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The Virtual Research Lab: Research Outcome Expectations, Research Knowledge, and the Graduate Student Experience

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This paper examines the complexities of working with student researchers in a virtual lab setting, logistics, and methods to resolve issues. To demonstrate the feasibility of a virtual lab, a mixed-methods study consisting of quantitative surveys and qualitative data examined changes in doctoral students' confidence as measured by research outcome expectations and changes in a self-assessment of research knowledge and skills test in a 3-quarter virtual psychology research lab. In the lab, 10 doctoral students conducted a faculty-designed project, analyzed data, and cowrote a literature review. Findings indicate lab students' research knowledge and research outcome expectations improved significantly over nonlab comparison students. Student journals provided qualitative evidence of the student experience in a virtual research lab. Students reported individual growth, self-learning, and appreciation of the shared group experience with a common goal. Students related that the application of skills learned in classes to a research setting was more difficult than anticipated.

Keywords: *graduate students, online lab, student research*

Introduction

A key element of graduate training in the social sciences is in-depth intellectual mentoring, particularly through research training. Research mentoring benefits students through the development of professional skills, increased confidence and self-efficacy (Love, Bahner, Jones, & Nilsson, 2007), dissertation success, reported satisfaction of the doctoral program in which the student was enrolled (Clark, Harden, & Johnson, 2000), and improved career potential (Demaray, Carlson, & Hodgson, 2003).

In contrast to undergraduate education, where learning occurs primarily in the classroom, the production of scholars at the graduate level occurs primarily through the process of mentoring (Forehand, 2008). There has been concern as to the ability of faculty to mentor students in an online environment (Belar, 2006) for the same reasons online faculty have had difficulty in conducting research: a lack of laboratories and student opportunities to assist in research. Currently, there is little opportunity for students to assist in faculty research projects online, due to the difficulty in conducting research with students in a virtual environment. Of particular concern to potential faculty supervisors is the ability to supervise lab students, maintain data confidentiality, and

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maintain the integrity of the study protocol. There is a paucity of research or information regarding how to do research with student researchers in an online research setting, which deprives online faculty of an understanding as to how to conduct such a research project and provide students with an experience equivalent to that in a land-based program.

In a land-based lab, students gain exposure to a positive research-training environment, faculty modeling of research skills and enthusiasm for the research process, and the social experience of working with others (Love et al., 2007). These factors have been reported to increase student research self-efficacy and lead to higher research productivity (Hollingsworth & Fassinger, 2002; Phillips & Russell, 1994). The land-based academic research training environment has been found to predict research outcome expectations (Bishop & Bieschke, 1998; Kahn, 2001) and research investigative interests (Bishop & Bieschke, 1998; Kahn, 2001).

It is not known, however, if a virtual lab can provide the research skills and research interest as seen in a land-based lab. In an attempt to examine this issue, the current study recruited 10 doctoral psychology students at an online university to participate in a 3-quarter virtual lab, in which they assisted in a faculty-designed research project. A comparison group of students was matched with the lab students based upon milestones in program progress (e.g., completion of all required courses). A measure of confidence in the development of research skills (measured with Bieschke and Bishop's [1994] Research Outcome Expectations scale), and a researcher designed research knowledge and skills self-assessment examined the students' experience, as well as weekly journals from the 3 quarters in the lab. In order to place the current virtual lab study into context, a brief history of labs in academia will be examined, as well as what is known about virtual research labs.

Laboratories in Academia

The use of seminar laboratories in an academic environment began in the 19th century (McNeely, 2009) and developed into an apprenticeship-type method to train students in conducting research. By the early 1900s, laboratories moved from being a domain of the natural sciences to being used by the social sciences whereby education, psychology, and public health began to be studied in an experimental setting. The 1940s through 1960s were a period of growth in higher education and resulted in a subsequent increase in research due to the increased funding for student tuition available through the Servicemen's Readjustment Act of 1944 (also known as the G.I. Bill of Rights; Walker, Golde, Jones, Bueschel, & Hutchings, 2008). During the 1960s, an increase in college enrollment from the Baby Boomers combined with an increase in federal research dollars resulted in a link between faculty research agendas and graduate student training in research. Graduate faculty teaching loads were reduced, allowing more time for laboratory research in the sciences, social sciences, and humanities (Walker et al., 2008).

Today, the laboratory is considered essential to many social science disciplines as an environment to study aspects of human behavior and as a mechanism to train students in the application of skills learned in the classroom. Typically, the laboratory serves a dual role from the faculty perspective: (a) it is a way to collect the data necessary to publish and to secure employment as a professor in the university and to be recognized as an expert in the field of study, and (b) it is a way to mentor students through the steps of a research project and teach them the skills necessary to conduct their own projects for their thesis and dissertation work and to become professionals in the field. An added benefit for many students is the potential for being coauthors on professional journal articles, which today is becoming a requirement for beginning faculty positions at research universities.

Depending upon the institution, some research mentoring may be done on an undergraduate level, often just with honor students. Research mentoring is expected to occur on the graduate level, and the importance of research mentoring in graduate education has long been a concern. Before the 1960s, a research-focused model leading to the Ph.D. was typical (Ellis, 1992; Roe, Gustad, & Moore, 1959). During this time, students were trained to teach and do research with the expectation that they would enter into academic positions (Altman, 1990; Ellis, 1992). In the 1960s, as more applied career options became available across disciplines, the traditional model began to be questioned (Ellis, 1992). The issue of research mentoring remains contentious, particularly for applied disciplines (Gelso, 1993, 2006); however, in programs leading to a Ph.D., research mentoring appears to be an inevitable need.

Moving Academia Online

Distance education derives from correspondence courses, first initiated in 1852 (Casey, 2008). The first course was the Pitman Shorthand training program that brought innovative stenographic practices to the United States. Using the United States Postal Service, self-taught secretaries would mail their exercises to the Phonographic Institute in Cincinnati, Ohio, and after completing the required coursework, received a certificate of expertise in stenographic shorthand skills (Casey, 2008; Matthews, 1999). With the advent of the computer, online programs were first developed in 1993 at Jones International University in Boulder, Colorado. The university provided instruction in five bachelor's degrees and 24 master's degree programs and was the first fully online university to be accredited by the Higher Learning Commission (Casey, 2008).

The essential characteristic of distance learning programs is that students and instructors are geographically dispersed (Murphy, Levant, Hall, & Glueckauf, 2007). Students and instructors may be not only anywhere in the United States, but also throughout the world. With the advent of the Internet, distance learning programs can incorporate video, email, and various classroom software (e.g., Blackboard, eCampus), as well as telephone communication and in-person meetings.

Today, distance learning has become a ubiquitous entity: more than 6 million students participated in at least one online course in the fall of 2010, an increase of more than half a million students over the previous year (Allen & Seaman, 2011). Between fall 2007 and fall 2008, the online enrollment growth rate increased 12%, while the overall higher education enrollment growth rates increased only 1.2% (Allen & Seaman, 2008).

Virtual Labs

There is very little literature on virtual or online research laboratories in graduate education, with existing research typically discussing the use of shared remote equipment. For example, González-Castaño and colleagues (2001) designed an Internet access laboratory that provided remote access to equipment used in a computer architecture laboratory. There were no descriptions of methodological-based virtual research labs in the literature until Stadtlander and Giles (2010), however.

Stadtlander and Giles (2010) discussed a virtual qualitative-method lab in psychology in which students assisted in collecting data from 35 elderly participants across the United States. Each of the seven graduate students in the lab conducted 3-hour interviews with their participants. Weekly student journals indicated that the students enjoyed the lab and felt they learned a great deal about the research process through the experience; however, the authors expressed concern as to whether the students had gained competence, research knowledge, and skills beyond their regular program of study.

There is a body of literature on collaboratories, e-Science, and cyberinfrastructure that relates to the current conception of the virtual lab. A collaboratory has been defined as "center(s) without walls in which researchers can work together regardless of physical location" (Wulf, 1993, p. 854). This concept has been used by professional researchers in a number of ways, such as email or a virtual space in which they collaborate on projects, generally in the physical or biological sciences and engineering. The terms e-Science (used in Europe) and cyberstructure (seen in the United States; Atkins et al., 2003) were developed to refer to the same or related ideas as the word collaboratories, but generally on a larger scale (Olson, Bos, & Zimmerman, 2008). They are all structured, however, to be collaborative spaces for professional or faculty researchers—not as a means to educate students in the research process, which is the basis for the current virtual lab.

The Lab: Virtual Versus Land-Based

The virtual lab environment offers challenges not present in a land-based lab. In a land-based lab, students have the advantage of being more closely supervised than is possible online. It is imperative that students working in a virtual lab be trained sufficiently so that they can handle any issues that arise independently. This means that they must have a good understanding of the methodology and have carefully considered a plan of action for problems. For example, the present project examined people in the oldest-old age group (over 85). Students must be prepared for issues that may arise, such as evidence of elder abuse and suspected dementia, which excludes the individual from inclusion in the study, as well as how to address issues with staff in facilities. In a virtual lab, students are often more coresearchers than in a land-based lab.

An additional difference between a virtual versus land-based lab is the issue of data ownership and security. In a land-based lab, it is relatively easy for the faculty to maintain control of the data and to provide security by locking the lab computer or door to the physical lab. Online, the students have continued access to the data that they have collected (and perhaps other students' data). It must be clearly and repeatedly stated who has ownership of the data and what, if anything, the students can do with the data independently.

Another element is training the students in the research protocol, which tends to be more complex online than in an in-person environment. In the current project's study, students were trained to conduct interviews. Training consisted of readings, an example interview between instructors, and three recorded practice interviews with pilot subjects. All student contact with pilot and study participants was recorded and reviewed by the faculty.

A security plan also must be in place to make sure that the confidentiality of the study participants is not violated. In the authors' virtual lab, students were required to send all data, including recording files through an encrypted website (YouSendIt.com). Students purchased a flash drive and maintained all data on the drive with password protection on the files.

Research Outcome Expectations

Research outcome expectations have been identified as accounting for more variance in students' research interests than any other significant variable, including research self-efficacy beliefs (Bard, Bieschke, Herbert, & Eberz, 2000; Bishop & Bieschke, 1998), the research training environment (Bishop & Bieschke, 1998; Kahn, 2001), investigative interests (Kahn, 2001), and age (Bishop & Bieschke, 1998). Kahn has speculated that students may be unable to discriminate between their interest in research and their expectations about the outcomes that may result from engaging in research activities. In the present study, the Research Outcome Expectations Questionnaire

(Bieschke & Bishop, 1994) was used as a measure of student researchers' confidence in the development of research competencies.

Research Knowledge and Skills

Bieschke (2006; also see Gelso & Lent, 2000; Heppner, Kivlighan, & Wampold, 1999) stressed the importance of examining actual competence as a researcher. Focusing on the precursors (e.g., interest in research) or the outcomes of competencies (e.g., research productivity) rather than the competencies themselves seems to overlook a valuable aspect of research training; however, there are no measures available in the literature for examining student research competencies. A measure of research knowledge and skills was developed by the researchers (see Appendix). The 34 items in the measure were selected from learning outcomes in two research methods and two statistics classes that all students were required to have taken in order to be in the study. Next, the measure was piloted with 11 dissertation students, the students' dissertation advisors were interviewed as to their qualitative assessments of the students' skill levels in each area, and the results were compared. The present study allowed the measure to be piloted over a 3-quarter period to examine reliability over time (reliability statistics will be presented in the Method section). Lab students who participated in the project for 3 quarters were matched with comparison students who continued in their program study without the lab. Both groups of students took the same measures at the same four points in time.

There were four main research questions in the current study:

1. Is there a difference in lab students' confidence in the development of research competency (as measure by the Research Outcome Expectations Questionnaire [Bieschke & Bishop, 1994]) over the 3 quarters of the virtual lab as compared to a group of matched comparison students?
2. Is the researcher-designed student self-assessment of research knowledge and skills a reliable measure?
3. Is there a difference in lab students' self-assessed research knowledge and skills over the 3 quarters of the virtual lab as compared to a group of matched comparison students?
4. How do the lab students qualitatively experience the 3 quarters of the virtual lab?

The Lab Course and the Current Study

In 2011, the first author received a grant from Walden University to conduct a mixed-methods study (consisting of quantitative surveys and qualitative interviews) on the current health experiences of people over 85 years (the oldest-old). In order to have the opportunity to gain elderly participants from across the United States, allow student participation, and be able to study students working in a virtual lab, the authors developed a virtual laboratory. eCollege software provided the framework, which allowed for asynchronous discussions and the ability to post information, such as downloaded Word files. Three faculty members supervised the project; all of them responded in the class and participated in twice-monthly lab meetings with the students. The course, Independent Research, was an elective course available to doctoral students in the clinical, health, or general psychology specialties.

Walden University student listservs posted the availability of the project, with interested students completing applications. Twenty-nine individuals submitted an application, which were then sorted by area of the country and priority was given to those students who had completed research methods courses and had an interest in gerontology. This resulted in 10 students selected and registered in the course. Ten additional psychology students were chosen from the qualified applicants (matched with lab students to be at similar milestone in their doctoral program, e.g., writing dissertation) to be comparisons for the study.

Students were asked to commit to working on the project for 3 quarters (9 months) and lab students agreed to each conduct four 1-hour interviews (not all students were able to recruit the four participants) and administer quantitative surveys. All lab and comparison students took the Research Outcome Expectations Questionnaire and Research Knowledge and Skills Self-Assessment at the beginning of the project and at the end of each quarter to evaluate learning and research expectations over the entire 3-quarter period. Lab students also submitted a brief reflection journal each week, discussing their impressions and opinions on the virtual lab experience.

The mixed-methods project that the students worked on during the 3-quarter lab was a continuation of Stadtlander and Giles' (2008) qualitative study on the elderly. The study examined oldest-old participants' interaction with their physicians through quantitative measures and an interview. The students conducted a 1-hour qualitative interview with each of their participants in which the elderly individuals examined their thoughts and opinions on their healthcare and physicians. The quantitative portion included a number of survey instruments to examine participants' current health, healthcare history and health efficacy.

Prior to the first quarter, all lab students received an Olympus digital voice recorder, purchased through the grant. The instructors developed and tested interview questions in focus groups and selected quantitative measures for the study that the students would conduct. The instructors developed consent forms, demographic questions, and scripts for contacting participants, which were all sent to the students. They also submitted an application to Walden University's Institutional Review Board for both the present study on lab versus comparison students and the study that the students conducted.

During the first quarter, lab students were trained on the methodology and protocol, and each student conducted interviews and surveys with four elderly individuals. During the second quarter, students read articles and texts on mixed-methods analyses and conducted both quantitative and qualitative analyses on the collected data. In the third quarter, students had readings on technical writing and jointly wrote a literature review on the project.

Students and instructors participated in lab meetings every two weeks during the 3 quarters using GoToMeeting software. During the meetings, the instructors provided additional training, answered questions, and clarified procedures. The instructors recorded the meetings and posted the recordings in the classroom for later review, as needed.

Method

Participant Demographics

Student applicants were recruited through Walden student listservs, and were asked to complete an application. Ten qualified psychology students were chosen as lab students based upon an interest in gerontology and their geographical location to ensure a nationally representative sample for the primary elderly study. The students age ranged from 35 to 67 years, $M = 49.2$ years; all were female, eight self-described as Caucasian, one biracial, and one as African American.

A possible confound in the study was that students may increase their research knowledge and research confidence through their education without the lab opportunity; therefore, a comparison group was used. Ten additional psychology students were chosen from the qualified applicants (matched with lab students to be at a similar milestone in their doctoral program, e.g., writing dissertation) to be comparisons for the study. Their age ranged from 40 to 67, $M = 49.2$ years; nine were female and one male, seven self-described as Caucasian, one Middle Eastern, and one as African American.

All 20 students (10 lab students and 10 comparisons) had taken at least two previous graduate-level research methods and two statistics courses. All participants took the two measures at the same four times: at the beginning of the project and at the end of each of the subsequent 3 quarters. The comparison students received a $50 gift card to Amazon.com in appreciation for their participation. Lab students participated in a virtual classroom in which they received mentoring and had twice-monthly conference calls with the instructors. Comparison students received an email at the end of each quarter to complete the survey measures.

Quantitative Measures

The Research Outcome Expectations Questionnaire was used (Bieschke, 2006; Bieschke, 2000; Bieschke & Bishop, 1994). This scale consists of 17 items reflecting both professional and personal positive outcomes (e.g., "My involvement in research will lead to meaningful contributions to the field") and one item reflecting negative outcomes (e.g., "Involvement in research will take time away from leisure activities") that might result from participation in research activities. Participants are instructed to indicate their degree of agreement with each statement using a 5-point Likert-type scale ranging from 1 *(strongly disagree)* to 5 *(strongly agree).* Reliability data have revealed good internal consistency with the scale, with coefficient alphas of 0.89 (Bieschke & Bishop, 1994; 1995) and 0.90 (Bieschke, Bishop, & Herbert, 1995). In the present study, internal consistency estimates using coefficient alpha was 0.82 for the pretest, 0.83 at the end of quarter 1, 0.84 at the end of quarter 2, and 0.80 at the end of quarter 3.

A Research Knowledge and Skills Self-Assessment measure was developed and piloted in the current study by the authors; the measure consisted of 34 research skills necessary in the study. The skills were selected from learning outcomes in two research methods and two statistics classes that all students were required to have taken in order to be in the study. Example skills included, "Identify gaps and patterns in existing research and generate researchable ideas" and "State the legal and ethical considerations associated with qualitative research." Participants rated their competence with each skill using a 5-point Likert scale ranging from 1 *(I do not feel strong in this area – beginner level)* to 5 *(I feel I am extremely strong in this area – expert level*). In the present study, internal consistency estimates using coefficient alpha shown to be reliable: 0.92 for the pretest and 0.97 at the end of the next three measurement periods. In order to examine the measure's stability over time (i.e., test-retest reliability), three sets of time-related (T1–T4) correlations were conducted. Three proximal test-retest correlations (T1 with T2 [$r = .88$, $p < .01$], T2 with T3 [$r = .71$, $p < .01$], T3 with T4 [$r = .80$, $p < .01$]), two intermediate (T1 with T3 [$r = .50$, $p < .05$], T2 with T4 [$r = .46$, $p = .056$]), and one distal (T1 with T4 [$r = .29$, $p > .05$]) were conducted. These findings suggest that the measure is stable proximally at a 3-month period, somewhat stable at a 6-month period, and does not show stability over a 9-month period.

Qualitative Data

In order to understand the virtual lab students' shared experience regarding the learning and skill development in the virtual lab, students wrote a one-page journal entry and submitted it weekly. In this assignment, they received the following instructions:

> Talk about how you are feeling about the training you are being given. Does it feel like enough training in its relevance to the project? How do you feel about the doing the project, and do you feel like there enough supervision? Do you have ideas on how things could be improved?

There was variation in how students approached journaling—some were insightful and self-revealing while others tended to recite statements that the individual had shared with the lab earlier in the week through discussions. Not all students were timely in submitting the journals; late journals were not used in the qualitative analysis. This qualitative data was examined to find themes that clarified the learning experience from the student perspective. Identified themes further examined how students' learning and skill development progressed from a personal perspective.

Analyses

In order to qualitatively analyze the lab students' journals, week 6 and 12 journals were examined for each of the three terms. Only journal entries that addressed at least one of the following topics were included: comments on the study, personal insights/thoughts, and comments on group interaction. No late assignments were used. Some students reflected on personal issues in their lives; these were not included in the analysis. The responses were coded and themes explored.

Ethical Issues

Both the students' elderly project and the current lab study received Walden University Institutional Review Board approval (approval #03-09-11-0784474). All students signed informed consent forms before they committed to participate in the study, as did individuals in the elderly study. The transcriptionist and student researchers signed confidentiality agreements.

Results

Quantitative Data

For the Research Knowledge and Skills Self-Assessment, a repeated-measures ANOVA was conducted for the total score for each of the four time periods. As shown in Table 1, there was a significant main effect of time ($F[1, 14] = 20.06$, $p < .001$), thus, the overall means for each of the four time periods were significantly different. Post-hoc t-tests indicated the pretest differed from all later tests ($p < .01$); the end of quarter 1 test differed from the two later tests ($p < .01$). There was not a main effect of condition ($p > .05$).

Table 1: *Research Knowledge Test Scores for Lab and Comparison Students (*SE *in Parentheses)*

	Pretest	End Quarter 1	End Quarter 2	End Quarter 3	Means
Lab group	91.3 (6.9)	104.9 (6.7)	132.1 (7.6)	137.4 (6.1)	116.4
Comparison group	119.4 (6.9)	123.8 (6.5)	125.1 (8.1)	124.6 (9.3)	123.2
Means	105.3	114.3	128.6	131.0	

As shown in Figure 1, there was an interaction effect ($F[1, 14] = 13.25$, $p < .01$), whereby the lab group showed a greater knowledge gain over the four periods as compared to the comparison group.

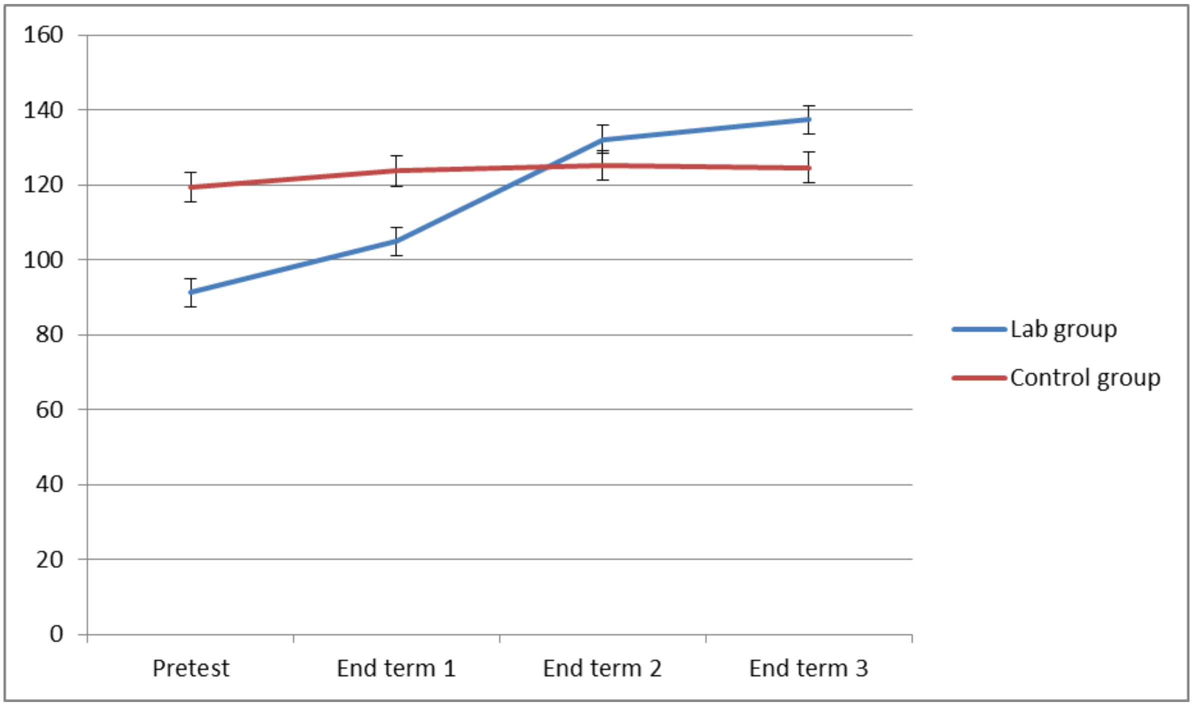

Figure 1: *Research Knowledge Test Scores Interaction Effect for Lab and Comparison Students*

For the Research Outcome Expectations Questionnaire, a repeated measures ANOVA was conducted for the total score across all four time periods. As shown in Table 2, there was a significant main effect of time ($F[1, 14] = 10.2$, $p < .01$), thus the overall means for each of the four time periods were significantly different. Post hoc *t*-tests indicated that the pretest differed from the test at the end of quarter 2 and quarter 3 ($p < .05$); the test at the end of quarter 1 differed from the tests at the end of terms 2 and 3 ($p < .05$). There was also an effect of condition ($F[1, 14] = 6.3$, $p < .05$) in which the overall mean for the lab students was higher than the comparison group. There was no interaction effect ($p > .10$).

Table 2: *Research Outcome Expectations Questionnaire Scores for Lab and Comparison Students (*SE *in Parentheses)*

	Pretest	End Quarter 1	End Quarter 2	End Quarter 3	Means
Lab group	71.3 (1.6)	73.6 (1.6)	76.38 (1.2)	76.88 (1.2)	73.78
Comparison group	69.1 (1.9)	69.4 (1.9)	68.63 (1.8)	70.25 (1.1)	68.47
Means	68.4	70.1	72.5	73.6	

There was no relationship between scores on the Research Outcomes Expectations Questionnaire and the Research Knowledge and Skills Self-Assessment at any of the four testing times (*p*s > .05). This suggests that the two measures examined different elements of the research process.

Qualitative Data

The qualitative data was coded and analyzed for both overarching themes and themes that tied directly to the specific focus of the virtual lab in each of the three terms. The themes that emerged emphasized aspects beyond those measured by the quantitative measures that affected the student experience. The themes clarified the personal aspects that most influenced the students' development of Research Outcome Expectations Questionnaire and knowledge.

Overarching Themes (Themes Over Three Terms)

Students identified their individual growth and self-learning, especially of their own self-limitations. They realized that they did not know how to apply concepts and skills they had previously learned in other courses. Students further identified that they were not only able to identify problems within their skill sets, but were able to develop plans to solve these problems.

> I suppose that the learning that occurs in the [other] classes is more on a knowledge base and increasing that base. The exposure I have had through the project is on a number of different levels. The actual immersion in the process, completing portions of the process and then putting the portions together encompasses other levels. (Student D)

The final overarching theme seen was the student appreciation of group connectedness.

Quarter 1 Themes

During this phase of the project, students learned how to interview, contact subjects, administer informed consent, collect data, and many other tasks involved in data collection. The themes that emerged from the journals during this phase related to the learning process. The students reflected on learning new skills, gaining knowledge about the elements involved in research, and gaining a clearer understanding of the reality of conducting a research project. In terms of the reality of research, the themes that emerged were time management, flexibility, the need for group support, and the appreciation of the shared experiences. Throughout this quarter, the students reflected excitement, confidence, and expanding and learning new skills. "This journey continues to prompt me to learn about myself and the experiences I have. I continue to expand my levels of knowledge." (Student D)

Quarter 2 Themes

The second quarter was designed to be primarily analysis of the data collected in the first quarter. Themes that emerged from student journals again focused around learning. There was an awareness of a lack of knowledge, but also an enjoyment of the research process. Students identified the mental challenge of this phase, but also reflected on the development and application of new skills, decision-making, and accomplishment.

> I will honestly say that before this point, I had not really thought a lot about the interview answers that some of my participants provided. Going back and transcribing them made me really think about the answers and what they had in common. (Student C)

A final theme that emerged during this phase of the project was the group learning process and the need and appreciation of regular conference calls with the entire lab.

Quarter 3 Themes

The final quarter of the virtual lab was designed to have students do a complete literature review on the project, and begin a journal quality write up of the research. Again, learning was a strong theme throughout the student experience. Throughout the theme of learning, the areas identified varied. Students identified, as in previous terms, that they learned skills (e.g., writing, APA format, literature searches) but also identified learning in terms of the self: attempting perfection, reducing anxiety, learning to ask questions, assisting in the dissertation process. They also became more focused on themes regarding an appreciation for the elderly, an awareness of the elderly, and a clearer understanding of issues facing the oldest-old. The students also identified the need and appreciation of regular conference calls again in this quarter. It was in this quarter that the theme of flexibility reemerged but was linked with a theme of fatigue in the process.

> I would like to think that my awareness of issues experienced by those 85 and older has increased. I find myself more conscious of those individuals I encounter on a daily basis. I feel that I have been able to increase this awareness in others as well. (Student D)

> My steam is beginning to run out, which is starting to be reflective in my work quality. I have to get over that and keep moving :>). (Student E)

The themes that emerged over the three terms appeared to indicate that although much of the learning was skill-based, learning was equally valued by the students in terms of the application of knowledge that had been gained previously in the classroom to a real research project. It was also clear that peer support and group communication enhanced learning.

Discussion

Involvement in the virtual lab significantly improved the students' research knowledge and skills and student researchers' confidence in the development of research competencies (as measured by the Research Outcome Expectations Questionnaire [Bieschke & Bishop, 1994]) over comparison students matched to be at the same points in their doctoral program. These findings are consistent with previous research in land-based labs (e.g., Bard et al., 2000; Bishop & Brieschke, 1998).

There has not previously been a measure of student researchers' knowledge and skills available. The current pilot of this measure suggests that the survey appears to be reliable and stable up to a 6-month period; it appears that it may be worth further exploration and validation with a larger sample. While the increase in lab students' research knowledge may appear to demonstrate simply an advantage of having additional experiences, it is also important to note that such applied research experience has been lacking in online graduate education. The comparison students participated in the normal graduate program and subsequently lacked the gain in confidence and knowledge that was seen in the lab students, thus demonstrating the advantage of having online students participate in an applied research project.

Students showed individual growth and self-learning. Many reported appreciating the shared experience of working and learning in a group with a common goal. Repeatedly, students reported that while they had studied and applied concepts and skills in a classroom setting, the application of those skills in a research setting was more complex. For example, everyone had taken statistics courses, but the application with a real data set was more difficult than expected for the students.

This study has demonstrated that it is possible for online faculty to provide research experience to students in a virtual environment that is comparable to that in a land-based setting. A measure of student research knowledge and skills was piloted and appears to be reliable over time; further validation of the measure is warranted. There are a number of logistical issues that faculty must address in an online research environment with student researchers; a summary of these issues is provided for faculty who may wish to develop their own virtual lab.

Logistical Issues

There are challenges specific to teaching a virtual lab. For example, training students with methodology is a challenge; monitoring their protocol compliance requires extensive communication and considerable trial and error. Each student's skills need to be evaluated and remediated online. Similar to land-based labs, personality issues can arise between students and between student and faculty, which must be carefully and judiciously handled with the added complication of the online environment.

The lab used a stripped course shell, which required that the instructor(s) develop their own syllabus and set up the course and grade book. We have found that having multiple instructors (there were three in the current project) is essential, particularly when reviewing recordings for a qualitative, mixed-methods project. We designated an individual faculty member to be in charge of each aspect of the project (e.g., monitoring ethical compliance, maintaining data and analyses), and all faculty members participated in the classroom instruction; one person was designated to assign grades. Faculty members need administration support through course buyout, workload adjustments, and tech support. We have found that supportive technology is useful, such as in using GoToMeeting software, maintaining a blog, and using YouSendIt.com for large data and recording files.

It is important to be clear to students on expectations, ownership of data, and potential author status on papers (we included this information in the student application and in the syllabi). Instructors should be mentors to the lab students by having regular lab meetings, assessing students' skills, and providing necessary training. It is also important for instructors to be flexible in both their own and students' expectations and be mindful of group dynamics: strong student personalities may have a negative impact on the research and class interactions.

We have demonstrated that faculty mentoring in a virtual lab environment effectively improves student research knowledge and skills and increases student research confidence while providing faculty the opportunity to collect national data in a short time period. The logistics of such a lab can be daunting, but the opportunities provided for the faculty and students are worth the difficulties.

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Appendix

Research Knowledge Questionnaire

There are no right answers on this questionnaire; it is simply a mechanism for us to look at areas that we might help you. Please try to *accurately* assess your own ability on each of the following items on a scale of 1 (*I do not feel strong in this area – beginner level*) to 5 (*I feel I am extremely strong in this area – expert level*). You can **bold** your answer or change the font to a different color, if you wish.

	I **do not feel strong** in this area (beginner)	I feel I have **little strength** in this area	I have **marginal or borderline strength** in this area	I feel I am **reasonably strong** in this area	I feel I am **extremely strong** in this area (expert)
Obtain certification in Protection of Human Research Subjects (NIH)	1	2	3	4	5
Anticipate ethical concerns related to conducting research with human participants	1	2	3	4	5
Begin a literature review for an area of interest	1	2	3	4	5
Analyze, evaluate, and synthesize research articles	1	2	3	4	5
Identify gaps and patterns in existing research and generate researchable ideas	1	2	3	4	5
Differentiate between types of research approaches and understand the rationale of each approach	1	2	3	4	5
Understand the strengths and limitations of different research approaches/methods	1	2	3	4	5
Assess the strengths and limitations of quantitative research designs	1	2	3	4	5
Choose the appropriate population and sample for a	1	2	3	4	5

research design					
Critically evaluate qualitative research methods	1	2	3	4	5
State the legal and ethical considerations associated with qualitative research	1	2	3	4	5
Prepare for and perform observations and interview	1	2	3	4	5
Assess the roles of bias, context, and the researcher in qualitative research	1	2	3	4	5
Describe and discuss the paradigmatic, methodological, analytical, inferential, pragmatic, legal, ethical, sociopolitical, and cultural issues related to the application of mixed-methods research in psychology	1	2	3	4	5
Describe the application of mixed methods to design; data collection, analysis, and interpretation; and preparation and dissemination of research findings	1	2	3	4	5
Discuss issues and describe strategies related to establishing data quality (validity, trustworthiness) of mixed-methods research findings	1	2	3	4	5
Critically evaluate mixed-methods research studies	1	2	3	4	5
Produce graphical displays used in descriptive data analysis and explain characteristics of data in terms of central tendency, variability, and symmetry	1	2	3	4	5
Explain the assumptions required for parametric	1	2	3	4	5

hypothesis testing and transform a research question involving two variables into an appropriate null and alternative hypothesis					
Compute the value, level of statistical significance, and confidence interval around a test statistic (including *t* statistic, *z*-score, correlation coefficient, *F*-ratio, and the chi-square statistic) and interpret the results of statistical tests	1	2	3	4	5
Understand the assumptions and limitations of nonparametric statistical tests	1	2	3	4	5
Understand statistical concepts and tests and apply them to real-world situations	1	2	3	4	5
Use SPSS to compute statistical values and perform statistical tests	1	2	3	4	5
Use and interpret outputs from SPSS	1	2	3	4	5
Use SPSS software package to perform a variety of descriptive and inferential statistical analyses and to interpret their results	1	2	3	4	5
Design, test, and interpret single-factor, factorial, and repeated-measures ANOVA designs with interaction terms	1	2	3	4	5
Perform appropriate follow-up tests to test for individual level differences within a statistically significant ANOVA	1	2	3	4	5
Compute post-hoc statistical	1	2	3	4	5

power based on SPSS output					
Design, test, and interpret correlational problems	1	2	3	4	5
Perform statistical and visual data screening and cleaning	1	2	3	4	5
Understand the ways that missing data can be handled and the limitations associated with these methods	1	2	3	4	5
Multivariate analysis of variance and covariance (MANOVA / MANCOVA)	1	2	3	4	5
Be able to match statistical questions with specific multivariate techniques and identify strengths and limitations of specific analyses	1	2	3	4	5
Use SPSS and theory to screen data and prepare it for analysis to include assessing assumptions of normality, use of procedures that account for missing data, presence of outliers, and linearity	1	2	3	4	5

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