ARTICLE
Dual Format Course Design: Neuroanatomy and Neurophysiology for Adult Learners

Rebecca I. Estes
Department of Occupational Therapy, University of South Alabama, Mobile, AL 36604.

Adult learners require alternative learning opportunities to enable them to work and still be able to upgrade their education. This dual format course, combining online and face-to-face components, was developed to meet the need of students to complete a prerequisite undergraduate level neuroanatomy and neurophysiology course while attending a program that included fly-in weekends (seven) and online instruction (15 weeks). A combination of online lectures and on-campus lectures were used to teach pre-requisite neuroanatomy and neurophysiology course topics. The article presents the teaching material division between online and on-campus lectures and presentation of data collected. Survey data collected included student preferred: online media presentation, online activities developed to facilitate learning of the online material, online case study discussion, and testing formats. Students also were asked to comment on whether the class should move to a 100% online format and what their concerns would be moving to an all online format. Additional qualitative data on student input related to the course, adult learning and the learning environment will be presented. Blackboard data include: student daily access patterns, media and documents access and download patterns, and case study participation. Additionally, descriptive statistics from in class quizzes versus online quizzes includes: student patterns of test taking in an unlimited retake environment, scores on retakes and final scores (highest of retakes), in-class quiz scores, and comparison of comprehensive final exam scores from online versus face-to-face lecture material and testing. Findings provide valuable information for online course formatting, revisions and additional course development.

Key words: College, graduate, professional, online, teaching neuroscience

There is a need for increased numbers of US scientists and increased quality of education for those seeking scientific information (National Science Board, 2006). Learning about neuroanatomy, neurophysiology, in truth, any topic with “neuro” in it, tends to intimidate not only students but also those employed or teaching in the medical fields (Schon et al., 2002).

Approaches presented in the literature to make learning neuroanatomy more meaningful, more user friendly and more interactive include use of a collaborative approach to case studies (Sheldon, 2000), use of peer review of scientific writing (Prichard, 2005), supplementation of face-to-face classes with online materials (Olivo, 2003; Lane and Tang, 2003), use of biographies to teach about interpersonal and intrapersonal dynamics in science (Mori and Larson, 2006), focusing on psychopathology and clinical application (Lambert, 2005) and integrating computer-based labs (Evert et al., 2005; Av-Ron et al., 2006).

Retooling adult learners who are also distance learners creates an additional challenge to create the right learning environment. To be successful, teaching the adult learner entails incorporation of a more equal and reciprocal relationship, a multi-directional experiential approach, a relating of material relevance to the students’ learning interests and needs, and incorporation of experiential, collaborative and interactive learning (Robles, 1998). Acquisition, processing, and retention of new knowledge by adult learners may be enhanced by prior knowledge and experience or it may be hindered by it as in the case of out-of-date or erroneous knowledge (Reid, 1999). Data were collected, in a post-hoc study, to determine student preferred media presentation of online lectures and use of and preferences for learning activities and case study discussion boards. Data were also collected on the testing environment and student views on the course changing to a 100% online format. Methods of online learning, cooperative learning, and problem-based learning will be discussed in light of the findings of this paper.

COURSE DESCRIPTION

Neuroanatomy and neurophysiology is a prerequisite course to enter Texas Woman’s University’s School of Occupational Therapy, entry level Masters of Occupational Therapy (MOT) degree program. The program, geared primarily for on-campus, full-time students, expanded to offer the opportunity for certified occupational therapy assistants (COTAs; an associate degree) to “bridge” from their current level of practice to a more advanced practice level through completion of the MOT degree. The program became known as the “Bridge Program” and was offered in a combined online and weekend face-to-face format so that working individuals around the United States could participate. With the program expansion, a barrier became apparent. Students from across the United States expressed frustration and inability to find an undergraduate neuroanatomy and neurophysiology course locally to meet the prerequisite neuroanatomy course requirement for admission. Thus, the faculty opted to offer the prerequisite as part of the Bridge Program.

Lectures conducted in a face-to-face format occurred on Saturdays during seven on-campus weekends. The course content taught each weekend is listed in Table 1. The online lecture material contents included lectures on

Neuroimaging, Development of the Nervous System, Cranial Nerves and Nuclei, and The Autonomic Nervous System.

Weekend 1
Introduction to the course
Introduction to Neuroscience and the Brain
Weekend 2
Neurophysiology (Neurons, Ion Channels, Synaptic Transmission, The Action Potential)
Clinical Correlations: Neurophysiology
Weekend 3
Ascending Pathways of the Spinal Cord & Sensory Atlas (class activity)
Clinical Correlations: Ascending Pathway
Neuroexam & Case Study
Weekend 4
Descending Pathways & Motor Atlas (class activity)
Control of Movement: Interactions & Reflexes
Clinical Correlations: Descending Pathways
Weekend 5
The Proprioceptive and Cerebellar System
Special Senses
Basal ganglia
Weekend 6
Limbic System
Higher Cortical Functions
Clinical Correlations: Higher Cortical Functions
Weekend 7
Comprehensive final exam
Neuroexam case study poster presentation

Table 1. Weekend course content taught in a face-to-face lecture format.

Course Syllabus

The course syllabus contained the course description, course objectives, recommended text (Martin, 2003), grading criteria, course expectations, required university statements on accommodations, attendance and academic dishonesty and a tentative detailed semester schedule.

The course description was typical of a three-hour fundamental course on neuroanatomy and neurophysiology of the human nervous system. It listed the major topics covered as the physical, electrical and chemical properties of cells in the nervous system and major structures and functions of the central and peripheral nervous systems. The course also included clinical application of material learned and discussion of the major neurological syndromes and diseases. The course objectives stated that "students who successfully complete this course will be able to:

1. Describe the structure and function of cells that compose the nervous system.
2. Explain chemical and electrical signaling in the nervous system.
3. Identify the sensory and motor systems and their functions.
4. Identify the structural and functional divisions of the brain.
5. Explain brain development and complex brain functions.
6. Identify and distinguish between tissues in the nervous system.
7. Demonstrate an understanding of basic neuroanatomy and neurophysiology as it pertains to the impact of acquired and inherited disorders."

The detailed tentative schedule was designed to assist the working adult learner to return to a classroom environment where assignments were due, readings were required prior to lectures and tests occurred on a regular basis. The schedule was planned to balance the load of required online and on-campus activities and requirements, a sample of two weekends and the schedule between them is detailed in Table 2.

WEEKEND ONE:
Lecture: 1. Introduction to the class, syllabus & assignments
2. Introduction to Neuroscience
3. Brain Environs

Between Weekend 1 & Weekend 2
Week 1 Online Lecture: Neuroimaging
Week 2 Online Quia Quiz: Neuroimaging

WEEKEND TWO:
QUIZ #1 - in class on: Intro to Neuroscience & Brain Environs
Lecture: 1. Neurons
2. Ion Channels
3. Synaptic Transmission
4. The Action Potential
5. Clinical Correlations: Neurophysiology

Between Weekend 2 & Weekend 3
Week 3 Online discussion board - case study 1
1. Read the case study then...
2. Enter the discussion board and respond to the questions/topics listed (complete this portion by midnight CST Friday of this week), then…
Week 4 Online discussion board - case study 1
3. Return to the discussion board after everyone has completed the first portion of the assignment and respond to/comment on a minimum of two other entries (complete this portion no later than Wednesday of this week), last …
4. Return to the discussion board and review all comments (by Friday before you head back for the weekend class).

Table 2. Sample of detailed tentative schedule for two on-campus weekends and the weeks between them.

RESULTS

Data were collected over two years from 33 students in two classes through an end of semester satisfaction and feedback survey, descriptive statistics available through Blackboard on download patterns and usage and Quia data on practice activity use and quiz scores. Blackboard (www.Blackboard.com) is an online service for instructors that allows the instructor to post documents, conduct threaded discussions, chat in real time and set up group activities. Quintessential Instructional Archive (Quia; www.quia.com) is an online service that allows the instructor to create interactive learning activities, automatically graded quizzes with feedback, and surveys. All data collected, were on standard class procedures. The

course evaluation survey conducted at the end of the semester included questions rating (Likert scale) the value of the learning activities (1 = very helpful to 4 = a waste of time), rank ordering viewing preference of the lecture presentation media and open-ended response questions. Survey data collected through Likert scale responses included: analysis of student preferred presentation of lecture content, preferred online activities (Quia) developed to facilitate learning of the online material, perceived benefit of online case study discussion boards, and perceived benefit of in class activities. Qualitative data were collected from two open-ended questions.

Survey Data

Students' first choice of lecture presentation method (see Figure 1) was split between face-to-face lecture presentation (53%) and online presentation methods (51%). Students stated the positives for the online lectures were that they were available to listen to more than once, a section that was not understood could be rewound and listened to again and they were good as a review of material for the comprehensive final exam. Student negative comments about online lectures included that questions could not be answered as the material was presented. Students stated the positives about face-to-face lectures were that students could interact with the instructor, questions could be asked about material as it was presented, and information that was unclear could be expanded on. Student negative comments on face-to-face lectures were that it was difficult to take adequate notes.

Students preferred that the online lectures be presented as movies (33%) rather than PowerPoint presentations (18%). Comments in favor of movies included that they could be burned to CD and listened to while driving in the car and that rewinding or moving between portions of the lecture was easier on the movies than on the PowerPoint presentations.

The online lectures were supplemented with practice activities (in the form of games) available through Quia, an online service. The activities developed used memorization or matching type tasks. The lecture material did not lend itself to the same games each time; the games developed for each lecture and the number of times students gained access to them are presented in Table 3. Survey results showed that 86% of the students felt these activities were very helpful, 11% felt they were somewhat helpful, and 4% felt they were not very helpful. No student rated them as a waste of time.

The online discussion boards were used for clinical case studies designed with a problem-based learning approach. Students were divided into groups, and provided a case study and questions to develop answers for, using the discussion board for group interaction. The instructor monitored the discussion boards to make sure students stayed on track. Answers to questions were provided, as students moved through the process of elimination to identify the motor and sensory pathways affected by the lesion. Survey responses showed that 28% of the students felt these case study discussion boards were very helpful, 56% felt they were somewhat helpful, and 16% felt they were not very helpful. No student rated them as a waste of time.

In class activities included creation of a brain mold that students labeled with structural divisions on one hemisphere and with functional divisions on the other hemisphere, flash cards for atlas-based spinal cord level recognition and presentation of research articles on the pathophysiology of neurological conditions. Survey results showed that 93% of the students felt the brain mold activity was somewhat or very helpful, 100% of the students felt the flashcards were somewhat or very helpful, and 71% felt the article presentations were somewhat or very helpful. Survey results showed ratings ranging from 90-100% for students' perceptions that the lecture coverage of course objectives was adequate or thorough.

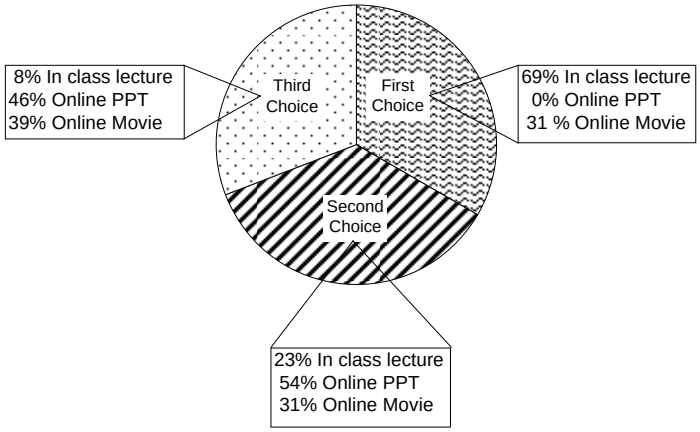

Figure 1. Student preferred media presentation format for online lecture material.

	ANS	CN	DEV	NI
JG	81	83	98	124
CM	36	32	30	
CB		185	77	
POP		46		
H		4	40	
PP		40		
OL		37	44	
BA				94

Table 3. Quia games developed for online lectures and the number of times students gained access to each game. ANS = autonomic nervous system; CN = cranial nerves; DEV = development of the nervous system; NI = Neuroimaging; JG = flash cards or concentration; CM = matching columns; CB = jeopardy; POP = matching pop-us; H = hangman; PP = picture perfect (ordering); OL = ordered lists; BA = battleship.

Qualitative Survey Data

Qualitative data were collected from two open-ended questions; all students responded to the first question; all except one responded to the second question. The first one asked: what thoughts do you have about this course going 100% online? Additional qualitative data on student input related to the course, adult learning, and the learning

environment were collected through responses to the question: Is there anything else you would like to say, please share it here.

Student responses were divided between those who thought the course could easily go online (47%) and those who were against an all online format (41%), 12% were undecided. Students in favor of the online course format liked the learning activities on Quia and the ability to listen to the recorded lecture more than once. Students opposed to an all online format were concerned that student-instructor interaction would be lost, and that the material was too complex and detailed for online learning. Responses typical of those in support of and opposed to the all online format may be found in the Appendix.

Qualitative data on student input related to the course, adult learning, and the learning environment primarily revolved around issues of working full time, organization and structure in the course, time management, and being treated as an adult rather than a young college student. Typical responses concerning these issues may be seen in the Appendix.

Blackboard Access Data

Blackboard data collected included: Blackboard application usage, student daily access patterns, and discussion board (case study) participation. Blackboard applications used in the course and the student use of them are presented in Table 4. The patterns are indicative of the way the course shell was established and the combined online and on-campus format.

Due to the on-campus weekends, students tended to bring assignments with them to turn in rather than using the digital drop box. The case study discussions all occurred during the time they were not on campus so the discussion board use reflects this requirement and the 74% use of this application. The low use of groups, messages and emails reflected an interesting phenomenon of the cohort group. The students, both years, quickly developed calling trees and those who did not have cell-phones bought them, some using "friends and family" packages shared among classmates to take advantage of increased or free minutes available. Communication between students and groups primarily took place over cell-phones. Students often mentioned that they would be on the telephone with group members discussing what to post on the discussion board!

Access / Application	Number of hits	Percent Use
Address Book	12	0.04%
Announcements	4341	15.41%
Communications Area	551	1.96%
Email	384	1.36%
Tools	1618	5.74%
Discussion Board	19958	70.84%
Drop Box	172	0.61%
Groups	28	0.10%
Messages	94	0.33%
Staff Information	92	0.33%
My Grades	922	3.27%
Total	28172	100.00%

Table 4. Blackboard applications used in the course, number of hits and percent use per application.

Students' weekly access patterns (Figure 2) were unexpected. The course assignment due dates were scheduled for Sundays with the expectation that the students who worked full-time would primarily be online during the weekend; however, usage patterns showed Tuesday through Thursday were heavy access days. Student verbal preference for due dates were repeatedly stated as weekend days. Daily access patterns were as expected (Figure 3) with increased traffic beginning at 5:00 P.M. (17:00 hours) and peak traffic at 9:00 PM (21:00 hours) reflecting the evening access pattern after work and children's bedtime.

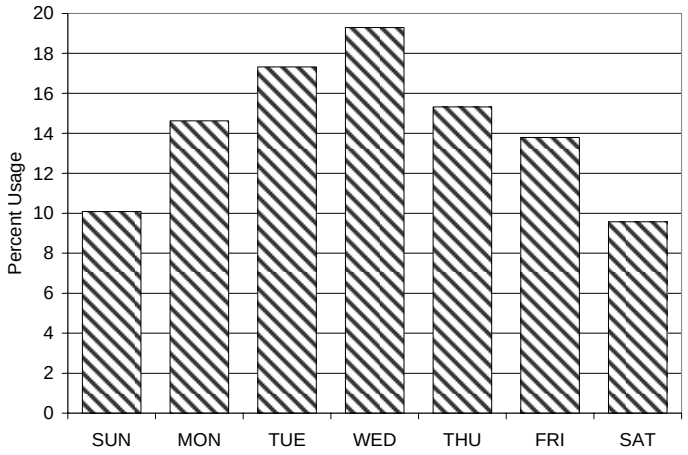

Figure 2. Blackboard access patterns by day of the week and percent of time used each day.

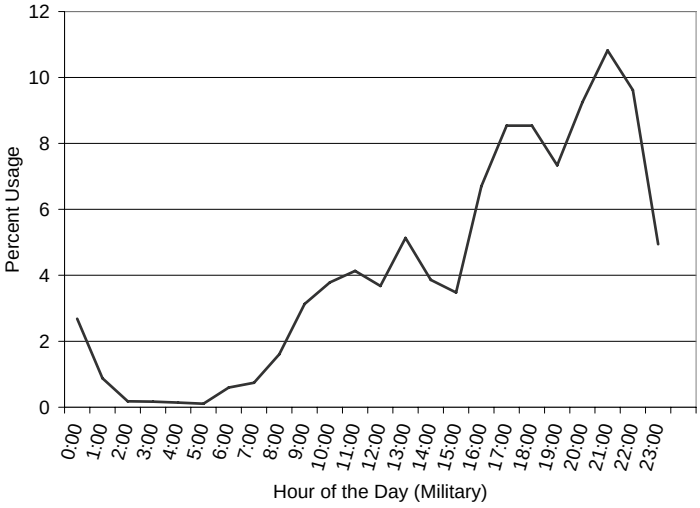

Figure 3. Blackboard access patterns by hour of the day in military time and percent of time used each hour.

Quizzes and Tests

Data from in-class quizzes and online quizzes included: student patterns of test taking in an unlimited retake

environment, scores on retakes and final scores (highest of retakes), in-class quiz scores, and comparison of comprehensive final exam scores from online versus face-to-face lecture material and testing. Both online and on-campus tests were from a pool of questions, organized by topics. The online quizzes contained randomized selections of questions, and thus, each retake corresponded to a different set of questions.

The first year of data collection the online quizzes were offered in an unlimited retake environment. The instructor (author) was amazed at the number of times some students took a quiz (in one case 46 times!). A review of the pattern of timing between quiz retakes showed students were retaking a quiz immediately after completing it. Since the quizzes represented a random selection from a pool of questions, retaking repeatedly in the unlimited retake environment provided students with the opportunity to view a maximum number of questions by retaking a quiz multiple times. Review of the grades showed that even though some students received 90% or better they continued to retake the quiz, often until they got 100%. Curious as to whether the number of retakes made a difference in the final grade, the average score for quizzes taken 1-5 times, 6-10 times and 11-46 times was calculated. When the descriptive statistics showed those students taking quizzes 1-5 times averaged 95%, while those taking it 6-10 times averaged 89% and those taking it 11-46 times average 90% the instructor limited the quiz taking opportunities to a total of 2 times for the next year's class.

In the second year of the course, in a limited retake environment (two opportunities) 70% of the students retaking the quiz took it immediately after the first time while 30% of the students waited an average of three days before retaking it. On average, students who took the quizzes only one time scored 96% while those who took the quiz twice scored, on average, 76% the first time and 95% the second time. Further study needs to be done to determine whether taking the test the first time for repeat test takers was a study strategy of viewing the question types before taking the quiz the second time, if they were not prepared the first time, or if there were other reasons. The two-time limitation for online quiz taking appeared to meet the needs of students while not providing an environment for excessive retakes. This was deemed a more effective and efficient use of student time.

The final exam in the course was comprehensive and included questions on face-to-face lecture material (65%), and online lecture material (25%) with the remaining questions (10%) on case study/application scenarios. Overall, students performed 11% better on questions covering the online lecture material than on questions covering the face-to-face lecture material.

DISCUSSION

The topic of neuroanatomy and neurophysiology is a challenging one for most students and comments on the survey for this course reflect this view (see comments in Appendix). The descriptive statistics show that the students were split on the idea of going 100% online with 47% for it, 40% against it, and 12% unsure. In future courses additional factors need to be documented and considered such as comfort with technology and level of online skills as well as student concerns about learning the course material. While a formal survey of comfort with technology was not conducted in these courses, over the course of the semester students shared comments that indicated expertise level such as the student who was on speed dial for classmates as the "techie guru" or the student who, on the first day of class, was still awaiting the delivery of her first computer and had yet to obtain at home Internet access. In an online only format a technology competence screening for readiness would be necessary to ensure success.

Students gained access to the online portions of the course primarily during the evening hours, as expected for working individuals. Online assignments were completed during the week while written assignments were said to be completed on the weekends. The course objective ratings indicated that overall, information was conveyed effectively and received positively irrespective of format (in class or online). The online format, with quiz retakes and supplemental practice activities, compared to face-to-face lectures and in-class quizzes, students did 11% better on comprehensive final exam questions from online material than from in-class material, suggesting similar overall learning retention and comprehension.

The explosion of technology and Internet use in our culture has provided the means to expand educational opportunities and allow outreach to those who would normally have limited access. The push to make the sciences available to consumers includes neuroscience. Instructors of online neuroscience courses have a wealth of shared information available to enhance their courses, a few are mentioned here. Av-Ron and colleagues (2006) describe a program: Simulator for Neural Networks and Action Potentials, available for download, that is appropriate for teaching and research. Evert and colleagues (2005) present three computer-based neuroscience labs and, while not all are online, they have potential for inclusion in an online teaching format. Lane and Tang (2003) review a variety of resources for undergraduate neuroscience courses. Calibrated Peer Review, an assist for learning to write in the sciences, is yet another online resource neuroscience teachers can use (Prichard, 2005). The teaching posters at the annual Neuroscience conference have always provided new and exciting directions for this author.

Using the neuroscience resources available to enhance course experiences is only one part of the overall picture. The course design must facilitate learning in the online environment. Adult learning characteristics discussed in the introduction must be considered along with appropriate online instructional methods. Collaborative learning online enhances learning, in part, through ongoing availability of communication, allowing more students to participate, and requiring reflection during composition of messages (Locatis, 1999). Collaborative learning may be implemented through synchronous (real-time chats) or asynchronous (discussion board) communication. Problem

based learning through the use of case studies enhances student learning of neuroanatomy and in medical sciences through the application of textbook knowledge (Ullmer, 1999; Sheldon, 2000).

The dual format course design discussed here was successful as an approach for teaching working adult learners. Converting to an all online format appears to be feasible based on the success of the online lecture/quiz results and student feedback. Students suggested including additional case study and application types of activities in future classes; this is supported in the literature on use of collaborative and problem based learning online. To maximize student success in an online format the following may need to be considered: verifying adequacy of student technology skills, hardware and software available prior to enrollment; including small group real-time chats for increased student-instructor interaction; limiting test retake opportunities; including optional on-campus weekend days for interaction and problem solving; and limiting the size of PowerPoint presentations and movies or, providing a CD of pre-prepared lectures.

REFERENCES

Av-Ron E, Byrne JH, Baxter DA (2006) Teaching basic principles of neuroscience with computer simulations. J Undergrad Neurosci Ed 4:A40-A52.

Evert DL, Goodwin G, Stavnezer AJ (2005) Integration of computer technology into an introductory-level neuroscience laboratory. Teach Psychol 32:69-73.

Lambert KG (2005) The clinical neuroscience course: Viewing mental health from neurobiological perspectives. J Undergrad Neurosci Ed 3:A42-A52.

Lane DM, Tang Z (2003) An online multimedia resource in behavioral neuroscience. J Undergrad Neurosci Ed 1:A8-A15.

Locatis C (1999) Cooperative learning and distance education online. In: An online education sourcebook (Eldon E, ed) pp 20-32. Bethesda, MD: National Library of Medicine. (ERIC Document Reproduction Services No. ED453360).

Martin, JH. (2003) Neuroanatomy text and atlas. Stamford, CT: Appleton & Lange.

Mori M, Larson S (2006) Using biographies to illustrate the intrapersonal and interpersonal dynamics of science. J Undergrad Neurosci Ed 5:A1-A5.

National Science Board (2006) Science and Engineering Indicators 2006. National Science Foundation. Downloaded 07/22/07 from: www.nsf.gov/statistics/seind06/pdf/volume1.pdf.

Olivo RF (2003) An online lab manual for neurophysiology. J Undergrad Neurosci Ed 2:A16-A22.

Prichard JR (2005) Writing to learn: An evaluation of the calibrated peer review program in two neuroscience courses. J Undergrad Neurosci Ed 4:A34-A39.

Reid JC (1999) Adult learning. In: An online education sourcebook (Eldon E, ed) pp 6-13. Bethesda, MD: National Library of Medicine. (ERIC Document Reproduction Services No. ED453360).

Robles HJ (1998) Andragogy, the adult learner and faculty as learners (Report No. JC-990-071). Washington, DC: US Department of Education. (ERIC Document Reproduction Services No. ED426740).

Schon F, Hart P, Fernandez C (2002) Is clinical neurology really so difficult? J Neurol Neurosurg Psychiatry 72:557-559.

Sheldon JP (2000) A neuroanatomy teaching activity using case studies and collaboration. Teach Psychol 27:126-128.

Ullmer EJ (1999) Problem-based learning in the health sciences. In: An online education sourcebook (Eldon E, ed) pp 33-38. Bethesda, MD: National Library of Medicine. (ERIC Document Reproduction Services No. ED453360).

APPENDIX

Qualitative Study Responses

Responses typical of those in support of the all online format are as follow.

- *"I think that I would prefer to take this course 100% online… The online study tools are extremely helpful and the movies are really helpful too. It was helpful to review the movie several times."*
- *"I think that this might be helpful because similar to our online lectures we can go back and forth to write more detailed notes and listen to the material as much as needed. It might be a bit overwhelming since it is such a difficult subject to tackle so maybe more class discussions <boards online> could be added."*
- *"I think that would be a great idea. I love online courses and believe this one would be an adequate way to study this topic at the student's own pace."*
- *"If it is done well, fully online will work well… The actual footage of the professor lecturing is also helpful. If the student first prints out the lecture notes and then follows the lecture, it is very effective. Coupled with the Quia quiz prep games, it would be a good online course."*

Responses typical of those against the all online format included the following.

- *"The interaction between instructor and classmates has proven to be quite valuable at times. Some of the areas addressed are too intricate or detailed to be addressed via email, discussion boards etc."*
- *"Students need to have time with the instructor to ask questions or clear up any confusion regarding some of the information. The way the course is set up now is ideal."*
- *"Its helpful to hear a lecture and have them explained when we have a question about something."*
- *"I think there is too much information, for the class to be offered completely online."*
- *"As distance learners it seems like a good idea, but I'm not sure if I would have received as much from the course with it all online. However, I think it could be successful with in-class sessions interspersed throughout the semester."*

Typical responses concerning time management are below.

- *"<course instructor name> was considerate of our challenges, and modified her lesson plan for our greatest benefit."*
- *"… the Quia exams being added on which allow a little more time of processing information."*
- *"Thank you also for having such detailed, and complete syllabi - This is a courtesy that I hope all instructors in this Bridge program try to offer. I realize we are choosing to work full-time and travel major distances to attend this program, but having (and adhering to) due dates and expectations laid out at the beginning of the semester makes our lives much*

easier."

Responses regarding the learning environment and instructor-student interactions were typical of the following.

- *"I have enjoyed the patience of the instructor to be available for any misunderstandings of interpretations."*
- *"The instructor is well informed, flexible, and interactive. There isn't anything we brought forward that wasn't considered and discussed in detail."*
- *"I appreciated your respect for us as adults, professionals, and individuals. You allowed our personalities to be present. Thanks for being flexible and adaptable."*
- *"We all come from a broad range of backgrounds and experiences. We aren't straight out of high school. I think you recognized the difference in the bridge program versus other traditional programs."*

Received July 31, 2007; revised October 15, 2007 and October 21, 2007; accepted October 29, 2007.

The author thanks the students who went through the course for their patience, feedback, and most of all, their humor.

Address correspondence to: Dr. Rebecca I. Estes, Department of Occupational Therapy, 1504 Springhill Ave., University of South Alabama, Mobile, AL 36604. Email: riestes@usouthal.edu