HOW ONLINE STUDENTS DESCRIBE THEIR PHYSICAL LEARNING ENVIRONMENT

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A descriptive case study with multiple data collection methods was carried out to understand how online graduate students identify the characteristics of their physical learning environment. Equivalency theory and the science of ergonomics framed the study. Participants were 10 online graduate students, all working adults (60% female, most between ages 45 and 64), at a single university. Data were collected via an online questionnaire, telephone interviews, and photographs. Findings showed that home was the primary location participants spent the majority of their time working on specific learning and research activities. Most used overhead lighting, preferred temperatures between 68 and 74°F, sat in chairs at desks, and heard many types of noise. The majority used laptops with Wi-Fi as Internet connection. The most difficult elements to manage were family responsibilities, inadequate workspace, and inappropriate equipment. Participants overcame those challenges with various innovations. Findings also showed that no participants received university information to help design their learning environments for maximum effectiveness.

Physical space affects individual thoughts, emotions, and behavior. Studies have identified a relationship between the physical work environment and job performance and satisfaction (Dul et al., 2012; Sundstrom & Sundstrom, 1986; Vischer, 2007), and between characteristics of the work place and employee reactions (Oldham & Rotchford, 1983). Physical space is also known to significantly affect student learning; studies have shown a relationship with school design and student outcomes (e.g., Earthman, 2004; Higgins, Hall, Wall, Woolner, & McCaughey, 2005; Hunley & Schaller, 2009; Tanner, 2008).

According to Lippman (2010), the spatial design of the learning environment in American education is specifically structured around the traditional classroom. However, with the paradigm shift in education to online learning, the physical learning space has also shifted from the brick-and-mortar classroom to one outside of classrooms. Nonetheless, relatively little attention has been given to identification of the characteristics of the physical spaces in

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which online students conduct their learning activities.

Distance education and the advent of mobile technologies have changed the physical learning space to anywhere at any time. Herman Miller Inc. (2009) recognized the importance of learning spaces and comfortable surroundings and pointed out that comfort depends on optimal temperature, lighting, and furniture. Yet, colleges and universities seldom provide online students with suggestions for choosing an adequate workspace conducive to learning.

The purpose of this study was to understand how online students identify the characteristics of their physical learning environment, specifically graduate students in an online doctoral program. The equivalency theory (Simonson, 1995) and the science of ergonomics (Grayson, 2009; Legg, 2007; McVey, 2001) framed the study. Three elements of the equivalency theory—learning experience, appropriate application, and students—were used as the framework to organize ideas and describe the characteristics of the physical learning environment of the participants. The science of ergonomics was used to help understand functioning values of the physical learning environment.

Because the physical learning space of online learning can be anywhere at any time as a result of the use of digital technology, it was considered useful to identify the learning experiences and appropriate applications of the equivalency theory to observe characteristics of the physical learning environment of online students. Four research questions guided the study:

1. Where do online graduate students spend the majority of their time working on specific learning and research activities, such as completing assignments, projects, and examinations; participating in discussion forums; and conducting Internet research?
2. How do online graduate students describe their physical learning environment in terms of light, temperature, furniture, and noise?
3. What equipment, such as hardware and networking capabilities, do online graduate students use to complete their learning and research activities?
4. What elements of the physical learning environment (light, temperature, furniture, and noise) do online graduate students find most difficult to manage while learning online, and how do they overcome the challenges of these environmental factors?

A descriptive case study was carried out. Three stages were completed to collect quantitative and qualitative data to answer the research questions. Data were collected via an online questionnaire, telephone interviews, and photographs. Participants described the location and work area in which they conducted their learning, as well as the types of equipment used to complete their learning activities. The elements of the participants' physical learning environment were examined to help identify the look, feel, and sound in terms of light, temperature, furniture and noise. Challenging elements to the participants and what they did to overcome them were also examined.

It was anticipated that results of this study would provide information to determine gaps between the elements of the physical learning environment of online students and the recommended guidelines in the literature. Findings would also help online students identify the challenges they must overcome in their physical learning environments, and would provide information for institutions to formulate guidelines for online students to help them increase their awareness of the most beneficial physical learning environment. Such set of guidelines would also be useful to help students select or change their learning environment to one that better suits their needs with attention to light, temperature, furniture, and noise.

REVIEW OF THE LITERATURE

In traditional campus learning, the formal learning space has been described as a place where "space and pedagogy are undeniably intertwined" (Hunley & Schaller, 2009, p. 34). Studies have shown that (a) relationships exist between the conditions of school buildings and student achievement (Earthman, 2004); (b) basic physical variables such as air quality, temperature, and noise affect learning (Higgins et al., 2005); (c) learning spaces encourage or constrain behavior (Hunley & Schaller, 2009); and (d) design patterns of movement and circulation reduces regression and increase academic achievement (Tanner, 2008). Thus, the quality of physical space is crucial to learning.

Following is literature related to the study of ergonomics; ergonomics in learning environments, including formal and informal learning spaces; the three characteristics of the equivalency theory that undergird this study, learning experience, appropriate application, and students; and the roles of light, temperature, furniture, and noise in this theory.

The Study of Ergonomics

The term *ergonomics* is derived from two Greek words: *ergos* meaning work, and *nomo* meaning natural law (International Ergonomics Association, 2000; Pheasant, 1991).The study of ergonomics is believed to have begun in the 15th century when Leonardo de Vinci studied human anatomy and physics. This study resulted in the birth of biomechanics (Kroemer, Kroemer, & Kroemer-Elbert, 2001; Ozkaya & Nordin, 1991).

In the 1800s, during the Industrial Revolution, ergonomics gained awareness as the work environment changed from homes and farms to factories. Injuries and health concerns grew because of employees' long hours of labor in awkward positions with repetitive motions. During World War II, ergonomics was studied from the standpoint of anatomy, physiology, psychology, industrial medicine, industrial hygiene, design engineering, architecture, and illumination engineering (Gainer, 2008). Dul et al. (2012) characterized ergonomics as a systems approach designed specifically for workers and their environments to help focus on goal-oriented tasks, with the outcomes of the ergonomic system focused on performance and well-being. Miles and Perrewe (2011) obtained evidence that verified ergonomic intervention "can reduce medical cost, lower absenteeism, and improve workers satisfaction and productivity" (p. 729).

The study of ergonomics in education began in the 1920s as a graduate study on student posture and classroom furniture (Bennett, 1928, as cited in McVey, 2001). However, the subject did not gain wide interest until the 1950s with a series of studies and publications from Harmon (1953, as cited in McVey, 2001) on the physical effects of the school environment (McVey, 2001) and pioneering reports by K. U. Smith and M. F. Smith in 1966 (Legg, 2007). Researchers agreed that little attention had been paid to ergonomics in schools (Bennett, Woodcock, & Tien, 2006; Legg, 2007), although the study and implementation of ergonomic practices was "long … considered essential in the workplace" (Grayson, 2009, p. 15). Bennett et al. (2006) pointed out that ergonomics in the school setting had several purposes: to implement new designs, improve current practices, protect learners' health, and enhance the learning and instructional environments. A more recent study revealed that the furniture in the lecture theaters of a university were not ergonomically suitable for students (Odunaiya, Owonuwa, & Oguntibeju, 2014). Odunaiya et al. found that 74% to 80% of students had unsuitable seat height, desk clearance, and desk height. The authors recommended that similar studies be conducted to help prevent health hazards due to unsuitable furniture.

Ergonomics in Learning Environments

Ergonomics has been somewhat researched in school settings (Grayson, 2009). The spatial design of the learning environment in

American education is specifically structured around bricks and mortar classrooms that are well designed and constructed with emphasis on flexibility, comfort, sensory stimulation and enabling technologies that support learning (Chism, 2006; Lippman, 2010). However, with the proliferation of online learning, the physical learning environment has changed significantly to virtual, informal learning spaces. The study of optimal characteristics of the virtual learning environment has been limited to that related to students' needs, preferences, and health needs that support learning

Continued efforts have been made by several organizations to promote the science of ergonomics in the workplace (e.g., Cornell University, 2015; Mayo Foundation for Medical Education and Research, 2015; United States Green Building Council, 2015; United States Department of Labor Occupational Safety & Health Administration, n.d.-a). However, safety prevention guidelines, best practices, and strategic planning have been developed for the workplace environment, but not for the learning environment. As ergonomics has slowly been addressed in schools, the focus of ergonomics has been on optimization of new designs; improvement of existing space, equipment and practice; and enhancement of comfort, safety, and usability (Bennett et al., 2006). Similar to ergonomics in the workplace, for educational settings policies and guidelines should be in place to safeguard the physical and mental activities of students and teachers (Smith, 2007).

Learning Spaces: Physical-Formal and Virtual-Informal. Oblinger (2006) describes two main types of learning spaces: physical-formal and virtual-informal. In traditional campus education, the formal learning spaces are primarily the classroom and library (Chism, 2006). Informal learning spaces may be any place where learning may take place, such as libraries, museums, social groups, and home environments. Informal learning spaces include any other place or space where learners study, read, research, or write. The shift from formal to informal learning space resulted from the changes in course offerings and delivery methods, students, information technology, and the understanding of learning (Oblinger, 2006). Informal learning space can be practically anywhere that has wireless network. The advent of technology and mobile devices, such as laptops, tablets, and smart phones has enabled students to learn anywhere at any time.

Physical learning spaces that are well-designed and constructed emphasize flexibility, comfort, sensory stimulation, and enabling technologies that support learning (Chism, 2006). However, with the proliferation of technology and online learning, informal learning spaces have replaced classrooms and other formal spaces for online programs. Research on informal learning spaces has focused on the architectural design of campus learning environments to help "justify investment and create a popular critical space on campus" (Lippincott, 2006, p. 7.15).

Studies on Learning Spaces. Factors such as collaboration, community involvement, and support have been the focal points of studies on informal learning spaces. Studies on informal learning spaces for online students have centered on development of university library space (e.g., Graham & Graham, 2013; Hall, 2013) or flexible space facilities (e.g., Hunter & Cox, 2014; McLaughlin & Faulkner, 2012). Studies also focused on design rather than on use and users—"practitioners and learners" (Blackmore, Bateman, Loughlin, O'Mara, & Aranda, 2011, p. iii). Blackmore et al. (2011) and Steel and Andrews (2011) identified gaps and imbalance in research literature pertained to the design and transition phases of both formal and informal learning spaces; however, they focused on what is primarily physical space provided by educational institutions.

An ergonomic consultant to children observed that when middle-school students "work at an adjustable, ergonomically designed workstation," their risks of problems of physical alignment are greatly reduced (Lang, 2000, p. 24). A study of 240 students in a 600-seat law lecture theater showed that the

furniture in this lecture theater were not ergonomically suitable. The researchers found that 74% to 80% of students had unsuitable seat height, desk clearance, and desk height (Odunaiya et al., 2014). This finding indicates that perhaps additional research is needed to determine the ergonomic and physical factors that contribute most effectively to students' comfort.

Comfort. Physical and psychological comfort is a major priority for basic human needs (Gee, 2006). For any learning space, comfort must be addressed. Herman Miller Inc. (2009) explained, "Learning spaces that are physically and psychologically comfortable promotes a sense of well-being, keep minds focused, and limit distractions" (p. 3). Cattier (2006) noted that learners are empowered when they are able to choose comfortable locations to complete their work.

McVey (2001) enumerated several essential characteristics of an effective learning environment, such as lighting, color, sound, space, and furniture. Thus, to ensure comfort, safety and usability, learning environments should be equipped with flexible lighting, temperature controls, comfortable and adjustable furniture, accessible natural light, and limited auditory distractions (Herman Miller Inc., 2009).

In a landmark report from 1979, Watson concluded, "Comfort activities in ordinary living [activities not specified] can be supportive, protective, or even corrective for a person's internal and external environments" (as cited in Kolcaba & Kolcaba, 1991, p. 1304). As a result, guidance for supportive, protective, and corrective actions may help individuals feel comfortable, acquiring ease and peaceful contentment. These qualities are especially important in the learning environment.

Equivalency Theory and Environmental Characteristics

The premise of the equivalency theory is that equivalent learning experiences must be provided for all learners regardless of location for their academic success (Simonson, 1995). Equivalency theory emerged as a result of the rapid growth and impact of new technologies and virtual education (Simonson et al., 2015). Simonson (1995) identified four key elements of the equivalency theory: learning experience, appropriate application, students, and outcomes.

Simonson et al. (2015) defined the learning experience as "anything that promotes learning, including what is observed, felt, heard and done" (p. 51). McVey (2001) suggested that the learning environment should adequately provide for maximum auditory and visual acuity as well as physical comfort. Thus, resources and technology are expected to be available and suitable for individual learners and their learning situations if learning is to take place.

Appropriate application, defined as the availability of the learning experience, should serve individual learners and their specific needs in their learning situations (Simonson, Schlosser, & Hanson, 1999). Simonson et al. (1999) explained, "The idea of appropriate application implies that learning experiences suitable to the needs of the individual learner and the learning situation should be available and that the availability of learning experiences should be proper and timely" (p. 71). The environmental factors of light, temperature, furniture, and noise pertain to students' learning experiences and appropriate application of these factors for optimal learning.

Researchers have recognized light as an important factor in the learning environment (e.g., Dunn, Krimsky, Murray, & Quinn, 1985; McVey, 1971) and have distinguished different types of light that affect behavior, performance, concentration, motivation, and academic achievement (e.g., Dunn et al., 1985; Mott, Robinson, Walden, Burnette, & Rutherford, 2012; Schneider, 2002). Temperature also plays an important role in the learning experiences of students (Earthman, 2004; Mendell & Heath, 2005; Wargocki & Wyon, 2007).

Noise and furniture are other important environmental factor that affect student

comfort and achievement. Noise has been found to negatively affect health (Evans, 2006) and academic performance (Shield & Dockrell, 2008). Researchers have suggested that furniture be lightweight and ergonomically designed to ensure comfort and flexibility (e.g., Herman Miller Inc., 2009; Hunley & Schaller, 2009; Kennedy, 2010; Timm, 2007; Wroblaski, 2011). Kennedy (2012) found a connection between inadequate furniture and health problems; and Rudolf and Griffiths, (2009) found effects of inadequate furniture on motor skill, learning, and concentration levels.

METHODOLOGY

A descriptive case study design with multiple methods was employed to collect quantitative data followed by qualitative data. Three stages were completed to collect data: Stage 1, administering the Physical Learning Environment Online Questionnaire (PLEOQ); Stage 2, conducting the telephone interviews; and Stage 3, requesting photographs. Qualitative data provided better understanding of the quantitative results and helped produce a comprehensive depiction of the participants' phys-

TABLE 1
Research Stages, Data Collected, and Instruments

Stages	*Data Collected*	*Instruments*
1	Quantitative data	PLEOQ
2	Qualitative data	Interview guide
3	Qualitative data	Photography guide

TABLE 2
Equivalency Theory Elements With Definitions, Research Questions, and Data Analysis

	Definition	*Research Question*	*Data Analysis*
Learning experience	A learning experience is anything that happens to or with the student that promotes learning, including what is: • observed, • felt, • heard, or • done	1. Where do online graduate students spend the majority of their time working on specific learning and research activities, such as completing assignments, projects, and examinations; participating in discussion forums; and conducting Internet research?	• Location • Work area • Time per day
		2. How do online graduate students describe their physical learning environment in terms of light, temperature, furniture, and noise?	• Light • Temperature • Furniture • Noise
Appropriate application	Learning resources (equipment = hardware, software, network, etc.) that are available, proper, and timely	3. What equipment, such as hardware and networking capabilities, do online graduate students use to complete their learning and research activities?	• Hardware • Network
Students	The individuals involved in the formal, institutional-based learning activities of instruction	4. What elements of the physical learning environment (light, temperature, furniture, and noise) do online graduate students find most difficult to manage while learning online, and how do they overcome the challenges of these environmental factors?	• Online graduate students • Working adults • Demographics

ical learning environments. Table 1 shows the stages, data collected, and instruments used.

Table 2 depicts the alignment of the elements of the equivalency theory, the definitions, the four study research questions, and the data that were analyzed. Figure 1 illustrates the recommended ergonomic appropriate application of the aspects addressed in Research Question 1 related to light (including sight), temperature (including feel), furniture, and noise (including sound), as well as the hardware, software, and network requirements for optimally comfortable and productive learning environments. The following sections describe the participants, the instruments, and the data collection procedures that were followed.

Participants

Ten participants were recruited from a university social media website. Participants were working adult learners and who were or had been completing coursework and research enrolled in an online doctorate program in education at a private university located in the southeastern region of the United States.

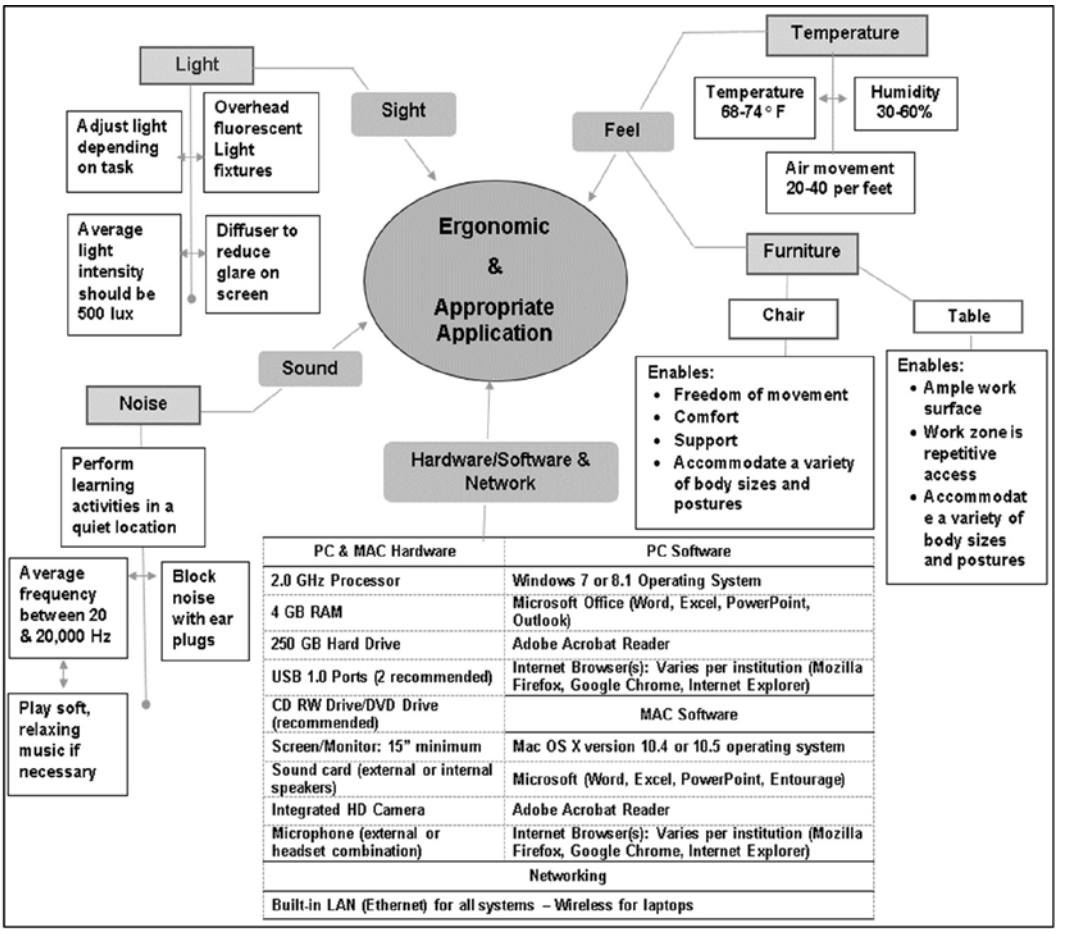


FIGURE 1
Recommended Ergonomic Appropriate Application Developed by the Principal Researcher

Data Collection Instruments

Three instruments were developed to collect data and thoroughly examine the elements of the physical learning environment of online graduate students: the PLEOQ; the Telephone Interview Guide; and the Photography Guide with directions and examples for participants to take photographs of their primary physical learning environment. The PLEOQ was the baseline for the data collection. The telephone interviews and the photographs helped produce a comprehensive depiction of the participants' physical learning environments. All three instruments were designed for this study following Czaja and Blair's (2005) five-step process; pilot tested, validated by a formative committee; and approved by a summative committee to enhance validity and reliability.

Physical Learning Environment Online Questionnaire (PLEOQ). The PLEOQ consisted of multiple-choice questions, *yes*/*no*, short-answer questions, and open-ended questions in three sections: Section I, Demographic Information; Section II, Location, Work Area, Equipment, and Time; and Section III, Description of Physical Learning Environment.

Section I, consisted of seven demographic items that were both general and specific to the study: gender, age, employment status, marital status, family responsibilities, year of enrolling as online graduate student, and stage of study as a graduate student. These items have been used in previous studies with graduate students (Clinefelter & Aslanian, 2014).

Section II consisted of 21 questions formulated to identify (a) the location and work area, as well as the look, feel and sound of the physical learning environment; and (b) the equipment online graduate students utilize to complete their learning and research activities. Answers to Section II addressed two research questions: Research Question 1, "Where do online graduate students spend the majority of their time working on specific learning and research activities, such as completing assignments, projects, and examinations; participating in discussion forums; and conducting Internet research?" and Research Question 3, "What equipment, such as hardware and networking capabilities, do online graduate students use to complete their learning and research activities?"

Section III, consisted of 22 items (multiple-choice questions, *yes/no* questions, and short answer questions). Section III addressed Research Question 2: "How do online graduate students describe their physical learning environment in terms of light, temperature, furniture, and noise?" Based on the participants' answers to the questions in Section II, they were asked to identify the single location where they spent the majority of their time carrying out their learning activities. This location was identified as their primary physical learning environment.

Interview Guide. Phone interviews primarily addressed Research Question 4, "What elements of the physical learning environment (light, temperature, furniture, and noise) do online graduate students find most difficult to manage while learning online, and how do they overcome the challenges of these environmental factors?" Interview answers also helped to expand on the first three research questions. Participants answered to nine open-ended questions in a semistructured interview format.

The phone interviews lasted approximately 30 minutes as recommended by Maxwell (2005). The interviews were transcribed with a speech recognition application powered by ListNote (Google, 2016). Participants were placed on speaker and the researcher used the ListNote Speech-to-Text Notes application (Google, 2016) on her phone to transcribe what the participants said. In member checking, to enhance reliability (Creswell, 2014), transcriptions were returned to the participants, who were asked to assure the accuracy of the transcriptions.

Photography Guide. Hunley and Schaller (2009) described photography as a "direct observational method" that offers a "validity check for interpretation from other measures"

(p. 13.7). As suggested by Szto, Furman, and Langer (2005), photographs were used for data collection, organizing, interpreting, and validating qualitative inquiries. A photography protocol was designed to structure the techniques of photography and ensure that participants efficiently provided the correct information requested. The protocol was accompanied by a photography guide that was developed following Czaja and Blair's (2005) five-step process.

Participants were asked to supply visual data that depicted their primary physical learning environment as directed in the photography guide. The guide included directions and visual examples for taking each type of photograph, with specific items in the work area that participants needed to capture. Directions included selecting a camera the participant could use to take the photographs, selecting a location (home, work, library, etc.) where he or she spent 2–3 days a week working on his or her learning or research activities (e.g., completing assignments and projects, taking exams, etc.), and visuals to exemplify the types of shots for each photograph (e.g., wide angles and close-ups of their working place, and wide angle of her or himself sitting at his or her work area).

Figures 2 through 5 depict the various photographs included in the photography guide that participants were directed to take. A last photograph was optional, and it would consist of any other item(s) that might help describe the participant's physical learning environment.

Validity and Reliability. The PLEOQ, the telephone interview guide, and the photography guide were validated by formative and summative committees. The final instruments were piloted with a group of the sample population of three online graduate students who did not participate in the study. The pilot results revealed that the instruments contained the essence of the research questions and were valid instruments to address the study purpose.

Data Collection Procedures

The following sections explain the sampling procedure and the data collection stages carried out.

Sampling. A purposeful sampling was used to select 10 participants as recommended by Gall, Gall, and Borg. (2007). Participants were online graduate students who were working adults and were, or had been, completing course work and research. Volunteers were recruited from a social media group of approximately 240 online graduate students of a single university.

Data Collection Stages. Data collection was achieved through three main stages: During Stage 1, quantitative data were collected with the PLEOQ; during Stages 2 and 3, qualitative data were collected from the telephone interviews and from the photographs submitted by participants. For data analysis, the qualitative data were then connected to the results from the quantitative stage, as recommended by Clark and Creswell (2008).

Stage 1: Administering the PLEOQ. The PLEOQ was developed with, and uploaded to, the secure FreeOnlineSurveys.com website. A five-step process for developing and administering the PLEOQ was followed, as recommended by Czaja and Blair (2005): survey design and preliminary planning; pretesting; final survey design and planning; data collection; and data coding, data file construction analysis, and final report.

Stage 2: Conducting the telephone interviews. After completing the PLEOQ, participants were contacted via e-mail to schedule individual 30-minute telephone interviews. The development and administering of the telephone interview questions also followed Czaja and Blair's (2005) five-step process.

Stage 3: Requesting photographs. After the telephone interview, an e-mail was sent to the participants with an attachment of the instructions and the Photography Guide to submit their photographs as discussed during the telephone interview. Participants were asked to submit via e-mail a total of five photographs of

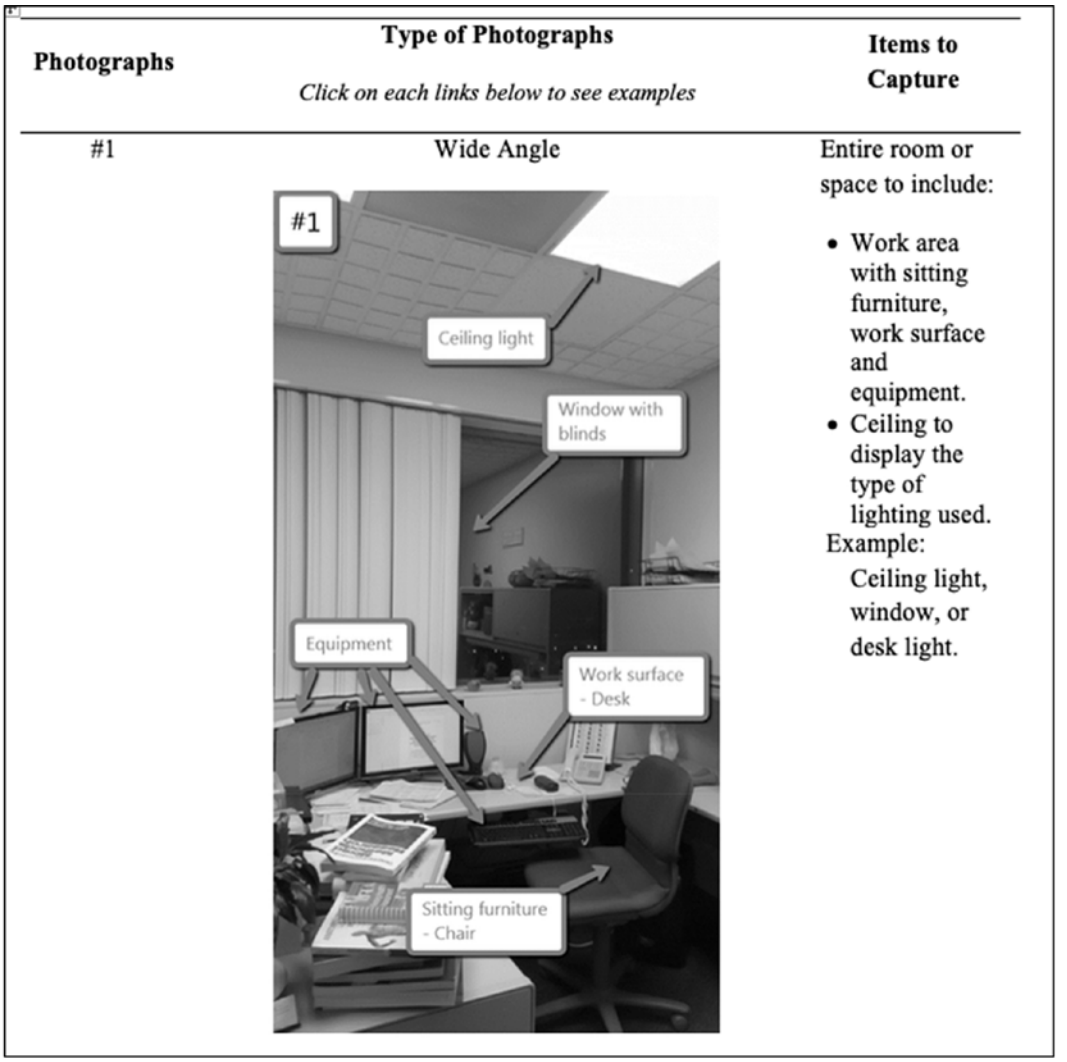


FIGURE 2
Example of a Wide-Angle Photograph That Captures the Entire Room

their primary physical learning environment and sixth optional one, as detailed in the guide. Participants were also instructed to use a digital device (e.g., mobile cell phone or digital camera) to take two wide-angel photographs and three close-up photographs of the physical learning environment where they spent 2–3 days a week working on specific learning and research activities.

Analysis of Quantitative Data

Quantitative data were collected from PLEOQ Section I, Demographic Information; Section II, Location, Work Area, Equipment, and Time; and Section III, Description of Physical Learning Environment. Data collected from Section II were analyzed and categorized with themes to answer Research

Photographs	Type of Photographs *Click on each links below to see examples*	Items to Capture
#2	Wide Angle	Have someone take a photograph of you at your physical learning environment - sitting on the furniture, at the work surface, with the equipment.
#3	Close-Up 	Work surface (e.g., desk, counter or platform) where the equipment, files, books, etc. are located and where writing activities take place.

FIGURE 3
Details of Wide Angle of Participant in His or Her Learning Environment

Questions 1 and 2. Section III data were also analyzed and categorized with themes to answer Research Question 3. Descriptive statistics were obtained to answer the first three research questions. A static report was generated from the FreeOnlineSurvey.com website and imported as a Microsoft Office Excel spreadsheet. Participants' names were coded,

Photographs	Type of Photographs *Click on each links below to see examples*	Items to Capture
	Close-Up	
#4		Furniture you sit on. Capture the furniture from a side angle showing the seat, back rest, and base/bottom of the furniture.

FIGURE 4
Example of Close-Up Photograph of the Furniture on Which the Participant Sits

alphabetized, and assigned identification numbers. Each PLEOQ question was sorted, from largest to smallest, to determine the range, mode, and frequency of responses.

Analysis of Qualitative Data

The interview responses were entered into a Microsoft Office Excel spreadsheet and the Photography Checklist was used (Figure 6) to help examine, categorize, and interpret the ergonomic and appropriate application setting and items identified in the photographs submitted by the participants. The interview responses and digital photographs were analyzed with content analysis and theme discovery. Content analysis is used to study texts and their meaning and to investigate visual representations, such as pictures and symbols (Neuman, 2011).

Inductive reasoning as recommended by Creswell (2014) and Patton (2002) was used to interpret both the quantitative and qualitative data, interpret the themes and elements of the physical learning environment, and answer the four research questions. The elements of the equivalency theory and ergonomic principles were also considered. A combination of the transcribed interviews and the use of reflective notes documented in Microsoft Office Word enabled the researcher to generate a common word list and to sort data into themes. Common themes were sorted and categorized pertinent to the environmental factors (i.e., light, temperature, furniture, and noise) and the elements of the equivalency theory (i.e., learning

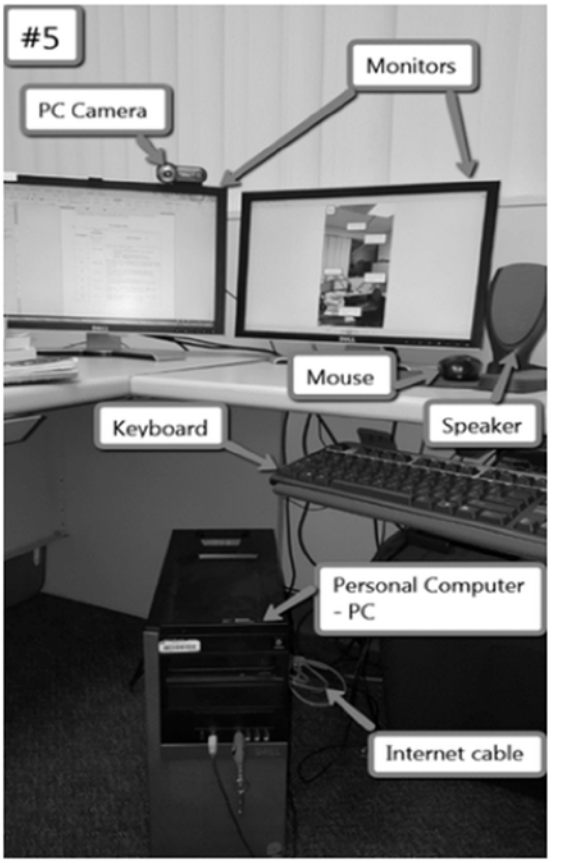
Photographs	**Type of Photographs** *Click on each links below to see examples*	**Items to Capture**
#5	Close-Up  	Equipment – Hardware (e.g., Desktop, laptop or tablet), plus network device (e.g., modem, router, satellite, etc.)
#6	Optional	Take a photo of any other item that may help to describe and illustrate your physical learning environment.

FIGURE 5
Example of Close-Up Photograph of the Equipment and Directions for Optional Photograph That May Help to Identify the Items in the Physical Learning Environment

Photographs	Type of Photographs	Items to Capture	Ergonomics & Appropriate Application
#1	Wide Angle	Entire room or space to include: • Work area with sitting furniture, work surface and equipment. • Ceiling to display the type of lighting used. Example: Ceiling light, window, or desk light.	Items include: ☐ Desk ☐ Chair ☐ Equipment ☐ Light o Desk light o Ceiling light o Window ☐ Door
#2	Wide Angle	Have someone take a photograph of you at your physical learning environment - sitting on the furniture, at the work surface, with the equipment.	
#3	Close-Up	Work area (desk, counter or platform) where the equipment, files, books, etc. are located and where writing activities take place.	Desk: ☐ Ample work surface ☐ Work zone is repetitive access ☐ Accommodate a variety of body size and posture
#4	Close-Up	Furniture you sit on. Capture the furniture from a side angle showing the seat, back rest, and base/bottom of the furniture.	Chair: ☐ Freedom of movement ☐ Comfortable ☐ Supportive ☐ Accommodate a variety of body sizes and postures
#5	Close-Up	Equipment – Hardware (Desktop, laptop or tablet), plus network device (modem, router, satellite, etc.)	Equipment: ☐ Desktop & monitor ☐ Modem &/or router ☐ Laptop
#6	Optional	Take a photo of any other item that may help to describe and illustrate your physical learning environment.	

FIGURE 6
Researcher's Photography Checklist

experience, appropriate application, and student).

DISCUSSION OF RESULTS

Following is a summary of demographics and a discussion of results related to the study's research questions.

Participants' Demographics

Of the 10 participants, 6 were female, 2 were between 24 and 44 years old, and 8 were between 45 and 64 years old. Six participants were married, three were divorced, and one had a partner. Eight of the participants cared for a child/children, one cared for a child/children and an elderly person, and four cared for a pet. The years in which participants enrolled in the online graduate program were from 2009 to 2016. Regarding their current dissertation stages, two participants were working on the concept paper, four were working on the proposal, and four had completed the dissertation.

Research Question 1

"Where do online graduate students spend the majority of their time working on specific learning and research activities, such as completing assignments, projects and, examinations; participating in discussion forums; and conducting Internet research?" Results showed that home was the primary location where online graduate students spend the majority of their time working on specific learning and research activities. Nine participants stated that home was their primary physical learning environment, and one responded that work was his primary physical learning environment.

This finding is supported by Harrop and Turpin's (2013) results that many learners preferred to study at home rather than other environments. Harrop and Turpin concluded, "Home was seen as a place offering private space and was associated with being relaxed, cozy, comfortable, and with being able to sit how you like" (p. 69). Similarly, Willging and Johnson (2004) observed that students preferred to perform their coursework at home were they had privacy with few interruptions, were able to concentrate better than in a public environment, and had comfort and convenient access to course materials.

On the other hand, results of the study showed that the locations where participants spent the majority of their time varied for each activity. It was noted that different tasks, activities, and learning styles called for different physical learning environments, similar to findings by Chism (2006) and Farmer (2009). Home was the preferred location to complete assignments and projects ($n = 8$), taking examinations ($n = 6$), participating in online discussions ($n = 9$), and conducting Internet searches ($n = 9$).

It was surprising that only one participant used the library, and it was to conduct Internet searches. Traditionally, libraries offered technology, content, and services; however, with the paradigm shift to electronic devices, many institutions are renovating and/or constructing library facilities to create more comfort and conveniences. The libraries have increasing harmonious space with flexible furniture, wireless Internet connections, extensive software, and allowance or offers of food and beverages (Chism, 2006; Lippincott, 2006).

The cafeteria and/or restaurant was selected by only one participant, who chose this place for taking examinations. Obviously, some physical learning environments, such as cafeterias and restaurants, have more distractions than others. As the participants noted, students' awareness of distractions and ability to control the physical learning environment are both important to learning success (Latha, 2014).

During the interviews, participants explained their preferences for different locations in their primary physical learning environment based on particular activities. One participant preferred having different work

areas for different tasks. For example, Participant 6 used her kitchen table to read and take notes and her computer desk in another room for research and submitting assignments. She also had two separate rooms for each course she was taking and the work required. Participant 4 stated she went to the library to find a quiet space conducive to learning. For her, home was a distraction, especially because of her children. However, she mentioned that travel and time constraints limited her library visits. Participant 3 stated that he was "Very easily distracted in libraries and coffee shops. Those locations [are] not good for writing." Although for some participants, the home had less privacy with distractions because of other family members, it appears that for most the home was the most comfortable, adaptive, and convenient location where students preferred to conduct their specific learning and research activities.

Research Question 2

"How do online graduate students describe their physical learning environment in terms of light, temperature, furniture, and noise?" All ten participants described each of the elements of the physical learning environment (i.e., light, temperature, furniture, and noise) as manageable and achieved comfort, safety, and usability after many trials and errors. Following is a discussion per element.

Lighting. Participants' indicated several types of preferred lighting elements. Seven participants used overhead light, of which four also used a lamp/task light, and one chose only lamp/task light. Seven preferred high lux light levels, of which two favored a bright summer sunshine (50,000 lux) and five chose a well-lit room (500 lux). Seven participants mentioned light as one of the most important elements when considering a comfortable and functional physical learning environment. Participant 4 stated, "With light [one] can see and can do anything." Studies have shown that overhead lighting, such as fluorescent light with a 1000 lux level, increased oral reading fluency; aided speed, accuracy, attentiveness or focus; and produced higher student achievement (Earthman, 2004; Mott et al., 2012). However, most of the present participants preferred lower lighting. The preference of lux level light ranged from 1 to 5000. The mode was 500 lux level and the average was 1,310. Over half the participants selected 500 lux level (well-lit office) or less, and only two selected 50,000 lux level (bright summer sunshine) in their primary physical learning environment. Mott et al. (2012) considered 500 lux level normal, creating enough illumination to see easily.

Findings were not surprising, because natural light was an alternative light source that students preferred to use. In addition to artificial light, eight participants indicated that their primary physical learning environment had windows with shades/blinds. Previous studies have indicated that natural light had positive effects on student achievement (Earthman, 2004), was considered the best lighting condition for learning (Schneider, 2002), and was favored among students who considered natural light softer and more relaxing than artificial light (Dunn et al., 1985).

On the other hand, qualitative statements about lighting revealed participants' desires to enhance, change, or modify their primary physical learning environment by adding more light. Participant 5 stated, "Proper lighting is needed." Participant 8 explained that she "would like more light in the evening. Would work more at night if had better light. Get tired with low light." Overall, for 70% of the participants, light was the common theme as one of the most important elements when they considered a comfortable and functional physical learning environment.

Temperature. The temperatures ranged from 65 to 95 degrees °F. Eight selected 68 to 74 °F as comfortable temperature level, one chose 75 to 81 °F, and one chose 82 to 85 °F. Two chose temperature as one of the most important elements when considering a comfortable and functional physical learning environment. Participant 8 explained, "Don't like air conditioners very much, Get cold very

fast." Participants selected over five different temperature levels, ranging from 65 to 95 °F. Each participant experienced different degrees of temperature and had different preferences for a comfortable physical learning environment.

Nine participants indicated the temperature in their primary physical learning environment was comfortable, and one indicated it was not. Participant 3 commented that he was cold and uncomfortable. McVey (1971) explained that comfort varies depending on the "student's age, sex, levels of physical activity, clothing density, and adaption to local climate" (p. 330). Conversely, the two participants who chose 75 °F and over were male and female, ages 53 and 50, in the similar climates of Singapore and Florida.

Relating to temperature, movement and air circulation were also examined; six participants indicated they felt air movement/circulation in their primary physical learning environment, and four indicated they did not. According to Earthman (2004), temperature is a form of human comfort regulated by adequate heating ventilation and air conditioning; temperature is a basic criterion of safety and health that impacts student achievement. The human body maintains a temperature of 98.6 degrees °F; thus, it is suggested that air temperature, radiant temperature, humidity, and air movement be regulated (Emmons & Wilkinson, 2001; McVey, 1971). However, according to adaptive theory, people can change, alter, or adapt to their environment to produce or restore comfort (Zhang, Zheng, Yang, Zhang, & Moschandreas, 2007). In various studies, the recommended appropriate application regarding temperature should be 68–74^{o}F. In addition, humidity should be maintained of 30% to 60%, and air movement of 20 to 40 feet per minute (Earthman, 2004; Emmons & Wilkinson, 2001; Lane, 1968; Wargocki & Wyon, 2007).

From the interview analysis, it was found that temperature was the least mentioned element. Only three participants indicated they would change the temperature in their physical learning environment to increase comfort. Two participants preferred a cooler temperature, and one stated he would add a heater for greater warmth. Although temperature was not a major concern among the participants in this study, temperature has been known to impact health and schoolwork performance greatly (Mendell & Heath, 2005; Wargocki & Wyon, 2007).

Furniture. Most participants (80%) spent a most of their time in their primary physical learning environment in sitting positions. These participants used a chair as their choice of sitting furniture. Three of those participants also switched to a sofa because of body pains (back, neck, and shoulders) from sitting too long or due to previous injury and/or surgery. Participant 9 used her sofa, Participant 6 switched location and furniture, and Participant 3 used a yoga ball exclusively to conduct their learning activities. According to Kennedy (2012), inadequate furniture is known to cause discomfort and fatigue.

Six of the nine participants stated that their sitting furniture pieces were adjustable, and they all adjusted their sitting furniture to their comfort levels. Emmons and Wilkinson (2001) suggested, "A well-designed ergonomic chair will provide freedom of movement, comfort, support, and accommodate a variety of body sizes and postures" (p. 9). Participant 4 was the one participant who spent a majority of his time standing used a treadmill. He stated that he felt back pains from sitting too long, and transitioned to a standing desk, having recently upgraded to a walking desk. Only one participant indicated his desire to change his chair for greater comfort.

Two participants further explained during their interview that they would change their furniture to increase comfort. Additionally, three considered furniture as the most important element. For most participants, their digital photographs showed that they had sitting furniture that was adjustable and provided back support. The participants may have considered the importance of comfort prior to purchasing their furniture and made the appropriate pur-

chase. Alternatively, because of increased general awareness of ergonomics, the furniture bought by participants was mostly lightweight, flexible, and adjustable (Herman Miller Inc., 2009).

Nine participants indicated that they used desks for the surface area in their primary physical learning environment. The other one used her lap for her laptop, and acknowledged an ergonomically correct place for a laptop. For maximum correctness, Kennedy (2010) suggested placement of an empty 2- or 3-inch binder beneath the laptop and on the knee. This placement creates an angle that helps keep the wrists remain straight while typing. Participant 9 sat on the sofa using her laptop a majority of the time. She stated she would move to the kitchen table to complete assessments for more focus and room. All participants except one stated the desks had sufficient space under the surface area for their legs and thighs.

Eight participants also indicated there was sufficient space on the surface area so that the necessary equipment and other resources (e.g., papers, books, telephone) were within easy reach. Seven participants indicated that the edges and corners of the surface area were rounded. According to the literature, the suggested appropriate application for maximum comfort of furniture is the ability to adjust the furniture to fit students' body types. Adjustment should allow them to align their eyes with the computer monitor or electronic device (Albin, 2008; Kennedy, 2012). The U.S. Department of Labor (n.d-b) suggested that desks should accommodate a variety of working postures. The work surface of a desk should have depths that allow view of the monitor at a distance of at least 20 inches.

Noise. Quantitative and qualitative findings for the physical learning element of noise had a common theme of external sounds: people, animals, transportation, and equipment. When asked to describe the sounds they heard, six participants stated they heard children, two heard cars/traffic, two listed footsteps/walking, two wrote talking/conversations, two listed trains, and two stated water. Other sounds listed were the following: phone ringing, doors opening/closing, air condition blowing, refrigerator humming, radio or television, and birds. Findings indicated half of the participants had doors that could be closed in their primary physical learning environment.

For noise level (dB), one participant selected 30 dB, two picked 40 dB, two chose 50–60 dB, one listed 50–65 dB, one selected 70 dB, one chose 80 dB, one picked 80–100 dB, and one chose 110 dB as the noise level that applied to their primary physical learning environment. For the most part, all participants' noise levels were below 85–90 dB, which is the level that hearing damage begins (U.S. Department of Labor Occupational Safety & Health Administration, n.d.-c). Earthman (2004) pointed out that high levels of noise negatively impacts student performance. The National Institute on Deafness and Other Communication Disorders (2014) recommended avoidance of noise above 85 dB. To block noise, Reed (2013) suggested changing time and/or location of learning activities or using ear plugs.

On the other hand, some students preferred to hear background noise. This noise helped their relaxation or motivation while studying or completing their work (Reed, 2013). For optimal learning and performance, it was recommended that students seek a quiet place for their learning activities (Reed, 2013) when working individually (Harrop & Turpin, 2013).

Research Question 3

"What equipment, such as hardware and networking capabilities, do online graduate students use to complete their learning and research activities?" The equipment used was primarily laptops, and several desktop computers. Most used laptops to complete assignments and projects (70%) and to participate in discussions. The majority used laptops to conduct Internet research (60%) and to take examinations (50%). Nine participants indicated they were prepared to work with their

equipment. Most participants had previous technology experience. Participant 5 stated she had a "master's degree in computer security, computer technical savvy, and work in both Mac and Windows."

A majority of the Internet connection was derived mostly from Wi-Fi, and a few from cable. The majority of participants (60%) used Wi-Fi to complete assignments and projects, to participate in discussions, and to conduct Internet research. Four participants used Wi-Fi and two used cable to take examinations.

It was surprising that none of the participants selected tablets or smartphones as their equipment of choice for the four categories. Laptops are the most commonly used mobile device for school work (Kennedy, 2010), and approximately 40% of college students used a smartphone and 66% used a tablet for school work on a regular basis (Foster, Fazelian, & Cytron, 2014).

Desktops were less favored but were used by several participants for certain activities. Three participants used desktops to complete assignments and projects and participate in discussions, four to conduct Internet research, and two to take examinations. In addition to desktop and mobile devices, some participants preferred multiple screens when completing learning activities. Photographs showed that 60% percent of the participants used two or more monitors/screens in their primary physical learning environment.

The other pieces of equipment online graduate students used for Internet connection were routers to connect Wi-Fi or cable. Wi-Fi was the favored Internet connection among the participants. Six participants used Wi-Fi to complete assignments and projects, participate in discussions, and conduct Internet studies, and four used Wi-Fi to take examinations. Milne (2006) commented, "Mobile technologies such as laptops, cell phones, PDAs, tablet PCs, iPods, digital cameras, Wi-Fi finders, USB drives, and GPS systems and more are part of our personal communication culture" (p. 11.3). Students' space should be equipped with power and reliable Internet service to connect them with instructors and course materials (Simonson et al., 2015).

From the interview responses, it was found that nine participants indicated they were prepared to work with the equipment (e.g., hardware, software, and network) to conduct their online graduate learning and research activities. Most of the participants had previous technology experience. Only one participant explained that she entered a new field of technology and had no prior experience.

Research Question 4

"What elements of the physical learning environment (light, temperature, furniture, and noise) do online graduate students find most difficult to manage while learning online, and how do they overcome the challenges?" Qualitative data were collected for this research question. The primary elements of the physical learning environment that participants mentioned as challenging were family responsibilities (e.g., children and pets), inadequate workspace, and inappropriate equipment.

Responses varied, with noise as the most challenging for 60%, furniture for 50%, light for 30%, and temperature the least challenging, for 10%. More than half the participants stated that noise was one of their challenges. The sounds they heard in their physical learning environment included children, cars/traffic, footsteps/walking, talking/conversations trains, and even water. Approximately half the participants had doors to muffle some of the sounds they heard. Most of the participants' noise levels were below the recommended avoidance noise level of 85 dB and above (National Institute on Deafness and Other Communication Disorders, 2014). To achieve a comfortable, safe, and usable learning environment, three (30%) participants stated that light was the most important element and added additional lighting to resolve the problem. One (10%) cited temperature and installed an electric heater to combat the cold. Five (50%) described furniture, and to resolve the challenge three purchased new ergonomic

furniture, and one occasionally stood, walked, and stretched. Six (60%) participants referred to noise, and three (30%) shifted their study time to avoid intrusive noises. One wore headphones to block the noise, one acknowledged the dog barking, and the other addressed intrusive noises by working at quieter times.

Regarding furniture, participants indicated that finding comfort to alleviate body pain was a challenge. According to Emmons and Wilkinson (2001) and the Mayo Foundation for Medical Education and Research (2015), sitting furniture should be well-designed ergonomic chairs that provide free movement, as well as support and comfort. Various body sizes and shapes should be accommodated, in addition to individual posture. Legg (2007) found that adjustable desks and chairs promoted better sitting postures that decreased tension and alleviated pain. Binboga and Korhan (2014) acknowledged that resources were scarce that investigated posture and musculoskeletal problems with mobile devices, such as laptops and tablets, and desktop computers.

Not having enough light was a challenge indicated by three participants. Seven participants preferred high lux light levels. The solution they found was adding more light, such as a desk light or moving to a location that had brighter lighting.

Implications and Recommendations for Future Research

As participants shared their challenges in their physical learning environments, they also provided means for overcoming them. Other online graduate students who may experience similar challenges can use these suggestions. The findings can help the development of appropriate learning environments for the three human senses of sight, touch, and hearing. Findings can encourage colleges and universities to provide online students with a user's guide, including suggestions and website links with videos for choosing an adequate workspace conducive to learning.

There should be discussions among educational institutions about optimizing student's physical learning spaces. Educational institutions should design and distribute guidelines for online students to help them select or change their physical learning environment to one that optimally suits their needs. The results showed that none of the participants received any type of information, such as pamphlets, links to websites, videos, or training materials from their educational institutions to help them identify and select comfortable and functional learning environments. Participant 1 responded, "I never received any information at all. Never had any official communication about space."

Based on the literature review, recommendations for appropriate application from an ergonomics standpoint were made to maximize learning and create a better physical learning environment. Figure 1 illustrated this application of aspects of the physical learning environment as addressed in Research Questions 2 and 3 of light, temperature, furniture, and noise. Included are the hardware, software, and network requirements for optimal comfortable and productive learning environment.

Findings showed that home is the place where online graduate students spent the majority of their time working on specific learning and research activities. Data and knowledge are lacking for other informal learning environments and student learning. Further research could explore the advantages of additional informal venues, such as libraries, cafes, and restaurants. Future studies can also explore how health hazards could be prevented from online students' poor lighting, inadequate temperatures, unsuitable furniture, and harmful noises.

Regarding the equipment online graduate students used to complete their learning activities, such as hardware and network devices, most participants indicated that they used laptops and Wi-Fi connection. Future research is recommended for online students' use of additional mobile devices. As technology changes, the devices and needs of online students may

also change. Foster et al. (2014) provided a broad view of college students and the technology they used for learning. However, the report did not differentiate between campus and online students.

Most participants named noise and furniture as their greatest challenge in online settings. Because this study focused only on the four elements of light, temperature, furniture and noise of the physical learning environment, additional research could expand to additional environmental aspects such as, for example, sensory stimulation regarding colors, space layout, and shapes.

The small sample size prevents generalizable results, and the instruments may not have incorporated all environmental aspects that can be considered. Additional research could expand the questions to other characteristics of the physical learning environment. Additionally, social desirability in which participants may respond as they assume the researcher would expect or want to hear or to raise their self-image (Gall et al. 2007; van de Mortel, 2008) may also have taken place.

Future longitudinal studies could follow up on the participants for changes in their experiences with their physical learning environments. Studies could document the reasons for their additional thoughts, changes, and improvements. Further research can also determine the relationships between the physical learning environment, achievement, and persistence. Additional questions could be explored. For example, would participants recommend online learning to their peers? What advice would participants provide to students enrolling in online learning for the first time? What types of technology would participants suggest as best meeting online learning goals and enhancing success? Such investigations could help students contemplating online study decide whether to pursue this mode of learning.

Additionally, virtual reality and augmented reality have slowly entered the educational arena. Both modes utilize technologies and are beneficial for actively engaging students in new interesting, exciting, and fun ways to increase retention (Burch, 2016). Numerous virtual reality and augmented reality applications and devices provide live three-dimensional (3D) content and enhance human interaction remotely on a global level. For example, in relation to courses, students can experience virtual reality sights and sounds of travel expeditions to outer space, underwater coral reefs, and the exploration of the human body. virtual reality and augmented reality are cutting-edge technologies in education that may completely change the physical learning environment.

With regard to theory, the science of ergonomics should be further explored to help online students choose the appropriate applications for selecting adequate workspaces conducive to learning. Especially because of the proliferation of mobile devices and their use, the physical impact of mobile technologies on students' health should also be studied. If the equivalency theory is used for future studies, perhaps the fourth element, outcome, could further explore two measurable areas: instructor-determined outcomes and learner-determined outcomes. The instructor-determined outcomes measure the course goals and objectives to identify learners' accomplishments. The learner-determined outcomes are personal to each learner and relate to what the learner hopes to accomplish upon completion of a given course (Simonson et al., 2015).

Environmental psychology (Pappas, 1990) might have had more explanatory power than the equivalency theory. The four key elements of environmental psychology include spatial behavior, physical characteristics of the environment, the role of tradition, and the affective (Pappas, 1990). Those elements would likely have promoted a better understanding and provided a future direction for online students and their physical learning environment.

Overall, findings had practical implications that were intuitive and made common sense. However, additional research is needed regarding the physical learning environment of online students. Replication of the present

study can be conducted with larger samples and drawn from more universities nationwide. Studies should also include a variety of students from different online programs. For greater understanding of online graduate students, expanded demographic characteristics should be collected, including ethnicity, socioeconomic status, residence location, and motivation for online education.

This study was a first step in filling the gap in understanding how online students learning outside the formal classroom in informal settings, primarily the home. More research is needed regarding the optimal learning environment to maximize positive educational outcomes. It is hoped that future studies will build on these findings to help online graduate students gain maximum comfort, flexibility, and access to necessary resources in their physical learning environment.

Distance education and informal learning spaces are the tip of the iceberg in terms of how, when, where, and what students are learning. With the advancement of mobile devices, virtual reality, augmented reality, robotics, and artificial intelligence, the landscape for learning will change the field of education. How will such changes affect how, what, and where students learn?

REFERENCES

Albin, T. (2008). *Comfortable portable computing: The ergonomic equation*. Retrieved from https://www.ergotron.com/Portals/0/literature/whitePapers/english/Portable-Ergonomic-White-Paper.pdf

Bennett, C., Woodcock, A., & Tien, D. (2006). Ergonomics for students and staff. In R. Geller, W. G. Teague, H. Frumkin, & J. Nodvin (Eds.), *Safe and healthy school environments* (pp. 58–77). New York, NY: Oxford University Press.

Binboga, E., & Korhan, O. (2014). Posture, musculoskeletal activities, and possible musculoskeletal discomfort among children using laptops or tablet computers for education purposes: A literature review. *Journal of Science Education and Technology*, *23,* 605–616. doi:10.1007/s10956-014-9505-9

Blackmore, J., Bateman, D., Loughlin, O'Mara, J., & Aranda, G. (2011). Research into the connection between built learning spaces and student outcomes: Literature review. Retrieved from http://dro.deakin.edu.au/eserv/DU:30036968/blackmore-researchinto-2011.pdf

Burch, A. (2016). *The top 10 companies working on education in virtual reality and augmented reality*. Retrieved from https://touchstoneresearch.com/the-top-10-companies-working-on-education-in-virtual-reality-and-augmented-reality/

Cattier, A. (2006). Navigating toward the next-generation computer lab. In D. G. Oblinger (Ed.), *Learning spaces* (pp. 8.1–8.10). *EducauseEbook*. Retrieved from http://net.educause.edu/ir/library/ pdf/PUB7102k.pdf

Chism, N. (2006) Challenging traditional assumptions and rethinking learning spaces. In D. G. Oblinger (Ed.), *Learning spaces* (pp. 21.1–21.9). *EducauseEbook*. Retrieved from http://net.educause.edu/ir/library/ pdf/PUB7102k.pdf

Clark, V. P., & Creswell, J. W. (2008). *The mixed methods reader*. Thousand Oaks, CA: SAGE.

Clinefelter, D., & Aslanian, C. (2014). *Online college students 2014: Comprehensive data on demands and preferences.* Retrieved from http://www.learninghouse.com/wp-content/uploads/2014/06/2014-Online-College-Students-Final.pdf

Cornell University. (2015). CUErgo: Cornell University ergonomics web. Retrieved from http://www.ergo.human.cornell.edu/

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: SAGE.

Czaja, R., & Blair, J. (2005). *Designing surveys* (2nd ed.). Thousand Oaks, CA: Pine Forge Press.

Dul, J., Bruder, R., Buckle, P., Carayon, P., Falzon, P., Marras, W., & Doelen, B. (2012). A strategy for human factors/ergonomics: Developing the discipline and profession. *Ergonomics*, *55*(4), 377–395. doi:10.1080/00140139.2012.661087

Dunn, R., Krimsky, J., Murray, J., & Quinn, P. (1985). Light up their lives: A review of research on the effects of lighting on children's achievement and behavior. *Reading Teacher*, *38*(9), 863–869. Retrieved from http://www.jstor.org.ezproxylocal.library.nova.edu/stable/pdfplus/20198961.pdf?acceptTC=true

Earthman, G. I. (2004). *Prioritization of 31 criteria for school building adequacy.* Baltimore, MD: American Civil Liberties Union Foundation of Maryland. Retrieved from www.schoolfunding.info/policy/facilities/ACLUfacilities_report1-04.pdf

Emmons, M., & Wilkinson, F. C. (2001). Designing the electronic classroom: Applying learning theory and ergonomic design principles. *Library Hi Tech, 19*(1), 77–87. doi:200670380

Evans, G. W. (2006). The effects of the physical environment on children's development. *Annual Review of Psychology, 57*, 423–451. doi:10.1146/annurev.psych.57.102904.190057

Farmer, L. (2009). *Library e-learning spaces*. Retrieved from https://www.researchgate.net/publication/253413978_Library_e-learning_spaces

Foster, M., Fazelian, J., & Cytron, R. (2014). "It's not a fad: Incorporating mobile devices into the classroom. Washington *University Libraries Presentations* (Book 13). Retrieved from http://openscholarship.wustl.edu/lib_present/13

Gall, M., Gall, J., & Borg, W. (2007). *Educational research: An introduction* (8th ed.). Boston, MA: Pearson Education.

Gainer, R. (2008). History of ergonomics and occupational therapy. *Work: A Journal of Prevention, Assessment and Rehabilitation, 31*(1), 5–9. Retrieved from http://iospress.metapress.com.ezproxylocal.library.nova.edu/content/735321623174j4w4/fulltext.pdf

Gee, L. (2006). Human-centered design guidelines. In D. G. Oblinger (Ed.), *Learning spaces* (pp. 10.1–10.13). *EducauseEbook*. Retrieved from http://net.educause.edu/ir/library/df/PUB7102k.pdf

Google. (2016). *Google play: ListNote speech-to-text notes*. Retrieved from https://play.google.com/store/apps/details?id=com.khymaera.android.listnotefree&hl=en

Graham, M., & Graham, W. (2013*). University libraries and space in the digital world.* Farnham, England: Ashgate.

Grayson, J. (2009). Elementary ergonomics: With the use of digital devices occupying a central role in students' lives, what was a workplace issue long ignored by schools now demands their attention. *THE Journal [Technological Horizons in Education*] *36*(6), 15. doi:A202365178

Hall, K. (2013). *The impact of new learning spaces on teaching practice: Literature review*. Retrieved from http://www.edu-tech.com/assets/the-impact-of-new-learning-spaces-on-teaching-practice.pdf

Harrop, D., & Turpin, B. (2013). A study exploring learners' informal learning space behaviors, attitudes, and preferences. *New Review of Academic Librarianship*, *19*(1), 58–77. doi:10.1080/13614533.2013.740961

Herman Miller Inc. (2009). *Adaptable spaces and their impact on learning: Herman Miller research summary.* Retrieved from http://www.hermanmiller.com/research/research-summaries/adaptable-spaces-and-their-impact-on-learning.html

Higgins, S., Hall, E., Wall, K., Woolner, P., & McCaughey, C. (2005). *The impact of school environments: A literature review.* London, England: Design Council. Retrieved from http://www.cfbt.com/evidenceforeducation/pdf/91085_SchEnvironments.pdf

Hunley, S., & Schaller, M. (2009). Assessment the key to creating spaces that promote learning. Retrieved from http://www.educause.edu/ero/article/assessment-key-creating-spaces-promote-learning

Hunter, J., & Cox, A. (2014). Learning over tea! studying in informal learning spaces. *New Library World, 115*(1), 34–50. Retrieved from doi:http://dx.doi.org.ezproxylocal.library.nova.edu/10.1108/NLW-08-2013-0063

International Ergonomics Association. (2000). *The discipline of ergonomics*. Retrieved from http://www.iea.cc/01_what/What%20is%20Ergonomics.html

Kennedy, M. (2010). In position to learn. *American School & University*, *82*(6), 20–22. doi:212759924

Kennedy, M. (2012). Learning in comfort: Ergonomic considerations are an important factor in classroom furniture. *American School & University*, *82*(6), 22–24. doi:212759924

Kolcaba, K. Y., & Kolcaba, R. J. (1991). An analysis of the concept of comfort. *Journal of Advanced Nursing, 16*(11), 1301–1310. doi:10.1111/1365-2648.ep8529503

Kroemer, K., Kroemer, H., & Kroemer-Elbert, K. (2001). *Ergonomics: How to design for ease and efficiency* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

Lane, W. R. (1968). *Thermal environment and learning.* Iowa City, IA*:* Iowa Center for Research in School Administration. Retrieved from http://search.proquest.com.ezproxylocal

.library.nova.edu/docview/64446204?accountid=6579

Lang, S. S. (2000). Ergonomist provides online guidance for children to avoid injury at computer. *Human Ecology*, *28*(1), 24. Retrieved from http://search.proquest.com/openview/03e1b96da79aa2db099151bdffcd6d58/1?pq-origsite=gscholar&cbl=27297

Latha, P. (2014). A study to assess the achievement motivation of higher secondary students in relation to their noise sensitivity. *i-Manager's Journal on Educational Psychology*, *7*(4), 25–30.

Legg, S. (2007). Ergonomics in schools. *Ergonomics, 50*(10), 1523–1529. doi:10.1080/00140130701584878

Lippincott, J. K. (2006). Linking the information commons to learning. In D. G. Oblinger (Ed.), *Learning spaces* (pp. 7.1–7.18). *EducauseEbook*. Retrieved from http://net.educause.edu/ir/library/ pdf/PUB7102k.pdf

Lippman, P. (2010). Can the physical environment have an impact on the learning environment? doi:http://dx.doi.org/10.1787/5km4g21wpwr1-en

Maxwell, J. A. (2005). *Qualitative research design. An interactive approach*. Thousand Oaks, CA: SAGE.

Mayo Foundation for Medical Education and Research. (2015). *Office ergonomics: Your how-to guide.* Retrieved from http://www.mayoclinic.org/healthy-lifestyle/adult-health/in-depth/office-ergonomics/art-20046169

McLaughlin, P., & Faulkner, J. (2012). Flexible spaces … what students expect from university facilities. *Journal of Facilities Management, 10(*2), 140–149. http://dx.doi.org/10.1108/14725961211218776

McVey, G. F. (1971). Modifying the home into a learning environment. *Education*, *91,*323–332. Retrieved from *Education Source*, EBSCO*host*.

McVey, G. F. (2001). Ergonomics and the learning environment. In D. Jonassen (Ed.), *Handbook of research for education communications and technology* (pp. 1045–1104). New York, NY: Simon & Schuster Macmillan.

Mendell, M. J., & Heath, G. A. (2005). Do indoor pollutants and thermal conditions in schools influence student performance? A critical review of the literature. *Indoor Air, 15*(1), 27–52. Retrieved from http://onlinelibrary.wiley.com.ezproxylocal.library.nova.edu/doi/10.1111/j.1600-0668.2004.00320.x/pdf

Miles, A., & Perrewe, P. (2011). The relationship between person-environment fit, control, and strain: The role of ergonomic work design and training. *Journal of Applied Social Psychology*, *41(4)*, 729–772. Retrieved from http://onlinelibrary.wiley.com.ezproxylocal.library.nova.edu/doi/10.1111/j.1559-1816.2011.00734.x/pdf

Milne, A. (2006). Designing blended learning space to the student experience. In D. G. Oblinger (Ed.), *Learning spaces* (pp. 11.1–11.15). *EducauseEbook*. Retrieved from http://net.educause.edu/ir/library/ pdf/PUB7102k.pdf

Mott, M., Robinson, D., Walden, A., Burnette, J., & Rutherford, A. (2012*).* Illuminating the effects of dynamic lighting on student learning. *SAGE Open.* Retrieved from http://sgo.sagepub.com/content/early/2012/05/03/2158244012445585.full.pdf+html

National Institute on Deafness and Other Communication Disorders. (2014). Common sounds. Retrieved from http://www.nidcd.nih.gov/staticresources/health/education/teachers /CommonSounds.pdf

Neuman, W. L. (2011). *Social research methods: Qualitative and quantitative approaches.* Upper Saddle River, NJ: Prentice Hall.

Oblinger, D. G. (Ed.). (2006). Spaces as a change agent. In *Learning spaces* (pp. 1.1–1.4). *EducauseEbook*. Retrieved from http://net.educause.edu/ir/library/ pdf/PUB7102k.pdf

Odunaiya, N. A., Owonuwa, D. D., & Oguntibeju, O. O. (2014). Ergonomic suitability of educational furniture and possible health implications in a university setting. *Advance Medical Education Practice.* 5, 1–14. Retrieved from http://dx.doi.org/10.2147/AMEP.S38336

Oldham, G. R., & Rotchford, N. L. (1983). Relationships between office characteristics and employee reactions: A study of the physical environment*. Administrative Science Quarterly*, *28*(4), 542–556. doi:10.2307/2393008

Ozkaya, N., & Nordin, M. (1991). *Fundamentals of biomechanics: Equilibrium, motion, and deformation*. New York, NY: Van Nostrand Reinhold.

Pappas, J. P. (1990). Environmental psychology of the learning sanctuary. *New Directions for Adult and Continuing Education, 46,* 41–52. doi: 10.1002/ace.36719904606

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: SAGE.

Pheasant, S. (1991). *Ergonomics, work and health.* Gaithersburg, MD: Aspen.

Reed, M. (2013). *Controlling the learning environment and how it will impact academic outcome*. Retrieved from http://reedsomething.com/2013/09/10/controlling-the-learning-environment-and-hot-it-will-impact-academic-outcome/

Rudolf, M., & Griffiths, Y. (2009). Evaluating the ergonomics of a student learning environment. *Work, 34,* 475–480. doi:10.3233/WOR-2009-0948

Schneider, M. (2002). *Do school facilities affect academic outcomes?* National Clearinghouse for Educational Facilities. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/62232360?accountid=6579

Shield, B., & Dockrell, J. (2008). The effects of classroom and environmental noise on children's academic performance. In B. Griefahn (Ed.), *ICBEN 2008: The 9th Congress of the International Commission on the Biological Effects of Noise: Proceedings* (pp. 369–377). Dortmund, Germany: Leibnitz Research Centre for Working Environment and Human Factors. Retrieved from http://www.icben.org/2008/PDFs/ICBEN_Proceedings_2008.pdf

Simonson, M. (1995). Does anyone really want to learn at a distance? *Tech Trends, 40*(5), 12.

Simonson, M., Schlosser, C., & Hanson, D. (1999). Theory and distance education: A new discussion. *American Journal of Distance Education, 13*(1), 60–75. doi**:** 10.1080/08923649909527014

Simonson, M., Smaldino, S., & Zvacek, S. (2015). *Teaching and learning at a distance: Foundations of distance education* (6th ed.). Upper Saddle, NJ: Prentice-Hall.

Smith, T. J. (2007). The ergonomics of learning: Educational design and learning performance. *Ergonomics, 50*(10), 1530. doi:10.1080/00140130701587608

Steel, C., & Andrews, T. (2011). *Re-imagining teaching for technology-enriched learning spaces: An academic development model*. Retrieved from http://www.academia.edu/235071/Steel_C._H._and_Andrews_A._2011_._Re-imagining_teaching_for_technology-enriched_learning_spaces_An_academic_development_model._In_M._Keppell_K._Souter_and_M._Riddle_Eds._Physical_and_Virtual_Learning_Spaces_in_Higher_Education_Concepts_for_the_Modern_Learning_Environment_IGI_Global

Sundstrom, E., & Sundstrom, M. G. (1986). *Work places: The psychology of the physical environment in offices and factories.* New York, NY: Cambridge University Press.

Szto, P., Furman, R., & Langer, C. (2005). Poetry and photography: An exploration into expressive/creative qualitative research. *Qualitative Social Work, 4*(2), 135–156. doi: 10.1177/1473325005052390

Tanner, C. K. (2008). Explaining relationships among student outcomes and the school's physical environment. *Journal of Advanced Academics*, *19(*3), 444–471. Retrieved from http://joa.sagepub.com/content/19/3/444#

Timm, D. (2007). Making ergonomic adjustments to the workplace. *Buildings*, *101*(5), 32. doi**:** 210221333

United States Department of Labor Occupational Safety & Health Administration. (n.d.-a) *Ergonomics.* Retrieved https://www.osha.gov/SLTC/ergonomics/

U.S. Department of Labor Occupational Safety & Health Administration. (n.d.-b). *Computer workstation: Desk.* Retrieved from https://www.osha.gov/SLTC/etools/computerworkstations/components_desk.html

U.S. Department of Labor Occupational Safety & Health Administration. (n.d.-c). *Occupational noise exposure*: Retrieved from https://www.osha.gov/SLTC/noisehearingconservation/

U.S. Green Building Council. (2015). *USGBC history*. Retrieved http://new.usgbc.org/about/history

van de Mortel, T. F. (2008). Faking it: Social desirability response bias in self-report research. *Australian Journal of Advanced Nursing*, *25*(4), 40–49.

Vischer, J. C. (2007). The effects of the physical environment on job performance: Towards theoretical model of workspace stress. *Stress and Health*, *23*(3), 175–184. doi**:**10.1002/smi.1134.

Wargocki, P., & Wyon, D. P. (2007). The effects of moderately raised classroom temperatures and classroom ventilation rate on the performance of schoolwork by children (RP-1257). *HVAC&R Research, 13*(2), 193–220.

Willging, P., & Johnson S. (2004). Factors that influence students' decision to dropout of online courses. *Journal of Asynchronous learning Networks, 8*(4), 105–118. Retrieved from http://sloanconsortium.org/jaln/v8n4/factors-

influence-students039-decision-dropout-online-courses

Wroblaski, K. (2011). School furniture reflects function. *Buildings*, *105*(2), 28. doi:853144421.

Zhang, G., Zheng, C., Yang, W., Zhang, Q., & Moschandreas, D. (2007). *Thermal comfort investigation of naturally ventilated classrooms in a subtropical region.* Retrieved from http://www.aseanenvironment.info/abstract/41015347.pdf

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