

ABSTRACT

BING, JADA QUINOME. Distance Education Teaching Methods and Student Responses in the Animal Sciences. (Under the direction of Shannon Pratt-Phillips and Charlotte Farin).

The overall objective of this dissertation is to observe whether or not an Anatomy & Physiology Distance Education (DistEd) course offered in the Animal Science Department will prove to be valuable in the learning process for students. Study 1 was conducted to determine whether gross anatomy of animals could be taught effectively at the undergraduate level using a DistEd delivery style. Students (n=159) completed an anatomy pre-test as well as a pre-survey to assess prior DistEd experience. Alternating each week, laboratory topics were presented either as face-to-face (F2F) or as virtual DistEd laboratories. Two laboratory examinations were administered and included material from both lab formats (DistEd and F2F). Questions from the pre-test were also included and used to generate the “post-test” scores. At the end of the semester, students completed a post-survey to determine if DistEd was a viable alternative to F2F. On exam 1, students achieved higher scores in fall 2008 ($P < 0.0001$) on material presented via DistEd compared to that presented as F2F. However, in spring 2009 students scored higher on material presented as F2F. There was no effect of presentation method on exam 2 scores for either semester. Based on the post-survey, 79.3% of students in fall 2008 and 52% of students from spring 2009 agreed that DistEd laboratories were a viable alternative to F2F laboratories. The results of this study support the conclusion that anatomy material can be taught effectively by distance education methods. The objective of Study 2 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 pre-test 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 “post-test” scores. On Laboratory Practical 1, students scored higher ($P=0.0012$) on questions from laboratories with SOR compared with laboratories without SOR ($80\pm 1\%$ and $75\pm 1\%$, resp.). In contrast, on Laboratory Practical 2, there was no effect of SOR supplementation on student scores ($83\pm 1\%$ and $83\pm 1\%$, 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. Study 3 was conducted to determine whether there was a relationship between undergraduate student cortisol levels, using a saliva collection method, and piglet cortisol levels during blood drawing procedures. Students ($n=61$) completed a pre-study survey and post-study survey to rate their opinion on statements centered on animals and how comfortable they were with handling animals. Salivary cortisol concentrations in students were determined on two occasions: during a laboratory lesson (recorded as baseline reading) and while students collected blood from 6-week old piglets. There was no significant difference between the students’ baseline cortisol concentrations and the cortisol concentrations the day of the blood sampling as well as between the piglets’ baseline cortisol concentrations and the cortisol concentrations the day of the study. When asked if the students preferred to let someone else draw blood from the piglet, there was no significant change in their salivary cortisol concentrations achieved

during the procedure compared to their baseline concentrations, such that students did not exhibit significantly higher cortisol concentrations when interacting with the piglets.

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Distance Education Teaching Methods and Student Responses in the Animal Sciences

by
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DEDICATION

To all those who believed in me

BIOGRAPHY

Jada was born in the Bronx, New York. She attended Westchester Community College in Valhalla, New York and received her Associate's degree in Math/Science. Jada continued her education at Delaware State University in Dover, Delaware and received her Bachelor's degree in Pre-Veterinary Medicine with the plans on attending Vet school. By the end of her academic stint, Jada decided to change her career goals and not attend Vet school. Instead, she went for a Master's degree in Animal and Poultry Science at Tuskegee University in Tuskegee, Alabama. It was at Tuskegee University that Jada realized that she wanted to pursue a career in teaching. She then enrolled in the PhD program in the Department of Animal Sciences at North Carolina State University.

Jada hopes to obtain a teaching position at a College/University in the Southeast.

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CHAPTER 1

Literature Review

Introduction

As technology changes, so must the way teaching is accomplished.

Universities and colleges nationwide constantly undergo the process of change to keep up with the times. Changes in society and new technology have created new challenges and have made it necessary to make adjustments to curriculums in order to further improve educational programs (Allen, 1983). The use of the internet has grown rapidly and evolved from primarily research purposes to academic settings (Lowe et al., 1996; Buchanan, 2008). Technology tools, like the internet, must be evaluated and used properly in order to add to the learning environment (Buchanan, 2008). Computer-based courses and degree programs have become more common as an option for educating students (Barnes et al., 1999). 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). However, the stresses of succeeding in academics can cause changes in mental and physical health of students and has also resulted in an increase in cortisol concentrations (Stowell, 2003; Saipanish, 2003). There are two types of stress that may affect a students' success: 'favorable stresses', which may be used to help learning and performance improvement; and 'unfavorable stresses', where situations presented may come with overwhelming consequences, negatively affecting future academic achievement (Saipanish, 2003). It has been suggested that pressures of performing tasks during undergraduate learning in medical and dental curriculums may cause unfavorable stress to students (Radcliffe & Lester, 2003).

Part I

Distance education teaching methods

In four-year colleges and universities, one out of every four students drops out during their first year (Braxton et al., 2007-2008). Unfortunately, the reasons students drop out are unknown in many institutions. High student drop-out rates cause retention and enrollment numbers to decrease. A major challenge with science programs in four-year colleges and universities is maintaining enrollment and retention (Allen, 1983). Jesse and Ellersieck (2009) conducted a study where one of their objectives was to determine why students change their major or fail to complete their BS degree in the Animal Sciences and found that over a quarter of the students reported that the curriculum was not flexible enough and students were not offered more than one option of learning in areas of interest. This is relevant because programs such as Animal Science need to meet the needs of a changing student population (Barnes et al., 1999). Student backgrounds are more diversified and this creates a challenge to retain them in academic programs such as Animal Science (Allen, 1983).

Student enrollments from urban backgrounds have increased in the Animal Science programs and many have little to no “hands-on” experience (Buchanan, 2008). Some of these students have only had experience or contact with a limited number of species (Allen, 1983). Therefore, departments involved in teaching Animal Science-related curricula must reach out to the students with urban backgrounds without overlooking the traditional students who grew up on farms and ranches and therefore have had experience and contact with animals (Buchanan, 2008). The increase in urban students will require departments to re-

evaluate their teaching methods since more incoming students are increasingly computer savvy and technology oriented (Allen, 1983; Barnes et al., 1999).

Encouraging the use of computers in animal agriculture and their incorporation in into academic curriculums (Allen, 1983) is an important goal for departments because this resource will increase information retention (Barnes et al., 1999) and an opportunity to include classes where there is no internal expertise (Buchanan, 2008). Being computer savvy is critical because students will expect this resource to be used in their educational experience (Buchanan, 2008).

Distance Education

The use of the internet for educational purposes began over thirty years ago, starting with large mainframe computers in the 1960s and moving to personal computers in the 1990s, with the numbers of personal computers using the internet growing more than 30% in the last twenty years (Pallen, 1995; Lowe et al., 1996; Johnson, 1999). Student access to information technology and the internet has become available in homes, schools, and libraries since the 1990s (Lim et al., 2008). Fifty-one percent of American households had one or more computers in 2000 and 42% of the households had at least one member who used the internet (U.S. Bureau of Census, 2001). By 2009, 69% had a computer in the home with internet access (U.S. Bureau of Census, 2011).

Distance education may consist of various forms of teaching and learning methods presented through different forms of communication for the purpose of the student to continue educating themselves within their own environment (Moore, 1973). In Distance Education, students and instructors communicate by printed or electronic media and, at

times, may come together in person. This contemporary teaching method combines the visual, textual, and audio information used in educational settings in such a way that students find it easily accessible and convenient (Johnson, 1999). The simplest form of Distance Education is a course that consists entirely of written communication (Allen et al., 2002). Some Distance Education courses are managed using audio, video, or other means of broadcasting, with written communication incorporated into the course (Allen et al., 2002).

The use of educational technology at university and college campuses has grown and changed substantially in the last 15 years (Weston, 2005). In the USA during the 2000-2001 academic years, 56% of all two-year and four-year degree-granting institutions reported offering distance education courses with an additional 12% planning to implement distance education courses within the next three years (Banks and Faul, 2007). In 2007, 3.94 million students had taken at least one online course, 80% of which are studying at the undergraduate level (Allen & Seaman, 2008).

Using Distance Education as a method of teaching is requiring many universities and colleges, as well as researchers, to re-evaluate how learning materials are presented and if the learning experience is still deemed valuable. Besser and Bonn (1996) described the motives behind the movement to distance education learning. Some of the motives included promoting higher quality education that is economical and designed to fit an individual's needs as well as schedule; pressure to become involved in distance education so that enrollment may increase, resulting in more tuition money; and conserving financial resources. For example, many institutions are exploring the Distance Education option to cut spending costs and increase revenue by giving more students the opportunity to enroll in the

course or program offered. A problem with this approach is that research is needed to determine if material currently being taught in person can be successfully transformed into Distance Education format. Distance education researchers agree that the key to effective distance education learning is to make it highly interactive (Johnson, 1999). Distance education learning should be approached with clear purposes, focused outcomes and objectives and include both problem-based and knowledge-based learning (The American Distance Education Consortium, 2000). Students must be able to gain knowledge as well as apply that knowledge to everyday situations. While textbooks will never cease to exist, universities are gradually publishing educational information on the Internet for student use (Johnson, 1999). Internet-published information can be easily updated and done so at a reasonable cost.

Distance Education is also designed to meet individuals' needs. It allows students with complicated schedules to be able to enroll in classes offered. They are able to access information when they need it, and in a format they prefer and understand (Johnson, 1999). This, however, could have an adverse impact on course instructors and faculty. For example, there may be fewer positions for faculty whose primary emphasis is teaching because distance education could promote a greater use of relatively cheaper labor through graduate students and adjunct faculty (Besser & Bonn, 1996). Furthermore, the role of the faculty member will change from having the position of distributing the information to the student, as occurs in a traditional lecture format, to a position of coaching or assisting with the online component and letting the material speak for itself (Johnson, 1999). Class time, if available, may be spent more on discussing the information learned rather than receiving the

information. Similarly, there may be a greater use of adjunct faculty in addition to using graduate students to minimize costs (Besser & Bonn, 1996).

Distance Education will also have an impact on the student. Besser and Bonn (1996) note that if a student is taught primarily through distance education, they miss out on building relationships among themselves as well as building relationships with faculty that can prove to be beneficial to them in the long run. However, Handelsman et al (2004) observed that students who had online courses showed better problem-solving skills and a better understanding of concepts than students who had traditional lecture formats. Allen et al (2002) conducted a meta-analysis of 25 colleges and universities who compared student satisfaction with a distance education course to a course using traditional face-to-face methods and the authors concluded based on their results, that distance education does not devalue the level of student satisfaction when compared to traditional face-to-face methods of instruction.

Teaching aspects of Distance Education

Gaining the knowledge and experience in a laboratory setting is an essential aspect of undergraduate education in the life sciences. However, when neither the facilities nor the resources are available to create the 'hands-on' experience, it becomes difficult to provide the appropriate educational experience (Buzzell et al., 2002). An evaluation of learning tools, such as textbooks, course presentation and objectives, is needed to determine the most effective methods to communicate information to students (Nnodim, 1988). There is a need to find ways to relay information with fewer contact hours and qualified instructors without affecting the learning process or outcome (Granger and Calleson, 2007). There are

some faculty members who are apprehensive to apply technology to their curriculums because they have vague conceptions of its benefits and believe the technology needs to be clearly defined and easy to understand in order to be used (Weston, 2005).

The effectiveness of integrating a dissection software package entitled, the Visible Human Dissector (VHD), into undergraduate anatomy classes in Colorado was assessed by Weston (2005). In his study, 13 instructors from 10 institutions participated and used the VHD application to present lecture material with a computer projector or present demonstrations and asked questions about images to smaller groups with a personal or laptop computer. Students were also able to use the software in computer labs or at home. Overall, instructors were motivated to use the software because they felt it was a substitute for other more limited educational resources such as cadavers. Furthermore, the instructors were generally comfortable using technology. The VHD software allowed students to access simulated cadaver structures free of time restrictions. It was also used for quizzing students on the structures, providing a means for students to learn the anatomy lessons in a different learning environment. Instructors recognized that the VHD software benefited as a plausible learning tool for students and overall, the use of technology in an educational setting has the potential to alter how teaching and learning occurs at universities and colleges.

Student aspects to Distance Education

The use of online learning has become popular because it is anticipated that this format can improve student communication, increase the use of interactive learning via the internet as well as increase student satisfaction. An interactive learning system allows students more control over their learning environment and requires that students

acknowledge responsibility for their own learning process (Aly et al., 2003). Lim et al (2008) investigated the effects of three different methods of instructional delivery on student achievement and satisfaction during a wellness course at a Midwestern university. One hundred fifty-three undergraduate students registered into one of three modes of instructional delivery based on their preference and were divided into three groups: online learning group, traditional learning group, and combined online and traditional learning group. The online learning group (n=31) received only online education with no face-to-face instruction between instructor and students and no interactions amongst the students. The traditional learning group (n=82) was taught on campus using a traditional face-to-face method. The combined online and traditional learning group (n=40) was taught on campus with a combination of online instruction and traditional face-to-face instruction. Regardless of the learning groups, most students indicated that they would like to see an online option when enrolling in the course in the future. Students in both the online and combined learning groups showed significantly higher achievement on exam scores compared to the traditional learning group. However, there was no significant difference in student achievement on exams between the online and combined learning groups. Students in the online learning and combined learning group stated that their particular section of the course helped them to increase their computer and internet skills. The findings in this study suggest that a well-designed online course can be effective in teaching a wellness course; however, it is necessary to investigate the factors that may influence the achievement and satisfaction of an online learning tool.

Aly et al (2003) conducted a study to develop and evaluate an interactive multimedia courseware package in orthodontics, which would provide dental undergraduate and postgraduate students with an interactive means of self-study and self-evaluation. The courseware package was presented for evaluation through a questionnaire to four groups of students. The first three groups consisted of third, fourth, and fifth year undergraduate students, respectively. The fourth group consisted of postgraduate students. There were 25 students in each group and each group was given all the time they needed to go through the package at their own speed. The authors reported that while the multimedia courseware package was generally liked by both the undergraduate and postgraduate students as a teaching method, the fifth year undergraduate students and postgraduate students appreciated the multimedia courseware package more so than the third and fourth year undergraduate students. This difference in preference was attributed to differences in experience and amount of educational background of the third and fourth year students compared to the fifth year and postgraduate students. The more senior students were likely more familiar with unconventional educational teaching methods. The authors argued that third and fourth year undergraduates likely were less experienced and exhibited less confidence confronted by unfamiliar multimedia programs.

Distance Education in Anatomy and Physiology

Courses in anatomy and physiology are an important component in all medical and veterinary curricula. Traditionally, students have been taught anatomy and physiology through cadaver-based teaching labs because such an approach emphasizes effective communication, cooperation and demonstrated technique. Anatomy is one of the

few areas of science where medical disciplines are introduced and habits are formed (Rizzolo and Stewart, 2006). However, anatomy courses are also seen as time consuming, labor-intensive, and costly (Rizzolo and Stewart, 2006) for students as well as instructors. Also, the proportion of time spent in anatomy laboratories may be decreasing but the costs of operating an anatomy laboratory increases, creating a mismatch between costs and benefits (McLachlan et al., 2004). Currently, there are fewer and fewer qualified instructors available to teach anatomy (Josephson & Moore, 2006). Trained anatomists are considered a diminishing pool and have expressed concern about who will be their future replacements (McLachlan et al., 2004). With the increase of financial expenses to keep an anatomy laboratory functioning, it has been suggested that distance education be considered an alternative to traditional teaching formats (McLachlan et al., 2004).

Distance education offers an opportunity for training students anatomy-related subjects in a cost-effective manner. Instructors would only need to purchase laboratory supplies to record a demonstration, lowering the financial costs of conducting laboratory activities. Also, students would have the capability to re-emphasize the importance of smaller structures repeatedly, with unlimited access to the material (Theoret et al., 2007). While this option may offer some advantage financially, it also may introduce a number of disadvantages in other areas. For example, students may not develop a true understanding of the body organization because they may not be able to distinguish the multidimensional levels of the body and its organs that can be seen when learning in the traditional, face-to-face format (Theoret et al., 2007). Furthermore, students will not experience “hands-on” activities that aids in developing improved practical skills. Finally, students taught through

distance education formats may miss out on peer learning opportunities. Theoret et al (2007) discovered that self-directed learning and peer-facilitated learning are important benefits that are derived from performing traditional cadaver dissection. Students can benefit from technology being incorporated into the curriculum but questions remain as to whether use of technology in teaching is helpful. There is greater motivation for a student to come to the anatomy lab to dissect than to simply sit and watch a video or work at a computer station. Also, according to Theoret et al (2007), the major difference between video and live dissection is that the video camera shows a rigid point of view, whereas a student watching a live dissection can gather information by viewing all aspects of the dissection. Although Theoret et al (2007) suggested that traditional dissections should remain a part of the anatomy course, it was also noted that students can still benefit from using the computer-based materials.

Josephson and Moore (2006) hypothesized that first year veterinary students using a DVD-based dissection program would increase the number of structures they identified and score five points higher on a practical exam than a similar group of first year students who did not use the DVD. Volunteers were assigned to one of two experimental groups, Blue/DVD or Orange/No DVD. They were given the same written dissection instructions, which were also used for the DVD audio script; the same resources; and the same amount of time for the dissection. Each group had 63 minutes to move on through the dissection instructions as far as they could. After a two-hour lunch break, the students returned and took a laboratory exam to test what they remembered. The students had 60 minutes to answer 50 test items. It was found that students spent considerably less time

watching and interacting with the simulations than students who had the live-animal laboratory, but this did not affect their performance on the tests. The effect of using the DVD under the conditions of the study showed there was no difference found within test performances between groups. Although student exam performance did not differ significantly between the DVD group and the No DVD groups, the levels of confidence seemed greater for students in the DVD group (80%) compared to the No DVD group (31%). Improved student confidence could arise from the fact that students using the DVD had the opportunity to repeatedly view and listen to the material about the structures that were identified on both the cadavers used and the video. In addition, student in the DVD groups were more consistent in their dissections compared to the No DVD groups. For example, a dissection of one of the No DVD groups made it impossible to see internal structures that lay beneath the skin. The data suggest that the impact of the DVD use helped students make more accurate dissections and become more confident about their answers on the exam. However, the authors also propose that using the DVD over an extended period of time may lead to less time being spent in the laboratory and prevent the students from understanding the material in depth. Therefore, it is suggested that more time be invested into expanding the usefulness of the DVD method.

Buzzell et al (2002) compared the effectiveness of a series of web-based, interactive, multimedia tutorials designed for teaching methodologies for analysis of human body composition to presentation of the same material using a traditional lecture format. Thirty-two students were randomly assigned to one of three learning groups: the “lecture only” group, the “tutorials only” group, or the “tutorial-supplemented” group. In this study,

Buzzell et al (2002) found that learning the material via the web-based tutorials was determined to be equally enjoyable for the tutorials only group as learning via either of the other two methods. This observation demonstrates that the web-based tutorials can be just as effective as the lecture-based format for teaching some types of course content. The authors suggested that academic institutions should take the time to develop web-based tutorials and further suggested that long term benefits will arise from a cost efficiency standpoint.

Universities around the globe are researching the use of web-based technology in their academic programs (Bernardo et al., 2004). Many have reported that learning by web-based technology can be as effective as learning by traditional education approaches. Bernardo et al (2004) developed, implemented and assessed the first web-based course for undergraduate medical students on experimental surgery at a university in Brazil. The purposes of the study were to describe and discuss the process and report on lessons learned in implementing a web-based course for medical undergraduates. In addition, these authors sought to analyze students' attitude and receptivity towards this educational tool. Fifty-six medical students were taught theory of experimental surgery online during a 5 week period. Teaching occurred through video quizzes, required readings, collaborative activities using discussion boards and asynchronous communication. The authors also analyzed the students' knowledge gained, the total number of viewed course pages, the total number of hours spent viewing the course pages, and their course evaluations. At the end of the course, students significantly improved their knowledge of experimental surgery. There was a significant correlation between the video quiz performance and the total time spent viewing the course and the number of course pages viewed, implying that students who paid more attention to

the content offered may have performed better on the quizzes than those who did not pay as much attention to the course content. The results of the study indicated that web-based courses for undergraduate students can be successfully implemented in a medical school curriculum. Students appeared to be supportive of the web-based course in that they rated it as efficient. However, they also indicated that overall, they would have preferred the course to be presented in a hybrid (traditional plus online) fashion. The students preferred to have access to the whole course content at the beginning of the course and were very interested in having access to the web material even after the course had ended. Bernardo et al (2004) pointed out several positive and negative aspects to having a web-based course. On the positive side, students had permanent access to the online material, the ability to print the material on an as needed basis, immediate feedback on their lessons/quizzes and the freedom of scheduling their time. On the negative side, students had to cope with technical difficulties throughout the course, difficulty reading the material from a computer screen as well as adapting to the web-based technology and had trouble dealing with the lack of communication with professors. The authors indicated that a lot of the negative points would have been reduced if the course was presented in hybrid format, where instructors and students can come together and discuss the material that was presented online.

Supplemental Online Resources

The use of instructional technology in the life sciences shows great potential as a distance education teaching tool as well as being used as a supplement to traditional teaching (Buzzell et al., 2002). 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 (Schitteck et al., 2001), web-based materials (Granger et al., 2006) or supplemental online resources (SOR). They are tools that provide learners with interactive and individualized instruction as well as provide ways to present the material in a manner preferred by the user (Al-Rawi et al., 2007). The use of SOR can be used to enhance the learning opportunities for topics that may not be taught or expressed as well with traditional methods (Schitteck et al., 2001). SOR may also enhance student learning by allowing students to learn at their own pace as well as permit additional interactions between the student and the subject content or learning material (Schitteck et al., 2001).

In addition to low staff to student ratio, the demand for change in education curricula has made computer-assisted courses more valuable (Aly et al., 2004). Development of computer-assisted courses for medical education is sometimes considered expensive and time-consuming; however, if used, they can allow instructors to design and create programs that will help students to identify their individual learning needs (Holt et al., 2001). Holt et al (2001) assessed the effectiveness of teaching undergraduate endocrinology using a computer-assisted learning program for medical students in the first year of their clinical course of study. One hundred eighty-five students agreed to take part in the study and were randomly assigned to participate in either traditional lectures or to receive the same lecture material through a computer-assisted learning program. Students were given two examinations that utilized multiple-choice questions and were asked to evaluate the courses. In addition, students who participated in the computer-assisted learning program were asked to compare

the course with their previous experience of being taught through the traditional lectures. There was no significant difference in the examination scores between the two student groups. Students in both the traditional format and computer-assisted learning groups showed improved scores after completing the course. Students in the computer-assisted learning group found use of this technology to be efficient and easy to run. Many of the students stated that the most beneficial part of the program was its flexibility. The majority of the students indicated that the computer program should be used as an addition to the traditional lectures even though they found it to be easy to use, efficient and acceptable.

There have been reports of skepticism regarding the use of online technology with much of it is based on instructors indicating that computers and electronics are not serious learning tools in the teaching field (Devitt and Palmer, 1998). To many instructors, the goal of any teaching resource should be to produce effective learning that matches or even exceeds those found through the use of traditional, conventional methods (Devitt and Palmer, 1998). At the University of Adelaide, a computer-aided learning package was developed to promote learning through the practical experience of real life simulations and problem solving. Eighty-four medical students in their fifth year at the Royal Adelaide Hospital were recruited and randomized into two groups. One group participated in a traditional lecture-style tutorial and the other group was given access solely to the computer-aided learning package. The students were given a pre-test and then provided with their respective learning material. The study was done over the course of a week and after the tutorial period was over, the students were given a post-test and asked whether the computer-aided learning package should be either a required part of the course or a supplemental

component to the course. While the group who had sole access to the computer-aided learning package scored significantly better than the group who learned through the traditional lecture-style tutorial, the majority of students expressed that they did not want to see the computer-aided learning package replace existing course teaching tools. It was stated that making the computer-aided learning package a required part of the course may result in a loss of its appeal and students would become less interested in it over time. Regarding the use of the learning package as a supplemental component, students felt they were able to work and learn in a stress-free environment at their own pace without fear of repercussion. The students also communicated that the computer-aided learning package was a good way to assess their ability to learn the material and also allowed them to review their areas of weakness. The results of the study have shown that computer programs can be used as effective teaching tools but the authors believe challenges lies in persuading other instructors that using computer-based learning systems will have educational value and will be a successful educational resource.

The use of software as an alternative teaching tool has the advantages of facilitating repeated student interactions and accessing lessons for self study at one's own pace (Samsel et al., 1994). Samsel (1994) reinforced concepts presented in traditional lectures by utilizing a cost-effective computer software simulation to teach cardiovascular physiology to first-year medical students. Each demonstration was led by a faculty member and assisted by another instructor, who was responsible for carrying out the interventions and collecting data. The animal laboratory demonstration was hands-on, using anesthetized dogs to explain cardiovascular physiology. An instructor guided the students through the

demonstration, stopping throughout the laboratory activity to engage in question and answer interactions. The computer software simulation was a prerecorded demonstration of cardiovascular physiology using heart models and offered during the scheduled laboratory period. The software was intended to complement, rather than replace, the traditional lecture format used to teach the course. When asked to choose between the two labs if only one could be offered, 34% of students selected the animal demonstrations whereas 66% students chose the computer lab. Many students indicated that the computer demonstration was straightforward because it allowed the students to focus on one question at a time. The students also pointed out that the animal demonstration appeared to more advance because the pace of the demonstration was set and they could not review the demonstration repeatedly. The combination of animal laboratories and computer simulations was regarded by the authors as highly effective teaching tools and they anticipate continued use and approval of this combination by the students.

Having the flexibility to utilize computer-assisted learning (CAL) is deemed important within an academic setting, especially for those students who enroll in part-time study due to other obligations (Lewis, 2003). CAL is also seen as an effective supplement to conventional teaching methods, particularly in subjects such as anatomy and physiology (Lewis, 2003). A brief survey was conducted by Lewis (2003) to examine previously published studies that were performed to evaluate the utility of CAL in teaching anatomy and physiology within subject areas allied with medicine. Ten studies met the following survey criteria: comparing the efficacy of CAL to some other form of teaching, either as a supplement or a replacement; utilizing sample populations of undergraduate or postgraduate

students; and using CAL in anatomy and physiology education. Lewis (2003) reported based on his meta-analysis of the data that there was an improvement in student performance after using CAL tools compared to more traditional methods of learning. In general, survey responses were positive, which further supports the use of CAL for teaching anatomy and physiology. The author viewed CAL as a tool that, if well designed, is useful for both the student and teacher to facilitate the learning process. It was also suggested that the most likely application of CAL will be as a complement to existing traditional courses, where it can provide students with additional resources to help retain information learned especially in the subjects related to medicine.

There is significant pressure to either upgrade the teaching techniques of anatomy dissection or eliminate it altogether from the teaching curricula (Granger et al., 2006). There is a need to restructure dissection exercises introduced in the anatomy curriculum to make them beneficial to students with the intention of raising participation, interest and learning (Reeves et al., 2004). In many US medical schools, computers have been introduced into the anatomy curriculum as a supplemental teaching aid. Reeves et al (2004) sought to articulate clear and concise instructions for dissection laboratories with the ultimate goal being to increase student productivity and learning. The objectives of these authors' efforts were to make a user friendly computer product that included images of anatomical structures that students would actually see in their dissections. The authors deemed the computer a perfect medium for delivering complementary educational aids but also indicated that the use of the computer as part of the dissection process should never replace the cadaver dissection experience. They also noted that use of computers as a

supplemental teaching aid for dissections will soon be an ordinary development in the field of anatomy in the 21st century (Reeves et al., 2004).

In order to be effective and efficient enough to teach anatomy, online programs need to show accurate and thorough evaluation methods (Granger et al., 2006). Granger et al (2006) created an online interactive anatomy program to enhance dissection experiences, observational learning, and three dimensional anatomical comprehensions. This program was evaluated by first-year medical students at three institutions as well as by an advisory board composed of faculty from the three institutions. The computer program was designed to help prepare students improve their dissection technique; understand the structures and functions well enough to repeat on an exam and to utilize laboratory time in a more efficient manner. The authors demonstrated that the web-based program had a positive impact on the laboratories, met the course objectives and allowed the instructors to focus more on the anatomy and less on the performance. The dissection videos were recorded with narration and contained a series of 2-4 minute series of various body regions. Each dissection step was linked to a resource page that was relevant to the particular dissection. Students completed pre-use surveys at the beginning of their anatomy course and post-use surveys at the completion of the anatomy course. Instructors who taught the course completed pre-use and post-use surveys as well. The surveys asked both students and faculty to rate the usefulness of the web-based program and their perception of its effectiveness. According to the surveys, both the students and faculty indicated that the web-based program helped to improve the quality of both the teaching and learning experiences. The students pointed out on the survey that they found the program and dissection videos useful to help

prepare for laboratory lessons and examinations. The faculty on the advisory board indicated on the survey that the program improved both students' and instructors' use of time in dissection and their overall learning experience. Based on the post-use surveys, the authors concluded that a comprehensive online program is a useful teaching tool and can significantly improve the quality and efficiency of human anatomy instruction.

Advancement in instructional technology may provide a reasonable, cost-effective alternative to teaching (Buzzell et al., 2002). Computer use has increased student knowledge and can be as effective as traditional teaching (Devitt & Palmer, 1998). The use of online education can provide students with a range of sources and increase their opportunities to improve the skills and knowledge to succeed in their academic career (Lim et al., 2008). Supplemental online resources provide additional information that students can use at their own pace (Lewis, 2003).

Part II- Student Responses

For students majoring in medical, dental or veterinary curriculums, anatomy and physiology can be one of the most stressful subjects to enroll in (Takatsuji et al., 2008). Stowell (2003) states that the term "academic stress" should be used to cover not only examinations but other related stress factors such as completing homework assignments, participating in presentations and/or demonstrations, and scheduling classes. The consequence of failing the tests and examinations taken in anatomy and physiology courses has the potential to cause student stress because a failing grade will have an impact on their academic success (Takatsuji et al., 2008). A student's academic achievement may be

affected by two types of stress: ‘favorable stresses’, which may be used to help learning and performance improvement; and ‘unfavorable stresses’, where situations presented may come with overwhelming consequences (Saipanish, 2003). Depending on the individual’s coping skills, too much stress can cause physical and mental health problems (Saipanish, 2003).

Hormones known as glucocorticoids are needed to cope with the body’s reaction to mental and/or physical stresses (de Kloet et al., 1999). Cortisol is a glucocorticoid that is a key regulator of stress responses (Ng et al., 2003). The measurement of cortisol concentrations has proven to be a reliable tool in determining which physical and mental stressors affect the body and activate the release of cortisol, resulting in cortisol concentrations rising above a resting baseline (normal levels) (Harris et al., 2007). The method in which cortisol concentrations are determined vary among species but salivary cortisol measurements have been noted as more accurate because there is a short delay between the time of production and the time cortisol is detectable in the saliva (Scholey et al., 2009; Strazdins et al., 2005; Ng et al., 2003).

Hypothalamic-Pituitary-Adrenal Axis and its response to stress

Stress is seen as any event that poses a threat to physical or emotional welfare and may be chronic and long-term or short-lived and acute (Bollini et al., 2004). When a stressful event occurs, there is an increase in hypothalamus-pituitary-adrenal (HPA) axis activity (Ng et al., 2003). The HPA axis is one component of the central nervous system that is responsible for coordinated behavioral, neuroendocrine, autonomic, and immune responses to changes in homeostasis (Marieb, 2005). The hypothalamus is responsible for emotional behavior and secretes hormones that are distributed to the pituitary gland via the hypophyseal

portal system (Marieb, 2005). Blood from a capillary network in the hypothalamus flows through vessels to the anterior portion of the pituitary gland and enters a second capillary system. Hormones released from the hypothalamus travel through this portal system to reach cells of the anterior pituitary (Frandsen et al., 2003).

The pituitary gland has two functional lobes; the anterior pituitary and the posterior pituitary. These lobes provide direct delivery of stimulatory and inhibitory hormones from the hypothalamus into the bloodstream (Marieb, 2005). While the anterior pituitary contains hormone producing cell bodies and secretes its hormones into capillary beds, the posterior pituitary contains axons from neural cell bodies of the hypothalamus (Marieb, 2005; Frandsen et al., 2003). Hormones are transported from the hypothalamus through the axons to the posterior pituitary and released directly into blood vessels going to their target cells (Frandsen et al., 2003).

The adrenal glands are two bean-shaped organs found immediately above the kidneys that are comprised of glandular and neural tissue (Marieb, 2005). The glandular tissue, known as the adrenal cortex, produces three major groups of steroid hormones: mineralocorticoids, glucocorticoids and sex hormones (Marieb, 2005). When human beings or animals encounter stress, the HPA axis is activated and it releases glucocorticoids from the adrenal cortex into the blood and helps to increase the individual's ability to cope with the particular stress effector (Marieb, 2005; Bollini et al., 2004; Korte, 2001; de Kloet et al., 1999). The secretion of glucocorticoids is regulated by adrenocorticotrophic hormone (ACTH) from the anterior pituitary (Marieb, 2005). This function stimulates steroidogenesis of the adrenal cortex, which leads to the release of cortisol (Buckley and Schatzberg, 2005).

Cortisol

Cortisol is a major glucocorticoid produced as a result of adrenalcortical activity (Ng et al., 2003). Like other steroids hormones, cortisol is lipophilic so it is able to diffuse quickly through cellular membranes (Scholey et al., 2009). Cortisol has long been an important hormone used to measure stress response (Harris et al., 2007). Cortisol follows a circadian rhythm and is usually found in high concentrations in blood in the early morning hours with decreasing concentrations throughout the day (Harris et al., 2007; Scholey et al., 2009). More than 90% of circulating cortisol is bound to corticoid-binding globulin (CBG) with the remaining 10% circulating freely. Only the freely circulating hormone is biologically active (Wedekind et al., 2000). The binding of CBG increases to saturation when the body is subjected to a long-term stressor, resulting in a reduction of free cortisol secretion (Wedekind et al., 2000). This leads to inaccurate measurements of total cortisol concentrations in blood because the biologically active fraction is not reflected in CBG saturation (Wedekind et al., 2000). Salivary cortisol concentrations have been used to exhibit the biologically active unbound cortisol concentrations (Scholey et al., 2009; Wedekind et al., 2000). Cortisol enters saliva by intracellular diffusion and its concentration can reliably estimate serum cortisol concentrations (Scholey et al., 2009; Lindfors & Lundberg, 2002; Wedekind et al., 2000; Blackshaw & Blackshaw, 1989; Bonnin et al., 1993).

Salivary cortisol as a method for stress assessment

Measuring cortisol in saliva has been helpful in overcoming sampling limitations and assay accuracy. In studies where salivary cortisol was compared to blood cortisol, a strong correlation was found between salivary and blood cortisol, with salivary

cortisol being at lower concentrations than blood cortisol and usually following the same time course as blood cortisol in humans (Ng et al., 2003; Lindfors & Lundberg, 2002; Strazdins et al., 2005). As noted above, cortisol enters saliva by intracellular diffusion and its concentration is unaffected by salivary flow rate. Because increased cortisol concentrations are associated with increased stress, salivary cortisol concentrations can be used as a physiological marker of stress (Scholey et al., 2009). There are several advantages of using salivary cortisol concentrations over serum concentrations of cortisol to monitor the stress response: (1) it is a stress-free and noninvasive method of collection, (2) simple collection of saliva allows multiple sampling for monitoring changes in adrenal activity and (3) saliva is easier to collect than urine or blood and can be used to measure biochemical and immunological markers (Bonnin et al., 1993; Strazdins et al., 2005).

Strazdins and colleagues (2005) investigated whether specific methods of data collection have an impact on the measurements of salivary cortisol and secretory immunoglobulin A (sIgA). The authors hypothesized that collection methods that people find acceptable, safe and easy to perform are likely to maximize compliance and minimize refusal to participate in studies that include collection of biological samples. Two studies were conducted. Study one compared assay concentrations of cortisol to sIgA obtained from plain cotton salivettes, eyespears and passive drool. Thirteen participants provided one or two samples of saliva by either passive drool (collecting saliva at the front of the mouth and then spitting into a sterile collection container), salivette collection (saturating cotton tubing by placing in mouth, between lower gum and cheek) or by eyespear collection (placed under tongue or between lower gum and cheek). Study two compared the ratings of each method in

terms of comfort, ease, pleasantness and willingness to participate. Sixteen participants provided saliva samples using each method, in rotation, used in study one and were asked to rate each collection for the comfort level, pleasantness, ease of taking sample as well as willingness to participate in a study. Results from study one indicated that salivettes provided significantly lower values for cortisol compared to passive and eyespear collection, suggesting that the salivettes showed greater interference in collection than the other methods of collection. In study two, participants indicated that there was no difference in their perception of collection methods and the methods would unlikely affect their willingness to volunteer for a study.

Studies on physiological processes have become a major focus in research with stress and its effect on health being among the top areas (Lindfors & Lundberg, 2002). These health effects include increased anxiety, increased negative mood, and changes in salivary pH, hormone levels and immune functions (Stowell, 2003). There is an impact of these effects on the medical and dental professions (Schmitter et al., 2008). A study conducted by Ng et al (2003) investigated the use of salivary cortisol, immunoglobulin A (IgA) and Chromogranin A (CgA) to assess stress before and after a written examination. Thirty-one undergraduate dental students were required to indicate how stressed they felt on a 5-point scale prior to the exam, answer two essay-type questions in one hour and then indicate how they felt again right after completion of the exam. A 5 minute unstimulated saliva sample was collected immediately before and after the exam. Results from the study indicated that the dental undergraduate students perceived a higher level of stress before the exam than after the exam. The authors suggested that the students were stressed due to anticipation of

difficult exam questions, feelings or beliefs regarding mastery in the subject as well as relative importance of the exam.

A study conducted by Takatsuji et al. (2008) determined the effect of examinations on salivary cortisol, IgA and CgA in nursing students. Fifteen female fourth-year nursing students completed a one hour, 100 multiple-choice anatomy and physiology examination. Saliva samples were collected by placing a cotton wad under the tongue for 1 minute and samples were taken 10 minutes before the exam, immediately after the exam and two hours after finishing the examination. The results revealed that while the stress of taking the examination increased IgA and CgA concentrations, it did not affect the concentration of salivary cortisol. The authors of this study suggested that salivary cortisol, in this case, may not be sensitive to the examination stressor.

Studies have shown that chewing may have anti-stress properties and that the chewing of gum or paraffin wax may reduce cortisol concentrations when a stressor is introduced to the subject (Scholey et al., 2009; Tahara et al., 2007). The goals of Scholey et al (2009) study were to prove that chewing gum would reduce self-rated stress, result in reduced cortisol concentrations and improve task performance. Forty young adults participated in the two-day study. The participants had to have chewed gum at least once in the previous week from the study and could not carry any negative opinion about chewing gum, such as it being a bad habit. Saliva samples were taken using salivettes and required the young adults to chew on the cotton roll for approximately 30 seconds and placed into the collection tube. On the days of the study, participants were subjected to a multi-tasking protocol at either low or medium stress intensities. The participants were to chew gum

throughout the 20 minute protocol and had mandatory 20 minute rest periods between the 4 protocols. This was repeated for the next level of stress intensity, both while chewing and not chewing. Results from this study showed that cortisol concentrations fell during both levels of stress intensities. It was suggested that chewing was associated with significantly better alertness and reduced stress and anxiety.

Tahara et al (2007) investigated the effects of chewing and clenching on relaxation under stress by measuring salivary cortisol concentrations. Seventeen males participated in the two-part study. The males were asked to provide a saliva sample and rest for 30 minutes to become more comfortable with the experiment. Next, they were given a series of mathematical calculations to perform within a 20 minute period. Immediately afterwards, a second saliva sample was taken. The males were then asked to chew on paraffin wax while reading their favorite book for two 10 minute periods. A third and fourth saliva sample was collected after reading each 10 minute period. This experiment was done with and without chewing. There was a significant difference in cortisol concentrations in the chewing experiment compared with those in the non-chewing experiment, such that the chewing experiment exhibited lower cortisol concentrations.

Statement of the Problem

A limited number of studies have investigated the effectiveness of DistEd anatomy courses to train veterinary students (Theoret, et al., 2007); however, none have examined the effectiveness of teaching animal anatomy to undergraduate students using a DistEd format. The use of SOR may enhance the learning opportunities for topics that may not be taught or expressed as well with traditional methods (Schitteck et al., 2001). SOR 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 (Schitteck et al., 2001). There have been many studies conducted to determine the effects of stress using cortisol concentrations involving human and animal subjects (Scholey et al., 2009; Strazdins et al., 2005; Ng et al., 2003; Armario et al., 1996). However, little information is known on the relationship between cortisol concentrations when humans and animals interact.

The overall objective of this dissertation is to observe whether or not an Anatomy & Physiology Distance Education course offered in the Animal Science Department will prove to be valuable in the learning process for students. This dissertation had three purposes:

1. To determine whether gross anatomy of animals could be taught effectively at the undergraduate level using a DistEd delivery style (the hypothesis was that students would perform similarly when evaluated based on material presented in a DistEd format compared to material presented in a F2F format)
2. 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 SOR was available compared to learning without the availability of SOR)
3. To determine whether there was a relationship between undergraduate student cortisol levels, using a saliva collection method, and piglet cortisol levels during blood drawing procedures (the hypothesis was that students would exhibit higher cortisol

levels when interacting with the piglets due to stress compared to their baseline levels).

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CHAPTER 2

Undergraduate performance in a domestic animal laboratory taught via distance education

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ABSTRACT: The objective of this study was to determine if laboratory modules of an undergraduate animal anatomy course offered in distance education (DistEd) format were as effective as face-to-face (F2F) format in helping students learn. Students (n=159) completed an anatomy pre-test as well as a pre-survey to assess prior DistEd experience. Alternating each week, laboratory topics were presented either as F2F or as virtual DistEd laboratories. Two laboratory examinations were administered and included material from both lab formats (DistEd and F2F). Questions from the pre-test were also included and used to generate the “post-test” scores. At the end of the semester, students completed a post-survey to determine if DistEd was a viable alternative to F2F. Student grades on each examination were compared using an ANOVA model that included main effects of presentation method (DistEd, F2F), semester (fall, spring) and their interaction. Learning was evaluated based on the students’ performance on pre- and post-test scores using unpaired t-tests. There was an increase ($P < 0.0001$) in anatomy post- vs. pre-test scores for both semesters, indicative of student learning, although there was no effect of presentation method (F2F or DistEd). On exam 1, students achieved higher scores in fall 2008 ($P < 0.0001$) on material presented via DistEd compared to that presented as F2F. However, in spring 2009 students scored higher on material presented as F2F. There was no effect of presentation method on exam 2 scores for either semester. Based on the post-survey, 79.3% of students in fall 2008 and 52% of students from spring 2009 agreed that DistEd laboratories were a viable alternative to F2F laboratories. The results of this study support the conclusion that anatomy material can be taught effectively by distance education methods.

Key Words: anatomy, distance education, laboratory, teaching, undergraduate

Introduction

Computer-based courses and degree programs have become more common as an option for educating students (Barnes et al., 1999). Distance education (DistEd) may consist of teaching and learning methods that are presented mostly by printed or electronic media (Moore, 1973; Walker & Kelly, 2007; Hofmann & Miner, 2008). Using DistEd as a means of instruction has encouraged educators to re-evaluate methods of material presentation and determine if the learning experience associated with instructional methods such as DistEd are valuable (Besser and Bonn, 1996).

Many animal science programs require students to enroll in an anatomy course as part of a curriculum that will prepare them for various careers or for post-graduate education such as veterinary school. Traditionally, students have learned anatomy through teaching laboratories utilizing preserved specimens; however, such laboratories are costly and labor intensive for faculty. Presentation through a DistEd format has been suggested as an attractive alternative to meet the needs of the students and reduce faculty workload once the format is implemented and running smoothly (Barnes et al., 1999). However, there has been concern regarding the effectiveness of replacing 'face-to-face' (F2F) laboratories for anatomy instruction with laboratories utilizing a DistEd format (Besser and Bonn, 1996).

A limited number of studies have investigated the effectiveness of DistEd anatomy courses to train veterinary students (Theoret, et al., 2007); however, none have examined the effectiveness of teaching animal anatomy to undergraduate students using a DistEd format. Therefore, the purpose of this study was to determine whether gross anatomy of animals could be taught effectively at the undergraduate level using a DistEd delivery style. The

hypothesis to be tested was that students would perform similarly when evaluated based on material presented in a DistEd format compared to material presented in a F2F format.

Materials and Methods

Approval was obtained from the University's Institutional Review Board, and all participants provided written informed consent. No identifying information was used in 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. This laboratory-based course is offered every semester and meets once a week for two hours, with three separate laboratory sections for which the students can register. At the end of the course, students should be able to identify the major organs, bones, and muscles of the body and understand how the organs function. In each laboratory lesson, students are 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 2008-2009. The same teaching assistant was responsible for actively teaching the laboratory lessons for both semesters; however, two different instructors supervised the teaching assistant in each semester. In fall 2008, 83 students were enrolled in ANS 206, with 67 of these students being female and 16 being male. Seventy-eight percent of the students were sophomores, 7% were freshman and 15% were juniors and seniors. In spring 2009, 76

students were enrolled in ANS 206, with 56 females and 20 males. Forty-six percent were freshman, 34% were sophomores and 20% were juniors and seniors.

Laboratory lessons were presented either as DistEd or F2F modules. In a given semester, students participated in the same laboratory each week such that all students participated in a DistEd laboratory one week and all students participated in a F2F laboratory the next week. In order that each content topic was presented either as a F2F laboratory or through DistEd over the two semesters in which the study was conducted, the presentation style (F2F, DistEd) was switched between the fall and spring semesters. For example, if Laboratory 1 was taught using DistEd in the fall, then it was taught F2F in the following spring (Table 1).

Each F2F laboratory began with an introductory presentation made by the teaching assistant, which was followed by students viewing models and performing specimen dissections. DistEd laboratories were created using Blackboard Vista (Blackboard, Washington, DC) and Adobe Dreamweaver (Adobe Systems, San Jose, CA). Each DistEd laboratory had an introductory web page presenting the overview and objectives of the laboratory lesson, recorded video demonstrations of specimen dissections with narration, animation, and captions, and video demonstrations from various commercial sites that could be accessed by web link. After viewing the various videos, 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 three different formats: self-testing video quizzes that could be attempted multiple times to help students review the information presented in the laboratory, online quizzes based on video

demonstrations provided by a commercial dissection program, and graded quizzes prepared and administered using Blackboard Vista. In addition, a commercial dissection program (Froguts, Inc., Seattle, WA) was made available so students could download the program to their personal computers, perform virtual dissections and learn about various systems of the body. Unlike the F2F laboratories, students were allowed to return to the DistEd material throughout the semester for further clarification of laboratory objectives as well as to practice their virtual dissections 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 DistEd and students' opinions on DistEd courses. A pre-test consisting of 11 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 ANS 206 in a DistEd format would be a viable alternative to a F2F version.

There were two practical examinations 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 6-11. The examinations were given in-person and consisted of material from both DistEd and F2F laboratory presentations. 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 11 questions included

in the pre-test were also included in the appropriate Laboratory Practical examination. Performances on these 11 questions were considered the students' "post-test" score.

All statistical analyses were conducted using SAS (SAS Inst. Inc., Cary, NC). Chi-square tests were performed to determine if differences existed in the proportions of students by gender or student classification. Unpaired t-tests were used to determine, within each semester, if student classification (freshman, sophomore) and gender (male, female) had an effect on final grade. Paired t-tests were performed on pre-test and post-test scores to assess student learning for both the fall and spring semesters. Analysis of variance using the mixed procedure was used to determine if there was a difference in learning between DistEd and F2F formats. The overall model included pre- and post-test scores, presentation style (DistEd, F2F) and their interactions. Analysis of variance was also performed to establish whether there was a difference between the scores on each of the laboratory practical examinations. The overall model for Laboratory Practical 1 & 2 included materials presentation (DistEd, F2F), the semester (2008, 2009) and their interactions. One-tail unpaired t-tests were performed to determine if students with prior DistEd experience had higher overall final grades. Data from the post-survey regarding whether DistEd was a viable option were analyzed using a Chi-square test. Statistical significance was accepted at an alpha level of $P < 0.05$.

Results and Discussion

There was a significant difference ($P < 0.001$) in student performance on final grades between males and females for both fall (77% vs. 82%, respectively) and spring (73% vs.

79%, respectively) semesters. There was no significant difference between the proportion of males as well as females between the fall and spring semesters (16/83, 19% vs. 20/76, 26% for males, fall and spring respectively; 67/83, 81% vs. 56/76, 74% for females, fall and spring respectively).

There was no significant difference with regard to the overall final grade achieved for freshman versus sophomores in either fall (79.6% vs. 80.3%, respectively) or spring (77.1% vs. 78.0% respectively) semesters. However, there was a significant difference ($P < 0.01$) in the proportion of freshman as well as sophomores between the fall and spring semesters (6/72, 8% vs. 35/61, 57% for freshman, fall and spring respectively; 66/72, 92% vs. 26/61, 43% for sophomores, fall and spring respectively).

There was an overall increase in post-test compared to pre-test scores for both semesters. The students in fall 2008 had an increase ($P < 0.01$) in post-test scores compared to pre-test scores ($88.0\% \pm 1.3\%$ vs. $42.2\% \pm 1.9\%$, respectively). Similarly, post-test scores for students in spring 2009 were increased ($P = 0.0004$) compared to pre-test scores ($86.5\% \pm 1.7\%$ vs. $40.3\% \pm 2.1\%$, respectively). While there was no effect of method of presentation on pre- and post-test performance, there was significant increase in learning for both the DistEd and F2F material for students in fall 2008 ($P = 0.02$) as well as in spring 2009 ($P < 0.01$), suggesting that learning occurred through both methods.

Despite having the same material instructed both semesters, there was a difference ($P < 0.01$) in overall performance on Laboratory Practical 1 between the two semesters, such that fall 2008 scored higher than spring 2009 (72.86 ± 1.26 vs. 67.54 ± 1.65 , respectively). On Laboratory Practical 2, the average scores for the students in fall 2008 were 75.5% and for

the students in spring 2009, 72.8%, but there was no significant difference between the two semesters. On the Laboratory Practical examination 1, students achieved higher scores in fall 2008 ($P < 0.0001$) on the material presented in DistEd format than the students in spring 2009 (Figure 1a). There was no difference between scores on material presented in F2F format on Laboratory Practical 1. On Laboratory Practical 2 (Figure 1b), students from both fall 2008 and spring 2009 averaged similar scores and there was no significant difference between style of materials presentation and semesters.

Although student performance on the Laboratory Practical examinations differed among semesters, students performed similarly overall when tested on material presented in DistEd format versus F2F format. Students in the present study were able to repeatedly review material, which may have allowed them to perform better on Laboratory Practical 2. Although it cannot be concluded in the present study that the availability of repeated review of material through DistEd always improved student performance, it has been demonstrated that students taught using DistEd methods performed at least as well as using F2F methods. It is also possible that material presented in the spring semester was not taught as effectively as in the fall semester, since the laboratory topics presented as either DistEd or F2F were alternated between the two semesters. For example, the F2F cardiovascular laboratory taught in fall semester may have been more effective than the DistEd cardiovascular laboratory taught in the spring semester. Unfortunately, due to the limited number of questions on each laboratory topic, it cannot be established whether differences existed between presentation methods within each laboratory topic.

Theoret et al. (2007) conducted a study with first year veterinary students and found that students learned anatomy equally well when instruction was provided by either live instruction or video demonstration. Results of the present study also demonstrate that students can learn anatomy of domestic animals from using computer-based material. Grizzle et al. (2008), Theoret et al. (2007), and Aly et al. (2004) suggested traditional dissections should remain a part of the anatomy course and that online teaching should be seen as a complement to traditional teaching that is more suited to clinical practices. Offering supplemental material through DistEd format may enhance learning and therefore a blended or hybrid type of approach to anatomy should be evaluated. However, Josephson and Moore (2006) reported that use of a DVD supplemented format for learning how to perform active anatomy dissections resulted in students scoring similarly on examination questions to those who were not provided the DVD- supplemented format.

Based on results from the pre-survey, 25% of students in fall 2008 and 26% of students in spring 2009 had taken a course through DistEd prior to enrolling in ANS 206. However, this prior experience with DistEd had no effect on their final grade. For the fall 2008 semester, 79.3% of students agreed that DistEd laboratories were a viable alternative to F2F laboratories. In contrast only 52% ($P < 0.05$) of students from spring 2009 felt DistEd laboratories were a viable teaching alternative. ANS 206 is a 200-level course and is usually recommended to students in their second year or higher. Although there were a greater number of freshmen in the spring semester class, and while this had no effect on overall grade performance, this group did not express the same positive attitude on the post-survey as the fall semester class. First-year students enrolled in an 200-level course tend to have

trouble adjusting to the expectations of studying and learning in college compared to what they executed in high school (Carew et al., 1997), and this may have contributed to the difference in attitude with the spring 2009 class. Investigating a similar hypothesis as the present study, Aly et al. (2003) also implied that the less experienced backgrounds associated with first-year undergraduates compared to upperclassmen are cause for the uncertainty with multimedia courseware packages. Willems et al. (2003) also noted that upperclassmen students would appreciate computer-assisted learning software more because they would be more familiar with unconventional educational approaches.

Students that have adapted themselves to traditional teaching methods may dislike the transition to online teaching practices because it forces them to modify their learning styles (Willems et al., 2003). It seems students in this study were overall more agreeable to a change in teaching style based on the fact that the majority of students from both 2008 and 2009 semesters agreed that a DistEd option is feasible for teaching anatomy, although notably more from the fall 2008 semester expressed this opinion than from the spring 2009 semester. The students in fall 2008 were largely made up of sophomores, thus they were more likely to adapt to alternate teaching methods than the freshman students in spring 2009. However, once the students in spring 2009 adjusted to the laboratory course format, they performed equally well on Laboratory Practical 2, and exhibited an equal overall grade performance, regardless of the method of materials presentation.

In summary, students appeared to perform similarly when tested on material presented using a DistEd format compared to F2F format. A majority of students across both the fall and spring semesters agreed that DistEd would be a viable option to live laboratories.

However, freshman students may be less comfortable with the DistEd format compared to upperclassmen. The results of this study support the conclusion that anatomy material can be taught effectively by distance education methods. Still, it may be necessary to investigate whether student learning styles may have had an impact on a DistEd teaching style or whether incorporating supplemental online resources into face-to-face laboratories would improve student learning and performance in an undergraduate gross anatomy course.

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Tables and Figures

Table 1. Method of presentation for laboratory lessons in fall 2008 and spring 2009.

Laboratory	Laboratory Topics	Method of Presentation	
		Fall 2008	Spring 2009
L1- Body water and Diffusion	body water, osmosis, and diffusion	DistEd	F2F
L2- Brain and Senses	structures and functions of the sheep brain and cow eye	F2F	DistEd
L3- Bone and Joints	comparative skeletal anatomy-horse, goat, dog, cat and rabbit	DistEd	F2F
L4- Cardiovascular System	external and internal cardiac anatomy of the sheep; describe blood flow	F2F	DistEd
L5- Muscles	Skeletal muscles of the horse	F2F	DistEd
Laboratory Practical 1	Covered laboratory topics 1-5	F2F	F2F
L6- Respiratory Physiology	anatomy of the respiratory system (sheep); inspiration and expiration	DistEd	F2F
L7- Blood	principal components of blood; explain procedures for blood sampling in pigs	F2F	DistEd
L8- Endocrinology/Blood Typing	major endocrine glands and tissues of the body; identification and function of major hormones produced	F2F	DistEd
L9- Urinary System	external and internal features and functions of the sheep and cow kidney	DistEd	F2F
L10- Digestive System	anatomy and function of the digestive system; comparative anatomy of ruminants and nonruminants	F2F	DistEd
L11- Reproductive Physiology	anatomy and physiology of male and female reproductive system of the cow	DistEd	F2F
Laboratory Practical 2	Covered laboratory topics 6-11	F2F	F2F

DistEd- distance education, F2F- face-to-face

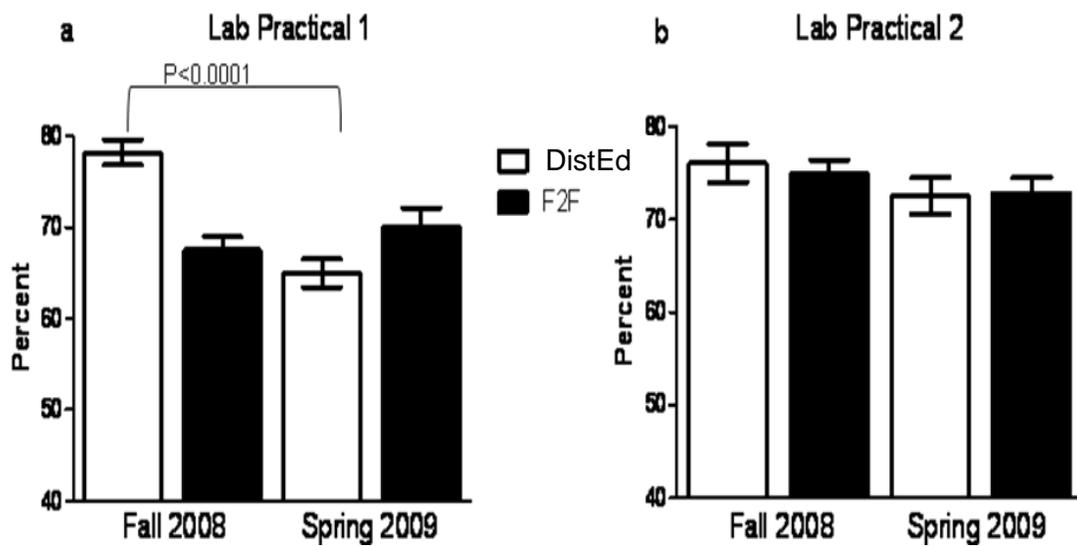


Figure 1. Effect of method of materials presentation on (a) Lab Practical Exam 1 and (b) Lab Practical Exam 2 for Fall 2008 and Spring 2009. DistEd- distance education, F2F: face-to-face.

CHAPTER 3

Effect of supplemental online resources in distance education format on undergraduate animal science laboratory instruction

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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 pre-test 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 “post-test” 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. Post-test scores (87±2%) were higher (P<0.0001) than pre-test 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 (Schitteck 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 (Schitteck 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 (Schitteck 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.

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 4 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, DC).

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 pre-test 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 pre-test were also included in the appropriate Laboratory Practical examination. Performances on these 10 questions were considered the students' "post-test" 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 pre-test and post-test 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 post-test compared to pre-test scores was observed for both semesters (Figure 1). The students in fall 2009 (Figure 1a) had an increase ($P < 0.0001$) in post-test scores compared to pre-test scores ($86\% \pm 2\%$ vs. $30\% \pm 2\%$, respectively). Similarly, post-test scores for students in spring 2010 (Figure 1b) were increased ($P < 0.0001$) compared to pre-test scores ($85\% \pm 2\%$ vs. $39\% \pm 3\%$, respectively). While there was no effect of method of presentation on pre- and post-test 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 ($80 \pm 0.1\%$ vs. $75 \pm 0.1\%$, 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 ($80 \pm 0.1\%$ vs. $75 \pm 0.1\%$, 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 ($85 \pm 0.5\%$ vs. $81 \pm 1\%$, respectively) (Figure 2c). There was no effect ($P=0.84$) of SOR availability for either fall or spring semesters for Laboratory Practical 2 ($83 \pm 0.1\%$ vs. $83 \pm 0.1\%$, 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, 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 ($P= 0.003$).

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 ($P < 0.05$).

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 post-test 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.

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Tables and Figures

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

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

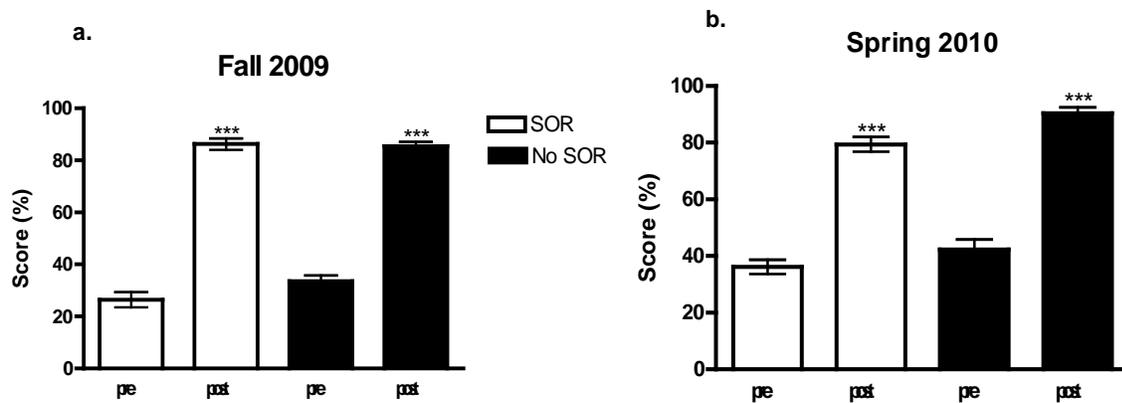
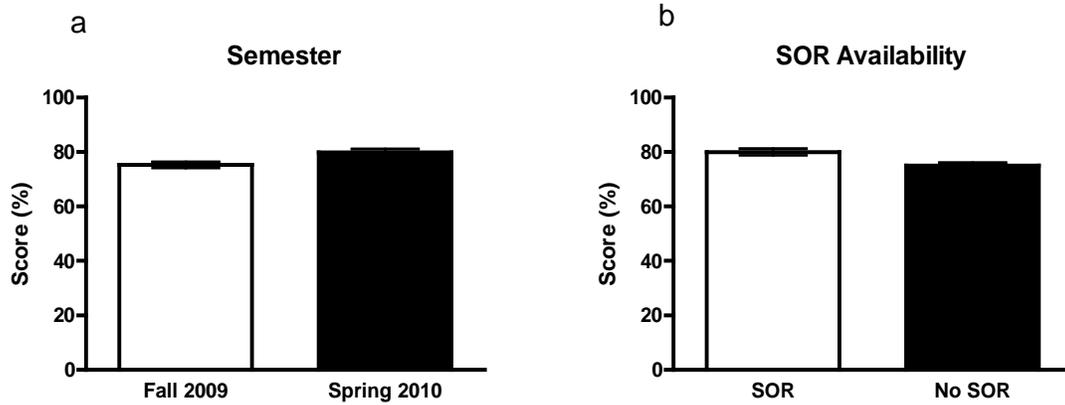


Figure 1. Effect of presentation material on pre- and post-test scores. SOR: supplemental online resources.

***- $P < 0.0001$ pre- vs. post-test scores

Lab Practical 1



Lab Practical 2

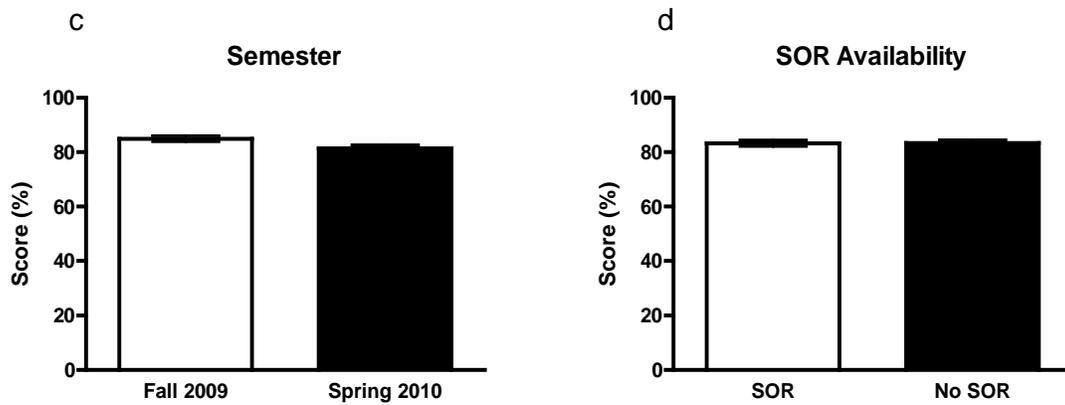


Figure 2. Semester and SOR availability effect on Laboratory Practical 1 (a,b) and Laboratory Practical 2 (c,d) exam score. SOR- supplemental online resources.

CHAPTER 4

Undergraduate student cortisol concentrations and piglet cortisol concentrations during blood drawing procedures

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ABSTRACT: The objective of this study was to determine whether there was a relationship between salivary cortisol concentrations of undergraduate students and cortisol concentrations of piglets during blood drawing procedures. Students (n=61) completed a pre-study survey and post-study survey to rate their opinion on statements focused on how comfortable they were with handling animals. Salivary cortisol concentrations in students were determined on two occasions: during a laboratory lesson (recorded as baseline reading) and while students collected blood from 6-week old piglets. Paired t-tests were performed to determine if differences existed in the baseline cortisol readings and the cortisol readings from the piglet blood drawing. Chi-squared tests were performed to determine whether there was a difference between pre-survey and post-survey student responses. The Proc Reg analysis of SAS was used to determine if correlations existed between student and piglet cortisol readings. There was no significant difference between the students' baseline cortisol concentrations and the cortisol concentrations the day of the blood sampling as well as between the piglets' baseline cortisol concentrations and the cortisol concentrations the day of the study. There also was no correlation between salivary cortisol concentrations during blood sampling and the responses to the question regarding if drawing blood made the student nervous. When asked if the students preferred to let someone else draw blood from the piglet, there was no significant change in their salivary cortisol concentrations achieved during the procedure compared to their baseline concentrations, such that students did not exhibit significantly higher cortisol concentrations when interacting with the piglets.

Key Words: cortisol, laboratory, saliva, teaching, undergraduate

Introduction

For students majoring in medical, dental or veterinary curriculums, anatomy and physiology courses can be one of the most stressful subjects in which students can enroll (Takatsuji et al., 2008). There are two types of stressors that may affect a students' success: 'favorable stressors', which may be used to help learning and performance improvement; and 'unfavorable stressors', where situations presented may come with overwhelming consequences and therefore, negatively affect future academic achievement (Saipanish, 2003). For example, the consequence of failing the tests and examinations taken in anatomy and physiology courses has the potential to cause student stress because a failing grade will have an impact on their academic success (Takatsuji et al., 2008).

Hormones known as glucocorticoids are needed to cope with the body's reaction to mental and/or physical stresses (de Kloet et al., 1999). Cortisol is a glucocorticoid that is a key regulator of stress responses (Ng et al., 2003). The measurement of cortisol concentrations has proven to be a reliable tool in determining which physical and mental stressors affect the body and activate the release of cortisol, resulting in cortisol concentrations rising above a resting baseline (normal levels) (Harris et al., 2007). The method in which cortisol concentrations are determined varies among species but salivary cortisol measurements are considered to be the most accurate because there is an approximate 20 minute delay that exists between the time of hormone production and the time at which cortisol is detectable in the saliva (Scholey et al., 2009; Strazdins et al., 2005; Ng et al., 2003).

There have been many studies involving human and animal subjects that were conducted to determine the effects of stress based on measurement of cortisol concentrations (Scholey et al., 2009; Strazdins et al., 2005; Ng et al., 2003; Armario et al., 1996). However, little information is known about the relationships between cortisol concentrations when humans and animals interact. Therefore, the objective of this research was to determine whether there was a relationship between salivary cortisol concentrations of undergraduate students, and piglet cortisol concentrations, when students drew blood from the piglets. The null hypothesis to be tested was that students would exhibit higher cortisol levels when drawing blood from the piglets due to stress compared to their baseline levels.

Materials and Methods

Approval was obtained from the University's Institutional Review Board, and all participants provided written informed consent. No identifying information was used in 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 registered for this lab met once a week for two hours. One of the laboratory lessons included an activity in which the students obtained a jugular venous blood sample from 6-week old piglets by performing a 'blind stick' technique. The objective of this laboratory was, first, to teach the students how to draw blood from an animal, and second, to learn about the properties of blood following the sampling procedure.

During a laboratory lesson in February 2010, after being instructed on the purpose of the study, sixty-one students agreed to participate. Participating students received a student identification number which was used throughout the study. Students then watched a demonstration on how to collect saliva using a Salivette collection tube (Sarstedt, Newton, NC). When all the participants had their identification numbers and collection tubes, they collected their saliva by placing the cotton swab (1½ in.) into their mouth and chewed on the swab for 1 minute. Once the minute was over, the students returned the cotton swab to the Salivette collection tube, replaced the stopper, recorded their student identification number on the tube and handed the collection tube to the study director. This was considered to be the students' baseline cortisol reading. The Salivette collection tube containing the baseline cortisol readings were stored at -20°C until analysis.

In March 2010, the participating students completed a pre-study survey that consisted of statements designed to determine their sensitivities about animals and explore how comfortable the students were with handling animals. Statements such as “I am nervous around animals”; “Drawing blood makes me nervous” and “I prefer to let someone else draw blood from an animal” were included in the pre-study survey. The students were asked to rate their opinion on those statements using a Likert scale where 1=strongly disagree and 5=strongly agree. Students were also asked whether they had eaten, drank or taken medication prior to the saliva collection. The students then collected their saliva (using the method described above) while also drawing a blood sample from 6-week old piglets at the North Carolina State University Swine Unit. There were 3 piglet blood drawing stations and approximately 4-5 students per station as well as a graduate student or Swine Unit employee

who knew the procedure and could help the student if necessary. At each piglet blood drawing station, one student drew blood while a graduate student or Swine Unit employee held the piglet and the remaining 3-4 students in the group watched the blood drawing. The students collected their own saliva samples when it was their turn to collect the piglet's blood sample. Following blood and saliva sampling, the students completed a post-study survey which was a repetition of the pre-survey questions and asked students to rate their opinion again regarding statements exploring their reactions after they had drawn blood from the piglets. Once the study director had the saliva collection tube, the piglet blood sample and the completed survey, the students' role in the study was completed. Baseline piglet cortisol concentrations for n=25 other piglets of the same age, weight and dietary status were determined in a sample obtained at another date by a Swine Unit employee.

Blood and saliva samples were immediately refrigerated after collection and then spun the next day. Both blood and saliva samples were stored at -20°C and later thawed for assay analysis. Saliva samples were extracted from the cotton wads by centrifuging (at 3,000 rpm for 2 minutes). Blood samples were centrifuged for 10 minutes at 3,000 rpm (400 G's) and the serum was used for analysis. Using a commercial solid-phase kit, cortisol concentrations in student saliva and pig serum were then determined by radioimmunoassay according to the manufacturer instructions (Coat-A-Count, Diagnostic Products Corporation, Los Angeles, CA).

All statistical analysis was conducted using SAS (SAS Institute Inc., Cary, NC). Paired t-tests were performed to determine if differences existed in the baseline cortisol readings and the cortisol readings from the piglet blood drawing for both the student and the

piglet. Chi-squared tests were performed to determine whether differences existed in total student responses on the pre-study survey results versus the post-study survey results. The Proc Reg analysis of SAS was used to determine if correlations were present between pig cortisol concentrations and student cortisol concentrations during the blood drawing.

Correlations between the survey answers and the student cortisol levels were also determined using the Proc Reg analysis of SAS. Statistical significance was accepted at an alpha level of $P < 0.05$.

Results and Discussion

Student responses on the pre- and post-study surveys are illustrated in Tables 1 and 2. On the pre-study survey, one hundred percent of the students either disagreed or strongly disagreed that they were nervous around animals but on the post-study survey, 10% of the students agreed that they were nervous around the piglets. Thirteen percent of the students either strongly agreed or agreed with the statement on the pre-study survey that drawing blood makes them nervous; however, when asked again on the post-study survey, 18% of the students either strongly agreed or agreed. When asked on the pre-survey if they preferred to let someone else draw blood from an animal, 13% of the students either strongly agreed or agreed. The statement was then repeated on the post-study survey and 5% of the students strongly agreed or agreed that they preferred someone else to draw blood from the piglet for them. One hundred percent of students either strongly disagreed or disagreed with the statement on the pre-study survey that asked whether they disliked interacting with animals up close and personal; however, when the statement was repeated on the post-survey, 4% of the students either strongly agreed or agreed.

Table 3 summarizes the chi-square results for the pre- and post-study survey answers. When asked the question whether the students had experience with drawing blood from a piglet, there was a significant ($P < 0.005$) increase in pre- versus post-study survey answers. Seven students agreed with the statement when asked on the pre-study survey but on the post-study survey, 19 students agreed with the same statement. There was also a downward trend ($P = 0.109$) in student responses when asked if the students preferred to let someone else draw blood from the piglet. On the pre-study survey, 8 students agreed with the statement that they would prefer to let someone else draw blood from an animal but after actually attempting to draw blood from the piglet, the number decreased to 3 students agreeing with the same statement on the post-study survey.

There was no significant difference between the students' baseline cortisol concentrations and their cortisol concentrations the day of the piglet blood sampling, as shown in Figure 1. While piglet cortisol concentrations were elevated, it was not significantly higher during blood drawing procedures (Figure 1). There was no significant positive correlation between the student cortisol concentrations and the piglet cortisol concentrations at baseline sampling (Figure 2) as well as on the day of the piglet blood sampling (Figure 3). It was observed that students that exhibited higher cortisol concentrations at baseline also had higher cortisol concentrations during the blood sampling procedure. However, piglet cortisol concentrations were higher than student cortisol concentrations. Students did not exhibit significantly higher cortisol levels when interacting with piglets compared to the students' baseline cortisol levels (Figure 4). A reason for this

could be that the student was calmer than the piglet and therefore, no significant changes in their salivary cortisol concentrations were observed.

Stowell (2004) states that the term “academic stress” should cover not only examinations but other related stress factors such as completing homework assignments, participating in presentations and/or demonstrations, and scheduling classes. In the present study, performing the blood drawing procedure would fall under the category of “academic stress” because the students are participating in a laboratory demonstration. Higher levels of stress were found among undergraduate medical students (Radcliffe & Lester, 2003) and dental students (Pöhlmann et al, 2005) who were in their residency stages which involved working with patients more than the undergraduate medical and dental students who were not in their residency stage and working with patients.

Cortisol, including salivary cortisol, shows a circadian rhythm with concentrations being higher in the morning followed by a natural decline in the afternoon in the absence of a stressor (Scholey et al., 2009; Bollini et al., 2004; Kudielka et al., 2004). The cortisol concentrations of the students in the present study did not show a significant change and this could be due to several reasons. One reason could be the fact that both the pre-study samples and the study samples were taken in the afternoon and not the morning. The pre-study samples were taken in the afternoon to mimic the time when the actual interaction with the piglets would take place. A second reason could be that the students in the present study were calmer than the piglets and therefore, no significant changes in their salivary cortisol concentrations occurred. It is possible that the student stressed the piglets

out and that is why the piglet cortisol concentration readings were higher than the students' cortisol concentrations.

A third reason as to why there was not a significant increase may be due to the fact that the cortisol measurements were taken during the blood drawing procedure and not after the procedure. Armario et al. (1996) discovered significant increases in cortisol concentrations in second year medical students 15-20 minutes after the students had taken an exam. It is possible that in the present study cortisol samples should have been taken approximately 20 minutes after the blood drawing in order to determine a significant change in cortisol concentration. It is likely that cortisol was released during the procedure but changes in concentrations may not have shown up in the saliva until 20 minutes after the procedure. While the students in the present study were not taking an exam, the act of drawing blood should have had the same effect as taking an exam; however, there were no significant changes in cortisol concentrations were identified. However, our results are more similar to Loft et al (2007) and Ng et al (2003) whose findings showed lower salivary cortisol concentrations after undergraduate medical students took an examination.

It was shown in studies conducted by Scholey et al (2009) and Tahara et al (2007) that chewing may have anti-stress properties and that the chewing of gum or paraffin wax may reduce cortisol concentrations when a stressor is introduced to the subject. While chewing the cotton swab in the Salivette collection tube was the method of collecting saliva in the present study, other studies reported increased (Murphy et al., 2010; Miller et al., 1995), decreased (Pawlow & Jones, 2005; Bollini et al., 2004; Ng et al., 2003) or neutral (Takatsuji et al., 2008) cortisol concentrations while placing the cotton swab under the

tongue, saturation of swab in cheek or passive drool into collection tube. Perhaps the chewing of the cotton swab in the Salivette collection tube helped maintain cortisol concentrations of the students in the present study.

There may be many other influences involved when aiming to calculate accurate cortisol concentrations. These include but are not limited to coffee, tobacco, medication and alcohol (Harris et al., 2007). In the present study, 25 of 61 students (41%) reported having taken medication prior to the saliva collection. Thirty-two of 61 students (52%) reported having eaten or drank prior to saliva collection. These may have had an influence on cortisol concentrations when saliva collection was taken. It has also been stated that Salivettes may provide significantly lower cortisol values compared to other saliva collection methods (Strazdins et al., 2005). It has been suggested that the material used in the cotton Salivettes may affect the absorbance levels of the cortisol molecules (Strazdins et al., 2005). Further analysis comparing collection methods as well as food and drink consumption would need to be completed in the present study in order to agree or disagree with previous research.

In summary, neither students nor piglets showed significantly higher cortisol concentrations when interacting with each other during blood drawing procedures. There was no significant difference between the students' baseline cortisol concentrations and the cortisol concentrations the day of the study. While the piglets displayed elevated cortisol concentrations the day of the blood sampling compared to the baseline sampling, it was not significantly higher than their baseline cortisol concentrations. There was a no significant positive correlation between the student salivary cortisol concentrations and the piglet cortisol concentrations the day of the piglet blood sampling. There also was no correlation

between salivary cortisol concentrations during blood sampling and the responses to the question regarding if drawing blood made the student nervous. When asked if the students preferred to let someone else draw blood from the piglet, there was no significant change in their salivary cortisol concentrations achieved during the procedure compared to their baseline concentrations. Students did not exhibit significantly higher cortisol concentrations when interacting with the piglets. In conclusion, students and live piglets can interact in a laboratory setting involving slightly invasive procedures (jugular blood sampling) without causing significant stress to either humans or animals. Several factors, such as time of day, method of collection and the intake of food, drink and medication must be taken into consideration for future studies.

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Tables and figures

Table 1. Pre-study survey responses (out of 61 students)

Statement	Strongly Disagree (1)	Disagree (2)	Neither Disagree or Agree (3)	Agree (4)	Strongly Agree (5)
1. I am nervous around animals.	36(59)	25(41)	0	0	0
2. I have experience with handling animals. ***	2(3)	5(8)	6(10)	29(48)	19(31)
3. I have experience with handling small animals.	2(3)	3(5)	2(3)	31(51)	23(38)
4. I have experience with handling livestock animals.	9(15)	13(21)	12(20)	13(21)	13(21)
5. I have experience with drawing blood from an animal.	14(23)	16(26)	4(7)	21(34)	5(8)
6. I have experience with drawing blood from a piglet.	34(56)	16(26)	4(6.5)	4(6.5)	3(5)
7. Drawing blood makes me nervous.	13(21)	22(36)	18(30)	7(11)	1(2)
8. I prefer to let someone else draw blood from an animal.	14(23)	25(41)	14(23)	7(11)	1(2)
9. I dislike interacting with animals up close and personal.	53(87)	8(13)	0	0	0
10. I prefer to limit my interaction with animals.	54(89)	7(11)	0	0	0

***EXPERIENCE is defined as knowing how to properly hold and handle an animal the safe and correct way, and being able to perform tasks (e.g. Draw blood) in a safe manner.

**Numbers in parenthesis are percentage of student responses

Table 2. Post-study survey responses (out of 61 students)

Statement	Strongly Disagree (1)	Disagree (2)	Neither Disagree or Agree (3)	Agree (4)	Strongly Agree (5)
1. I was nervous around the piglets.	24(39)	23(38)	7(11)	6(10)	0
2. I had the experience to handle the piglet. ***	5(8)	20(33)	14(23)	14(23)	8(11)
3. I had the experience to handle small animals.	2(3)	3(5)	4(7)	33(54)	19(31)
4. I had the experience to handle livestock animals.	5(8)	13(21)	11(18)	17(28)	15(25)
5. I had the experience to draw blood from an animal.	7(11.5)	15(25)	7(11.5)	21(34)	10(16)
6. I had the experience to draw blood from a piglet.	12(20)	21(34)	8(13)	12(20)	7(11)
7. Drawing the blood from the piglet made me nervous.	16(26)	21(34)	13(21)	9(15)	2(3)
8. I preferred to let someone else draw blood from the piglet.	25(41)	22(36)	11(18)	2(3)	1(2)
9. I disliked interacting with the piglets up close and personal.	39(64)	18(30)	2(3)	1(2)	1(2)
10. I preferred to limit my interaction with the piglets.	33(54)	21(34)	7(11.5)	0	0

***EXPERIENCE is defined as knowing how to properly hold and handle an animal the safe and correct way, and being able to perform tasks (e.g. Draw blood) in a safe manner.

**Numbers in parenthesis are percentage of student responses

Table 3. Chi-square results for pre- and post-study survey answers

Question	Average Response	Chi-square	Significance
1. I was nervous around the piglets.	1.6±0.741	2.1	NS
2. I had the experience to handle the piglet. ***	3.5±1.110	26.43	<0.001
3. I had the experience to handle small animals.	4.1±0.925	0.12	NS
4. I had the experience to handle livestock animals.	3.2±1.363	0.77	NS
5. I had the experience to draw blood from an animal.	2.9±1.384	1.63	NS
6. I had the experience to draw blood from a piglet.	2.2±1.248	9.56	<0.005
7. Drawing the blood from the piglet made me nervous.	2.3±1.063	0.45	NS
8. I preferred to let someone else draw blood from the piglet.	2.1±0.968	3.69	=0.109
9. I disliked interacting with the piglets up close and personal.	1.3±0.564	0.54	NS
10. I preferred to limit my interaction with the piglets.	1.3±0.508	0.00	NS

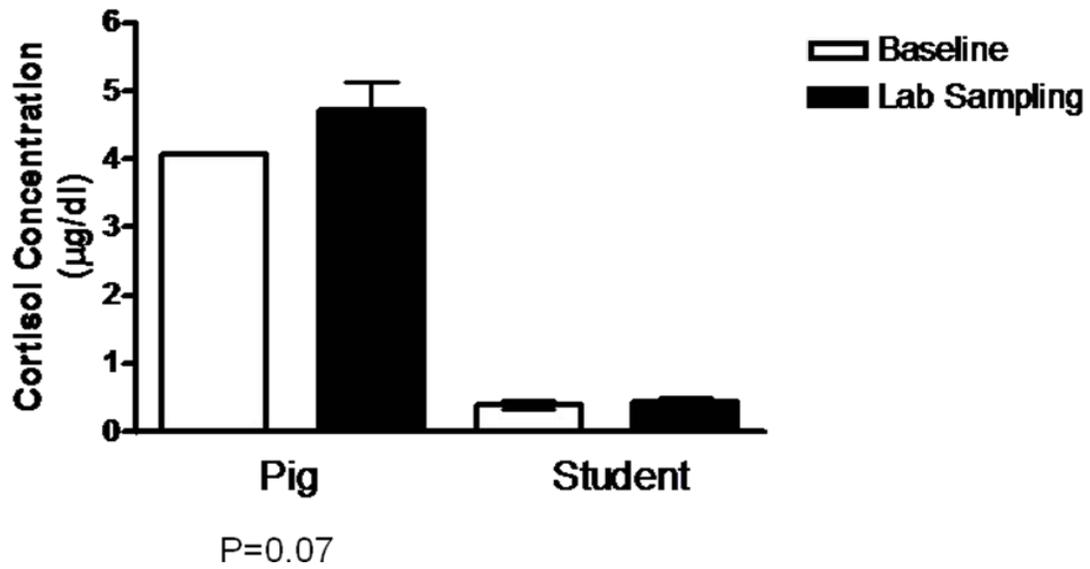


Figure 1. Cortisol concentrations of students and piglets at baseline and study sampling.

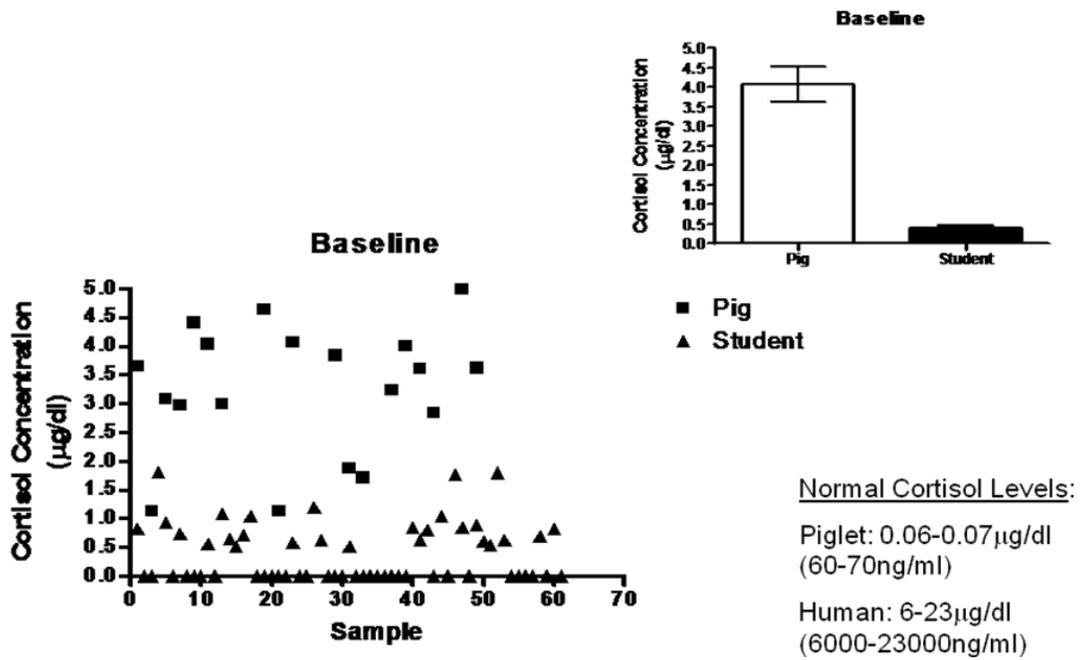


Figure 2. Regression analysis of cortisol concentrations at baseline levels for students and piglets

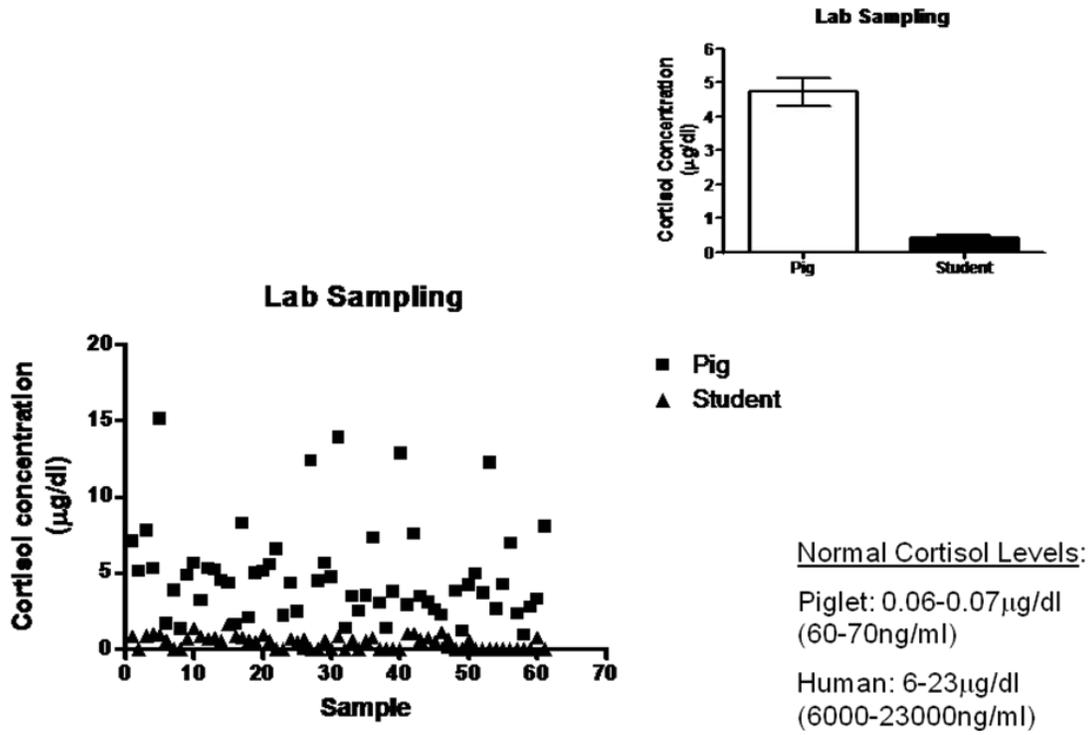


Figure 3. Regression analysis of cortisol concentrations at lab sampling for students and piglets.

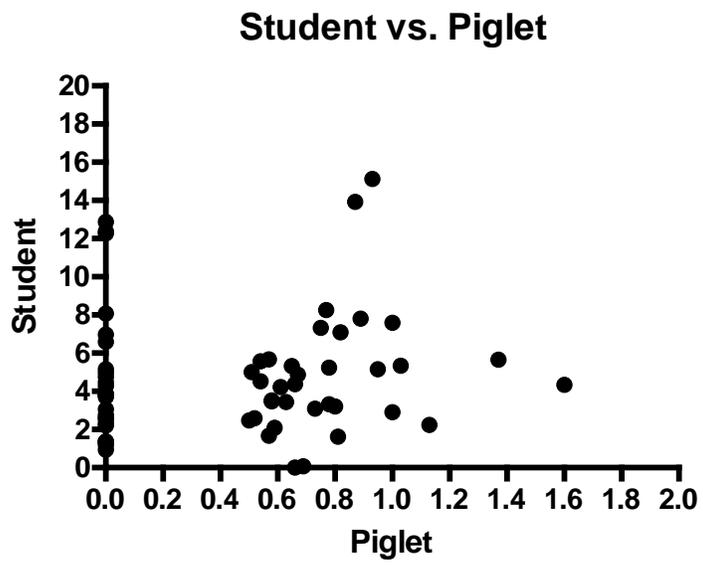


Figure 4. Student to piglet correlation.

CHAPTER 5

General Conclusions/Future Implications

The increased use of technology in the classroom and the incorporation of computer-based programs and degrees has caused many colleges and universities world-wide to re-evaluate the programs offered. The overall objective of this dissertation was to observe whether or not an Anatomy & Physiology Distance Education (DistEd) course offered in the Animal Science Department will prove to be valuable in the learning process for students. There were three purposes for conducting this research: 1) to determine whether gross anatomy of animals could be taught effectively at the undergraduate level using a DE delivery style, 2) to determine the effectiveness of SOR on student learning in an undergraduate domestic animal anatomy laboratory and 3) to determine whether there was a relationship between undergraduate student cortisol levels, using a saliva collection method, and piglet cortisol levels during blood drawing procedures.

In study one, the results showed that anatomy material can be taught effectively by distance education methods. Students appeared to perform similarly when tested on material presented using a DistEd format compared to F2F format. On exam 1, fall semester students achieved higher scores on material presented via DistEd compared to that presented as F2F. However, the spring semester students scored higher on material presented in F2F. There was no effect of presentation method on exam 2 scores for either semester. While a majority of students across both semesters agreed that DistEd would be a viable option, freshman students may be less comfortable with the DistEd format than upperclassmen. Further investigation of student learning styles may help determine whether a DistEd teaching style would improve student learning and performance. Also, determining

whether supplemental online resources should be incorporated into the face-to-face teaching style may assist in student learning as well.

The results for study two demonstrated that SOR availability is a useful learning tool and may be an effective way to allow students to review as needed on their own time. 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. 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.

The findings in study three revealed that neither students nor piglets showed significantly higher cortisol concentrations when interacting with each other during blood drawing procedures. There was no significant difference between the students' baseline cortisol concentrations and the cortisol concentrations the day of the study. While the piglets

displayed elevated cortisol concentrations the day of the blood sampling compared to the baseline sampling, it was not significantly higher than their baseline cortisol concentrations. There was no significant positive correlation between the student salivary cortisol concentrations and the piglet cortisol concentrations the day of the piglet blood sampling. Students did not exhibit significantly higher cortisol concentrations when interacting with the piglets. In conclusion, students and live piglets can interact in a laboratory setting involving slightly invasive procedures (jugular blood sampling) without causing significant stress to either humans or animals. In order to further validate the results of this study, several factors such as time of day, method of collection and the intake of food, drink and medication must be taken into consideration for future studies.