest scores to assess overall student learning for both the fall and spring semesters. Within each Laboratory Practical exam, two relative exam scores were calculated for each student. The first relative exam score was calculated by dividing the number of correctly answered questions derived from all laboratory exercises with SOR availability by the total number of questions derived from all laboratory exercises with SOR availability. Similarly the second relative exam score for each student was calculated by dividing the number of correctly answered questions derived from all laboratory exercises with No SOR availability by the total number of questions derived from all laboratory exercises with No SOR availability. A hierarchical design was used to determine if there was a difference in student performance in each laboratory practical examination based on the availability of supplemental online resources (SOR) across two semesters of data. Semester is considered a 'between-subject' factor because students (our subjects) in a class for a given semester are subjected to similar academic conditions characterized here as "semester." Scores are characterized by their source (named SOR availability): questions from labs with SOR availability and questions from labs with no SOR availability. The factor SOR availability is considered a 'within-subject' factor, since each student has both scores. The statistical model for performance data from Laboratory Practical 1 or 2 included the main effects of semester (fall, spring), SOR availability (SOR, No SOR) and their interactions as fixed effects, and students within each semester as random effect measuring the experimental error. Linear regression analysis was performed on tracking data (sessions logged on, files viewed, time spent online) and student performance on Laboratory Practical 1 and 2 using the Proc REG command of SAS. Tracking data was also compared between students who thought the SOR was useful vs. not useful in an unpaired t-test. Data from the post-survey regarding students' opinion on SOR usefulness were analyzed using a Chi-square test. Statistical significance was accepted at an alpha level of $P<0.05$.

Results and Discussion

An overall increase in posttest compared to pretest scores was observed for both semesters (Figure 1). The students in fall 2009 (Figure 1a) had an increase ($P < 0.0001$) in posttest scores compared to pretest scores (86% ± 2% vs. 30% ± 2%, respectively). Similarly, posttest scores for students in spring 2010 (Figure 1b) were increased ($P < 0.0001$) compared to pretest scores (85% ± 2% vs. 39% ± 3%, respectively). While there was no effect of method of presentation on pre- and posttest performance, there was significant increase in learning regardless if SOR was available or not ($P<0.0001$), suggesting that learning occurred through both methods.

On Laboratory Practical 1, there was a semester effect ($P=0.02$) such that spring semester performed better than the fall semester (80±0.1% vs. 75±0.1%, respectively) (Figure 2a). There was also an effect ($P<0.0001$) of SOR availability such that students performed better on material that had SOR available than with material that didn't have SOR available (80±0.1% vs. 75±0.1%, respectively) (Figure 2b). On Laboratory Practical 2, there was no semester effect ($P=0.11$) such that fall semester performed similarly to the spring semester (85±0.5% vs. 81±1%, respectively) (Figure 2c). There was no effect ($P=0.84$) of SOR availability for either fall or spring semesters for Laboratory Practical 2 (83±0.1% vs. 83±0.1%, respectively) (Figure 2d).

For the post-survey results, in both semesters, more students agreed that the SOR was useful than disagreed with this statement. While spring semester had numerically more students who agreed that SOR was useful (49/60, 82%) compared to students in the fall semester who agreed that SOR was useful (44/64,

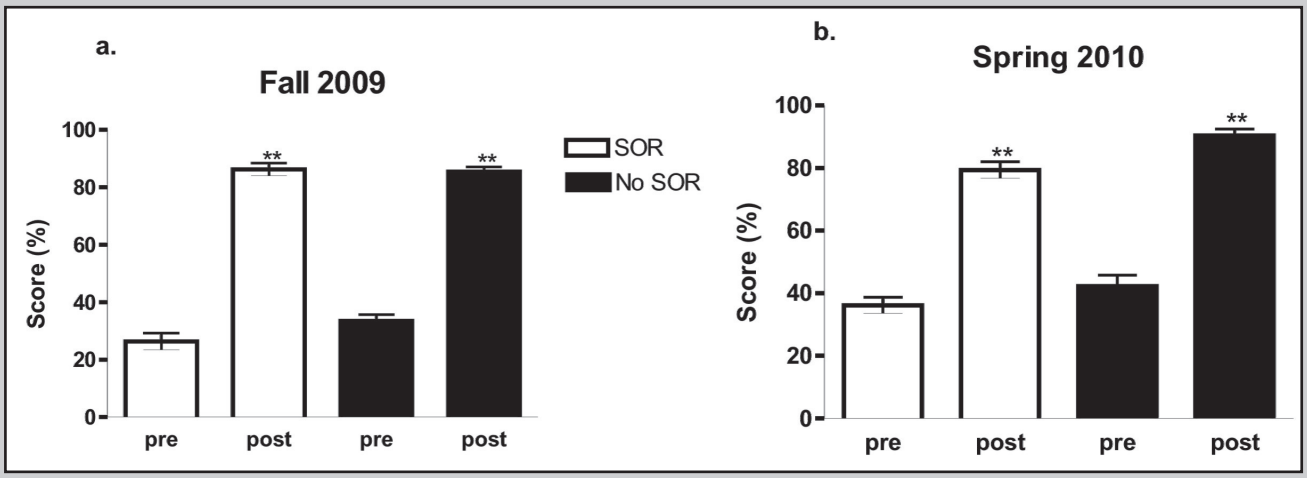

Figure 1. Effect of presentation material on pre- and post-test scores. SOR: supplemental online resources.
***- P<0.0001 pre- vs. post-test scores.

69%), there was no significant difference between semesters (P=0.10).

The relationship between the tracking data and performance on Laboratory Practicals 1 and 2, expressed as Pearson correlation constant values (r), are shown in Table 2. Between the first day of class and Laboratory Practical 1, there was a significant difference (P<0.0001) in the average number of SOR sessions the students in the fall semester logged onto compared to that for the students in the spring semester (33±12 vs. 44±17, respectively). From Laboratory Practical 1 to Laboratory Practical 2, there was also a significant difference (P<0.01) in the average number of sessions logged onto for the fall compared to the spring semesters (37±15 vs. 31±14, respectively). There was no significant correlation between the number of sessions logged onto and the examination grade for the students in the fall semester on Laboratory Practical 1 or Laboratory Practical 2. There was, however, a significant correlation between the number of sessions logged onto and the examination grade in the spring semester for Laboratory Practical 1 (P= 0.005) and Laboratory Practical 2 (P= 0.003).

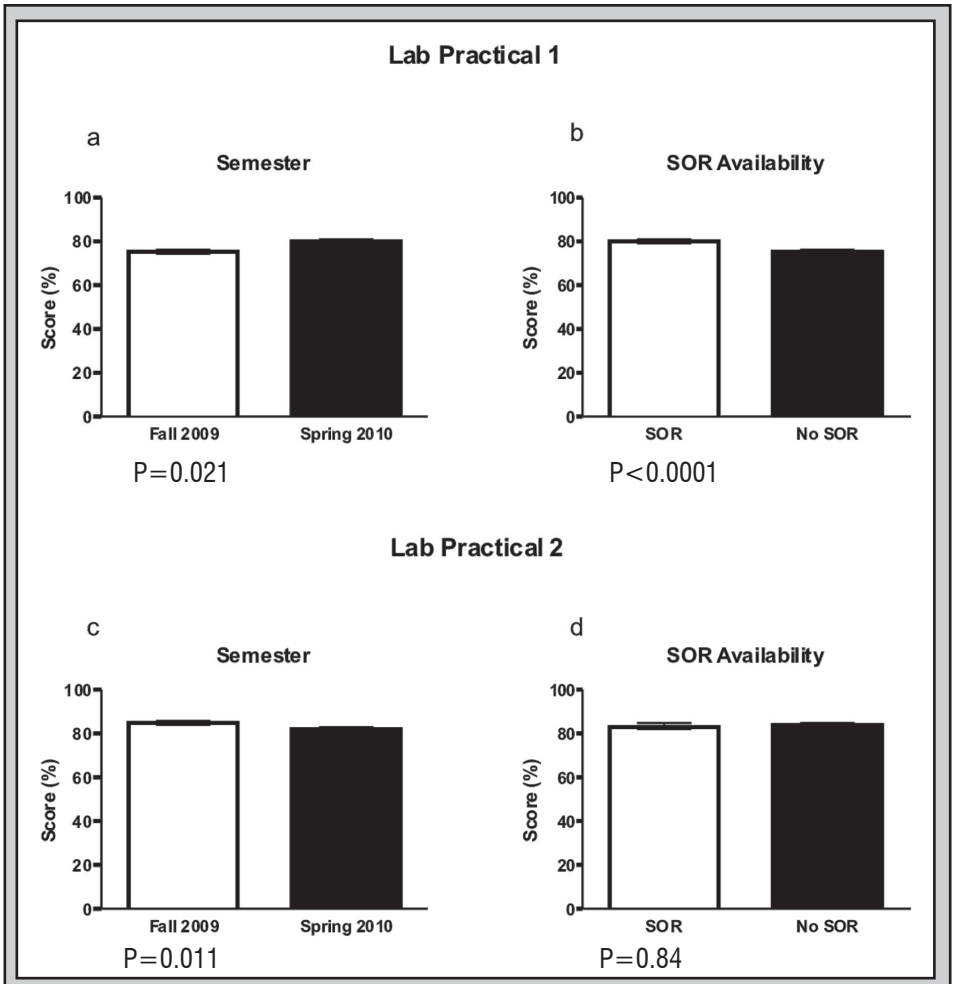

Figure 2. Semester and SOR availability effect Laboratory Practical 1 (a,b) and Laboratory Practical 2 (c,d) exam score. SOR- supplemental online resources.

The average number of files viewed differed (P<0.0001) from the first day of class to Laboratory Practical 1 for the fall compared to the spring semesters (58±28 vs. 40±20, respectively). From Laboratory Practical 1 to Laboratory Practical 2, while the fall semester students viewed an average of 30±14 files compared to the spring semester students who viewed an average of 28±15 files, there was no significant

difference in the average number of files viewed between the semesters. There was no significant correlation between the number of files viewed and the examination grade in the fall semester for either Laboratory Practical 1 or 2. There was no significant correlation between the number of files viewed and the examination grade in the spring semester on Laboratory Practical 1 but there was a significant correlation between the number of files viewed and the examination grade on Laboratory Practical 2 ($P<0.05$).

Table 2. Pearson Correlation Constant values (r) for Relationship between Lab Practical Exam Scores with Sessions Opened, Files Viewed, and Time Spent for Fall 2009 and Spring 2010

	Fall 2009		Spring 2010	
	Lab Practical 1	Lab Practical 2	Lab Practical 1	Lab Practical 2
Sessions	0.0024	0.0029	0.1188*	0.1364*
Files Viewed	0.0003	0.0193	0.0617*	0.0561
Time (min)	0.0025	0.0102	0.0056	0.1299*

** P-values < 0.05*

The average number of time spent online, in minutes, from the first day of class to Laboratory Practical 1 was 446±174 minutes for fall semester and 432±434 minutes for spring semester, but showed no significant difference in time spent online between the semesters. From Laboratory Practical 1 to Laboratory Practical 2, the total time spent online differed significantly ($P<0.0001$) between the fall semester students and spring semester students (433±175 vs. 250±148, respectively). Fall semester showed no significant correlation between the amount of time spent online and examination grades on Laboratory Practical 1 or 2. Spring semester showed no significant correlation between time spent online and examination grade on Laboratory Practical 1, but there was a significant correlation between the amount of time spent online and their examination grade on Laboratory Practical 2 ($P= 0.003$).

It was of interest to determine if students who thought the SOR was useful were also those who used it more. Therefore, unpaired t-tests were conducted on tracking data for students who indicated that they had found SOR useful compared to those who did not find it useful. In fall 2009 those who found SOR useful also opened significantly more files than those who claimed SOR was not as useful, perhaps suggesting those who deemed SOR not useful didn't actually take full advantage of this resource.

The aim of any new teaching resource should be to produce effective teaching and learning materials that match or even exceed conventional methods (Devitt and Palmer, 1998). The present study found that SOR complemented student learning and was overall found to be useful by students.

Grizzle et al. (2008) stated that the use of a virtual laboratory offered students a means of review after lecture and traditional dissection laboratories to reinforce what had been learned; however, its use may not influence exam grades. It was also suggested that low-scoring students benefit from SOR more than students with higher scores, due to the differential effect that computer use has the tendency to increase motivation, self-confidence, self-discipline and knowledge within individuals (Gathy et al., 1991; Holt et al., 2001). In the present study, SOR availability only impacted exam score on Lab Practical 1. The SOR material associated with the lessons evaluated in Lab Practical 1 may have been more educational and useful to the students than the SOR material associated with the lessons evaluated in Lab Practical 2. Alternatively, the actual content of the lessons associated with Lab Practical 1 may have been more amenable to effective SOR supplementation than for the lessons associated with Lab Practical 2.

Although students in the fall semester logged into more SOR sessions, viewed more files and spent more time online compared to students in the spring semester, there was no significant correlation shown between the actions of the fall students and the examination grades obtained for either Laboratory Practical 1 or Laboratory Practical 2 during the fall semester. For students in the spring semester, however, there were significant correlations between the files viewed and time spent online with the examination grade on Laboratory Practical 1. Similarly, for Laboratory Practical 2, there were positive correlations with the exam results for the number of sessions logged onto and the time spent online. Thus, SOR material made available during the spring semester laboratories may have had a higher measure of relevance to the topics being presented compared to that for the fall semester laboratories.

Developing a web-based program that is to be used as a supplement to the dissection laboratory may have the potential to become a critical resource as well as a partial substitute for dissections (Granger and Calleson, 2007). Although students in other studies found SOR materials to be efficient, easy to run and useful to help prepare for laboratories and examinations, it was suggested that SOR should be used as an addition to traditional lectures and laboratories as opposed to replacing traditional laboratory methods (Holt et al., 2001; Granger et al., 2006). Over half the students in each semester from the present study stated in their post-survey that they felt the SOR was useful in improving course grades and should be made available for all laboratory lessons.

Summary

In summary, there was significant increase in posttest scores for both semesters regardless of SOR availability. On Laboratory Practical 1, there was a semester effect in which spring semester scored higher than fall semester and a SOR effect in which students in both semesters scored higher on material with SOR than no SOR. On Laboratory Practical 2, there was a semester effect in which fall semester scored higher than spring semester; however, there was no SOR effect for either semester. The fall semester students showed no correlation between the number of sessions logged onto, the number of files viewed or the amount of time spent online and the examination grades for both Laboratory Practical 1 and 2. The spring semester students exhibited different outcomes. While there was only a significant correlation between the number of sessions logged onto and the examination grades on Laboratory Practical 1, the spring semester students showed a significant correlation between the number of sessions logged onto, the number of files viewed or the amount of time spent online and the examination grades for Laboratory Practical 2. The results of this study demonstrate that SOR availability may be a useful learning tool and an effective way to allow students to review course material as needed on their own time. Nonetheless, it may be necessary to further explore the use of SOR effectiveness as it relates to usefulness for examination preparation, student perception, and student tracking.

Literature Cited

Adobe Dreamweaver. Adobe Systems, San Jose, CA.

Bing, J., S. Pratt, L.A. Gillen, and C. E. Farin. 2011. Undergraduate performance in a domestic animal laboratory taught via distance education. Jour. of Animal Science 89: 297-301.

Blackboard Vista online learning system. Blackboard, Washington, D.C.

Devitt, P. and E. Palmer. 1998. Computers in medical education 1: Evaluation of a problem-orientated learning package. Australian and New Zealand Jour. of Surgery 68: 284-287.

Gathy, P., J.F. Denef, and S. Haumont. 1991. Computer-assisted self-assessment (CASA) in histology. Computers Education 17(2): 109-116.

Granger, N.A., D.C. Calleson, O.W. Henson, E. Juliano, L. Wineski, M.D. McDaniel, and J.M. Burgoon. 2006. Use of web-based materials to enhance anatomy instruction in the health sciences. The Anatomical Record (Part B: New Anat.) 289B: 121-127.

Granger, N.A. and D. Calleson. 2007. The impact of alternating dissection on student performance in a medical anatomy course: Are dissection videos an effective substitute for actual dissection? Clinical Anatomy 20: 315-321.

Grizzle, J.M., A.M. Saxton, P. Snow, and C. Edwards. 2008. A virtual laboratory for undergraduate instruction in domestic animal reproductive physiology: Help or hindrance? NACTA Jour. 52(1): 49-54.

Holt, R.I.G., P. Miklaszewicz, I.C. Cranston, D. Russell-Jones, P.J. Rees, and P.H. Sonksen. 2001. Computer assisted learning is an effective way of teaching endocrinology. Clinical Endocrinology 55: 537-542.

Mahmud, W., O. Hyder, J. Butt, and A. Aftab. 2011. Dissection videos do not improve anatomy examination scores. Anatomical Sciences Education 4: 16-21.

Reeves, R.E., J.E. Aschenbrenner, R.J. Wordinger, R.S. Roque, and H.J. Sheedlo. 2004. Improved dissection efficiency in the human gross anatomy laboratory by the integration of computers and modern technology. Clinical Anatomy 17: 337-344.

SAS 9.1. SAS Inst. Inc., Cary, NC.

Saxena, V., P. Natarajan, P. O'Sullivan, and S. Jain. 2008. Effect of the use of instructional anatomy videos on student performance. Anatomical Sciences Education 1: 159-165.

Schittek, M., N. Mattheos, H.C. Lyon, and R. Attstrom. 2001. Computer assisted learning. A review. European Jour. of Dental Education 5: 93-100.