A graduate thesis project submitted in partial fulfillment of the requirements
for the degree of Master of Science in
Family and Consumer Sciences

By
Alejandro Hernandez

In collaboration with
Niloofar Khalighi

May 2015
The graduate thesis project of Alejandro Hernandez:

___________________________________   _________________________
Judith Griffin, MA, CID

___________________________________   _________________________
Yoko Mimura, Ph.D.

___________________________________   _________________________
Anu Thakur, Ph.D. Chair

California State University, Northridge
ACKNOWLEDGMENT

I would like to thank our committee members who supported our efforts in writing this graduate thesis project.

To my chair, Dr. Thakur, who suggested this thesis project topic, provided the guidance to include all the different parties involved, and remaining in our corner so we were headed in the right direction.

To Dr. Mimura who read my drafts and provided excellent feedback which in turn helped correct my writing mistakes so this thesis project submission would be in line with expectations.

To Professor Griffin who helped guide my design drawings and corrected design flaws or code issues.

Support and encouragement from my friends and family were invaluable and have always given me the motivation for my research. Additionally, to Dr. Lisagor who was a guiding force in my last Spring semester and kept me on course to complete our thesis project and graduate on time.
# TABLE OF CONTENTS

Signature Page  
Acknowledgment  
List of Figures  
Abstract  

CHAPTER I – INTRODUCTION  
Statement of the Problem  
Purpose  
Definitions  
Assumptions  
Limitations  

CHAPTER II – REVIEW OF LITERATURE  
Pedagogy  
Built Environment  
Technology  
Summary  

CHAPTER III – METHODOLOGY  
The Management Model: Input-throughput-output  
Design Concept Development  

CHAPTER IV – FINDINGS  

CHAPTER V – DISCUSSION  
Recommendations for Further Research  
Limitations  
Implications  
Conclusions  

REFERENCES  

LIST OF FIGURES

Figure 1 – Traditional Classroom Formation

Figure 2 – Learning Lab Formation

Figure 3 – Team Work Formation

Figure 4 – Floor Pattern Guide for Classroom Arrangement
ABSTRACT

PROVIDE A PHYSICAL SPACE THAT SUPPORTS MULTIDISCIPLINARY, TEAM-TAUGHT, HIGHLY INTERACTIVE LEARNING UNBOUND BY TRADITIONAL BUILT PEDAGOGY

By

Alejandro Hernandez

Master of Science in

Family and Consumer Sciences

The purpose of this graduate thesis project was to study existing literature and design a classroom of the future. I conducted a thorough literature review to evaluate relevant articles that described different pedagogies, built-environments, and technology to support the need for a classroom of the future. The Extended Learning Center at California State University, Northridge allocated one classroom for this purpose. I was selected from the Graduate program to conduct the research and design. The thesis project will not be completed before this submission; however, this design should serve as a guide to implementing the necessary findings for a classroom of the future. Further research or testing may be required after the classroom is built.
CHAPTER 1

INTRODUCTION

As technology continues to evolve, we see how it affects our everyday lives. Acquiring a higher education is essential to positioning ourselves for greater standards, quality of life opportunities and goals. The global economy has created international competition for local jobs. In order for our traditional and continuing education students to compete we must prepare them for technologically diverse learning environments. As an example, of the global competition in India alone there are approximately 350,000 advanced degree graduates per year (Fielding, 2006). Higher education equates to colleges, universities, and other forms of post high school education. These goals are shared by a diverse student population seen at all levels of education, from traditional to post-graduate to professionals returning for continuing education. Students are impacted daily by the dynamic assortment of technology that affords them the opportunity to maximize their daily schedules and routines. The use of mobile devices has created a sub-team of smart phones, tablets, traditional laptops, and computers (Fox, 2012). In an ever-advancing world filled with technology, the boundaries of the traditional classroom setting may not be boundless enough for today’s learners. Today’s technological variables extend the boundaries of everyday information access, and in some instances the use of virtual reality (VR) technology is replacing screens (Wang, 2012).

When these highly technologically evolved individuals enter traditional higher education classrooms, the old-style classroom presents a static situation that may contrast with student’s more modern-life routines. Obeidat and Al-Share (2012) inform us that classroom seating layouts that do not encourage collaborative work are considered dull, empty, huge, and meaningless. The built pedagogy (i.e. the design or layout of classrooms that conform to
traditional teaching theories) in our universities and other higher education institutions may be at their sunset, because they cannot sustain their existence while the outside world zooms by at a feverish pace to grow and innovate through technology. It is time to design classrooms to be more dynamic and robust with regard to technology. According to Fox, (2012) Greek philosopher Plato informs us that at one point in history the written word was thought to encourage laziness and forgetfulness. This highlights the possibility of rival theories that might disparage our concept.

The private sector has numerous examples of using built environments to shape behaviors that promote collaborative and technological synergy. Apple Inc. has redefined their built environment as different, where previously segregated departments now collaborate throughout the day (Isaacson, 2011). Apple redesigned their built environment with cross sectional properties. The idea of cross sectional properties is designing floor layouts to systematically construct departments adjacent to each other that traditionally may have been situated as close. It is a decision that continues to return excellent dividends for Apple’s workforce (Fox, 2012). It may be possible to maximize active and engaged learning in a specified classroom through the use of all or most modern technology in the built environment to render a new built pedagogy.

California State University, Northridge is building an Extended Learning Center (ELC) that will feature a technically driven built pedagogy that encourages more collaborative behaviors. It will feature the use of mobile and standard devices that accentuate the Wi-Fi nature of the new built classroom environment. Projecting ideas will not be the same in this new Center, as students and instructors seamlessly interact and present their work. In a way, students will be able to seamlessly interact with the outside world at the same rate. This paves the way
for millennials, or digital natives, (Prensky, 2001), and newer generations to engage and interact within this new technological pedagogy.

Statement of the Problem

Traditional instructor-centered teaching uses built pedagogies that may not fulfill the technological needs that students and instructors have become familiar and dependent upon. Classroom design that is static in nature may be limiting, and may no longer satisfy the changing dynamics of technology and student practices. The exterior world is advancing by factors that traditional built pedagogies do not afford to their students and instructors. If changes do not occur to traditional classrooms the net result may not be fruitful for the all the parties involved.

Purpose

The purpose of this thesis project is to create architectural drawings and renderings for a physical space that supports a wholesome, team-taught, highly interactive learning unbound by traditional built pedagogy; a construct that would improve flexibility, comfort, sensory stimulation, technical support, and de-centeredness in the modern classroom setting. Through this thesis project, each of these factors are broken down to subcategories to accomplish overall main constructs, including: furniture, color, lighting, temperature and acoustics. Completion of the classroom of the future is the ultimate goal of this thesis project.

Definitions

1. Baby boomers are individuals born after World War II from 1946 – 1965 during the baby boom.

2. Built-environment is all the interior architectural elements that combined form the interior occupancy and affect human behavior either positively or negatively (Sommer, 1969; Altman, 1970).
3. **Clerestory** is a row of windows in the upper part of a wall.

4. **Collaboration** is working together with other individuals for the purpose of accomplishing a single goal or thesis project.

5. **Comfort** is when a person is in a state of ease and or solace.

6. **De-centeredness** is the classroom teaching environment that provides for instruction to be explained and collaborated throughout the classroom, and not specific to the front of the classroom.

7. **Environment** is all the components within a physical spaced designed to affect the occupancy type and occupants.

8. **Flexibility** is the classroom’s ability to use different technology for learning or teaching.

9. **Flipped learning** is the teaching method that is opposite of the traditional, podium at the front of the classroom, and instructor focused environment.

10. **Generation Xers** are the team of people born between the mid-1960s and early-1980s.

11. **Holistic** encompasses all the components within an interior space to form one system.

12. **Millennials** are a team of people born between the early-1980s to the early 2000s and sometimes referred to as Generation Y.

13. **Multidisciplinary** is the participation of several academic disciplines within a specific occupancy or interior built environment.

14. **Paradigm** is to change the boundaries or rules of design to include new ideas or designs to support new pedagogies.

15. **Pedagogy** is the theory of teaching as a result of the built environment.

16. **Sensory stimulation** is for the purpose of our thesis project, is defined as how the occupants react and behave as a result of the built environment.
17. *Team-taught* instruction coming from a team or students rather than the traditional single lecturer or teacher.

18. *Teleconference* is the communication between two parties physically located in different regions or areas through the use of web cameras and software.

19. *VR (Virtual Reality)* is real-time computer graphics hardware and software that support the generation of high-quality, photo-realistic, images in real time (Zhu & Wang, 2012, p. 24).

**Assumptions**

This thesis project was created based upon certain assumptions.

- The renderings in this thesis project are accurate and are for the purpose of design development and not construction drawings.
- The renderings accurately represent a built classroom for a University campus setting.
- Participants are of above or equal requirements with regard to cognitive ability prior to admission to the extended learning classroom and University standards.
- Participants are familiar with basic technological processes like email, word processing software, and other relevant computer necessary tools.
- Participants are able to read and write in English.
- Participants are either physically able or disabled.
Limitations

This thesis project will contribute to the redesigning of the built environment for classroom setting of today. However, certain limitations exist:

- This thesis project is to be implemented in the Extending Learning Center building on the California State University, Northridge campus. Therefore, it may not be appropriate for other University campus settings.
- The thesis project is limited to implementing the technologic design rich environments of today, and may not anticipate all of the changing technologies for the future.
CHAPTER 2

LITERATURE REVIEW

The purpose of this literature review is to provide a review of the existing research regarding classrooms that utilize contemporary and future technology, to gain better insight into the need for classrooms with multidisciplinary versatility. The pedagogy, or theory and practice of education, of this technology-focused classroom, has as much impact as the technology itself. It is reviewed to illuminate its early characteristics to today’s Flipped Learning pedagogy (Roehl, Reddy, & Shannon, 2013). Flipped learning, we believe, is the most appropriate pedagogy for this thesis project’s technological and learner focused design goals.

The areas of literature that constitute the basis of this literature review include pedagogy, built-environments, and technology. Researching these existing literature sources may pave the way for a better understanding of successful contemporary built environments, as well as set the stage for this thesis project. Ultimately, this review serves to inform and shape our thesis project design, which will be applied in a single case study classroom in the new Extended Learning Center at California State University, Northridge (CSUN).

Pedagogy

Early Pedagogy

Before this period of flipped learning, most composition studies and other pertinent pedagogy from the middle of the nineteenth century focused on analyzing student work for errors (Salvatori & Donahue, 2012). The thesis project may or may not cater to composition studies, but as a design for a contemporary multidisciplinary classroom, the classroom design for this thesis project needs to be flexible enough for wider application, in case it does get utilized for
composition studies classroom. This is also why we believe the technology needs to be flexible for today’s and tomorrow’s needs. Purpel (1967) informs us of the challenges to high-quality teaching in the mid-20th century. Sometimes the survival need trumps the best teaching intentions, the principles of pedagogy may get missed. Purpel (1967) explains that instruction needs to include “description, analysis, and evaluation” (p.22) in the teaching experience. However, teaching using existing and new pedagogies necessitates appropriate supervision. Providing appropriate supervision was challenging for mid-20th century teaching, because of scarcity of resources, including faculty and funding (Purpel, 1967). Supervision of the newer technology and multidisciplinary classrooms will need further study, as it is not the focus of this literature review or thesis project.

In 1967, Purpel researched barriers to high-quality teaching. Though conditions have evolved since that time, these areas may still as important in contemporary teaching pedagogy. Pencil and paper evolved into modern technology. For this thesis project, tablets and laptops are the primary instruments used by students and faculty alike. It appears the early stages of pedagogy may have shared the same concerns as today’s educators.

**Traditional**

For the purposes of this thesis project, traditional mid-20\(^{th}\) century pedagogy will be reviewed. Salvatori and Donahue (2012) focused on evolving pedagogy in an effort to solve problematic issues that were contributing to loss of students in Composition Studies. The major influx of diverse students (e.g. older, Vietnam vet, working class, female, African American, Hispanic, etc.) required a change in Composition Studies pedagogy in the 1960s (Salvatori & Donahue, 2012). Other researchers like Nancye Blair (2012) focus on identifying the limitations of traditional pedagogies that support a static approach. Blair notes that new millennials are far
advanced in their technological skills, when compared to previous modes of educational instruction.

Barr and Tagg (1995) promote a paradigm shift in higher education, Undergraduate, from the “Instruction Paradigm” to the “Learning Paradigm”. This paradigm shift supports the hope for increased collaborative and team-taught teaching. The traditional instruction paradigm was designed to provide instruction; conversely, the learning paradigm focuses on producing learning. The classroom is no longer just limited to 50-minutes of instruction as in traditional settings.

Salvatori & Donahue (2012) concluded that pedagogy minimizes the need to expose the limits of a given teaching theory. This is what we hope to accomplish with what we refer to as the technology multidisciplinary classroom. The diverse teams of students that comprise the occupants for this classroom are made up of Baby Boomers, Generation Xers, and Millennials. The learning paradigm removes the traditional constraints of undergraduate education. Traditional paradigms are, at times, resistant to change; with the learning paradigm, it is no different. Educators and institutions may need to embrace “produce” instead of “provide” as learning is the ends, not the means. Our thesis project may face similar obstacles as we promote flipped learning as the most suitable teaching theory for the multidisciplinary technology classroom. Barr and Tagg note that Stravinsky’s *The Rite of Spring* experienced tomato throwing and being hooted off stage at the outset of its own musical paradigm shift (1995). Change is not always well-received; but change is a normal part of life.

**Flipped Learning**

Re-envisioning the role of technology in the classroom supports the idea of flipped learning. It is necessary to provide the means to quick information access in flipped learning
environments to afford 21st century students new knowledge (Blair, 2012). Our thesis project seeks to address the needs of Baby Boomers, Generation Xers, and Millennials.

Friedow, Blankenship, Green, and Stroup (2012) inform us of the difficulties and benefits of Interdisciplinary Pedagogies. Our thesis project concentrates on designing a multidisciplinary built environment driven by the latest technology. However, interdisciplinary and multidisciplinary apply to our thesis project because there are still few examples of this practice according to Friedow, Blankenship, Green, & Stroup (2012). Therefore, providing limited classroom environments that have outcomes in line with Newell’s (1994, page 35) suggestion that interdisciplinary or multidisciplinary courses “promise a wide range of desirable educational outcomes for students” may still present a challenge. Amey and Brown (2005) and Davis (1997) note the necessity of faculty collaboration and team teaching as necessary variables in interdisciplinary, or in our case, multidisciplinary environments.

Roehl, Reddy, and Shannon (2013) conducted a review to examine the increased levels of engagement within Millennial students (i.e. students born between 1982-2002) using Flipped Learning pedagogy. These students are regarded as “Digital Natives” (Prensky, 2001). They have a predisposition to collaborative work as they are accustomed to non-stop access to information and technology. Prensky (2001) states that Millenial students have fundamental differences with their predecessors in how they think and process information. Ritchhart et al., (2011) take this further in stating that flipped learning classrooms, supported by advanced technology, may increase students’ depth of learning. This contrasts traditional surface learning, which is grounded in memorization. The current study concentrated on courses within Family and Consumer Sciences (FCS). Lage et al. (2000) conducted a study using flipped learning in an economics course and found results supporting changing pedagogy within the economics course.
The main construct was engaging millennial students through the active learning or flipped classroom pedagogy independent variable.

Fox (2013) investigated how an improved library research variable may translate to the classroom. The focus of this study was to determine the pedagogical processes that lead to improved library research, looking specifically at instructional design and educational technology. Proactive pedagogy, according to Fox (2012), provides for contemporary awareness and utilizing modern technologies and encourages collaborative research and studying methods. It was noted that 90% of the students had a high gaming proficiency, suggesting that those students were adaptable to newer technologies. Using the same existing pedagogy and classroom technology may stall the ability of these newer generations to learn curriculums. The main construct for the Fox study was to evaluate the effectiveness of libraries in improving student research and study potential. The results showed libraries are not immune from the technology and collaboration trend and added to existing literature regarding technology in education.

Lee, Lee, and Park (2013) parallel the built pedagogy of our thesis project, looking at multidisciplinary and technological versatility. Kim et al. (2011) like the current study, noted that the most prominent growth sector for (ICT) Information and Communications technology (i.e. Computer Information technology [CIT]) is in the education sector. Lee, Lee, and Park (2013) note that advanced pedagogies are most appropriate for a technologically advanced classroom. They identify them as 1) Student-Centered learning which promotes constructivist learning; 2) Cooperative learning which is different from our Collaborative learning variable and; 3) Problem-Based learning which focuses on creating a process to solve problems and learning happens within the process (Lee, Lee, & Park, 2013). The current project literature review is composed of three areas, which include Pedagogy, Built-Environment, and Technology. These
areas are designed to develop and support a multidisciplinary technology classroom. Lee, Lee, and Park (2013) slightly vary in their model of an advanced classroom. They promote a model that includes advanced pedagogy, content, and ICT to form the Smart Learning (Lee, Lee, & Park, 2013).

Friedow, Blankenship, Green, and Stroup (2012) conclude that interdisciplinary studies have specific beneficial characteristics that include: institutional citizens from different disciplines who collaborate to create and design new teaching and learning experiences, a willingness to look at challenges or struggles as opportunities for discussion and not as failed pedagogy, and faculty willing to re/learn or continuing education to make this newer pedagogy work. This may include a faculty approach that presupposes they approach projects as learners instead of experts, as this leaves an open mindedness to new pedagogies. Rebecca Nowacek (2009) reminds us that there is still obscurity in the general discourse of interdisciplinary pedagogy or for our thesis project multidisciplinary pedagogy.

Flipped learning presents similarities to workplace environments where collaboration and team-teaching are more than buzz words, in return highlighting the multidisciplinary technology classroom as a microcosm of the outside university world. The Partnership for 21st Century Skills supports implementation of the “four C’s: critical thinking, creativity, communication, and collaboration” (Blair, 2012, p. 10). Blair sees the teacher as the orchestrator, or facilitator, of students and the students as explorers, and the focal point of the classroom, such as when kindergarteners create image-based movies, or when first-graders develop PowerPoint presentations, or when fourth graders create digital storybooks in preparation for standardized tests. Younger students start to develop confidence when their work is published worldwide and they receive feedback from a global audience of their peers (Blair, 2012).
Roehl, Reddy, and Shannon (2013) found that students and educators may need to shift the pedagogy paradigm to include active learning utilizing flipped learning strategies. This pedagogy may provide increased versatility that will involve students who normally are recluse in lecture-based formats. It is possible that this idea will improve those students’ work and future prospects because there is increased student and teacher collaboration. Blair (2012) implies that students are well served to acquire the technological skills while still in college. It will benefit traditional students as well as continuing education students as they enter into the workplace. Additionally, the collaborative nature of a flipped classroom translates into the workplace. For these goals to be met, instructors will need appropriate training in order to guide these new built environments and pedagogy.

Instructional design and educational technology lead to improved comprehensive and proactive services within libraries. These variables may translate to improved classroom design when considering the classrooms need to adapt to multiple disciplines and users. Fox (2013) concluded that baseline requirements of technology include various devices and access to information, and that these are necessary to accomplish the technological classroom of the 21st century.

Though the nomenclature of our thesis project varies from Lee, Lee, & Park’s (2013) smart learning, we believe the ultimate goal is almost identical with the difference being, as designers, we intend to additionally focus on the built environment to help shape the pedagogy and behaviors within the multidisciplinary technology classroom. While Lee et al. emphasized cooperative learning, the current built design is focused on collaborative learning pedagogy; Lee et al. promote constructivist learning specifically, while in the current thesis project, we are designing the classroom to support many forms of learning, including but not limited to
constructivist learning. Pedagogy is an important variable in the design of our multidisciplinary technology classroom.

**Built Environment**

Yildirim, Capanoglu, and Cagatay (2011) inform us of the perception that comfort, motivation, and concentration students and teachers develop in relation to the effects of physical environment in computer classrooms. The built environment is the second component or variable in the design of the multidisciplinary technology classroom. Environmental psychology teaches designers to understand the behavioral effect on occupants. Within the built environment, the authors evaluate 1) flexibility, 2) comfort, 3) sensory stimulation, 4) technological support, and 5) de-centeredness. Yildirim, Capanoglu, and Cagatay (2011) found the following quote from a teacher:

> I am a teacher. There is a need to change the classroom design to meet educational reforms…There are desk centered classrooms with computers in front…The classroom could be less structured with more space… (p. 502)

**The Human Ecological Theory and the Built Environment**

Understanding how a physical space that supports a multidisciplinary, team-taught, highly interactive learning, unbound by the traditional pedagogy is related and supported by Urie’s Bronfenbrenner’s Human Ecology Theory (1979). His theory explains how the different environments we encounter throughout our lifespan influence our behavior. There are five environments in Bronfenbrenner’s model; the microsystem, mesosystem, exosystem, macrosystem, and the chronosystem. The theoretical model can be used to identify and
understand how interior learning environment design can affect both the students’ and professors’ perceptions and behaviors.

**Flexibility**

“The setting of a computer classroom is as important as that of a traditional classroom” (Yildirim, Capanoglu, & Cagatay, 2011, page 501) is a statement that may be applicable to the multidisciplinary technology classroom, as it promotes a holistic design that considers variables outside of the physical elements. Walden (2009) suggests that designers should consider spatial factors when designing for the occupant’s wellbeing. He informs the designer to consider olfactory (smell) as part of spatial design. Understanding olfactory impacts as a design consideration lends more flexibility to the design.

Flexibility may include additional design considerations, such as lighting (Yildirim, Capanoglu, & Cagatay, 2011). Their research suggest that desks or tables covered in computer equipment may diminish students’ flexibility perceptions of the computer classroom. For example, the authors recommended that equipment be stored under the desk or work area. Storage may add to perceptions of flexibility and result in a favorable feeling towards the multidisciplinary technology classroom.

Oreidat and Al-Share (2012) examined the physical environment satisfaction of users in Interior Design programs. The authors evaluated workstations (flexibility and de-centeredness) and their impact on students’ ability to receive instruction from educators in Interior Design programs in Jordan. Physical environments help shape behaviors, perceptions, and interactions with students and teachers in design studios and other instructional classroom settings. Peripheral influencers like psychological, cultural, social, and physical were not directly addressed in this study. The main construct was to determine to which level specific
environmental features assure users’ needs and objectives with the design-studio classroom environment. The classroom environment was an accumulation of furniture, flexibility of furniture arrangement, color, lighting, and temperature. Individual workstations were examined to see if perception the of classroom environment was affected. Interior Design program participants (n=86) completed surveys. Of these, 47.7% of the respondents currently have experience using studio workstations. Sixty percent of the remaining respondents plan to implement workstations into the classroom environment that addresses the furniture and flexibility of furniture arrangement variables. Participants ranked lighting as the most important interior feature of design-studio environments; the least important feature was color. Thus, it seems that lighting is the most important feature and should be thoroughly considered for quantity and quality of lighting source. These features should be carefully considered at the beginning of design process and should include input from users of the occupancy.

Comfort

Comfort is afforded in a classroom when designers understand the effect spatial conditions have on an occupant (Yildirim, Capanoglu, & Cagatay, 2011). In their study, students felt more comfortable when table arrangements provided for increased space between occupants. However, students felt more connected to the instructor when table arrangements were closer. Walden (2009) informs us that designers should consider heating, cooling, and ventilation, in addition to spatial conditions and aesthetics to increase comfort. However, comfort is not always considered. Luppicini’s 2009 study excluded climate control and olfactory (smell) perception. Emmons and Wilkinson (2001) noted that seating arrangements may significantly affect comfort, including ergonomic design principles. Owu (1992) noted that seating arrangements need to be
directed toward the instructor, as in traditional computer classroom settings, which contrasts this thesis project’s multidisciplinary technology classroom.

According to research by Veltri, Banning, and Davies (2006), the college classroom environment affects the occupant’s psychological attitude, behavior and performance from both the students and instructors. A classroom environment should be designed to be enjoyable, comfortable, flexible, adaptable, and suitable for several generations to come.

In a literature review including more than 50 articles, MacMillan (2006) noted the connection between new well-designed buildings and student and staff’s concentration and quality of education. MacMillan (2006) suggests that the existence of well-designed buildings on a campus is a significant factor in the successful recruitment and retention of staff and students. The research respondents identified beautifying features like cleanliness, a feeling of space and bright working areas as being most influential, when asked about what about a building design determines whether they would like to work and/or study at a facility. The building user’s overall level of satisfaction while studying or working is greatly influenced by how the space makes them feel and how happy they are in the learning facility.

There are several features such as functions and facilities of buildings, which had the most positive impact upon how the staff and students feel and behave while they are in learning spaces. Staff also specified that their office and workspace, and the size, proportion and openness of the building they worked in were positive contributing factors to the way they feel and behave. "Most staff categorized situational features, such as the external views and surroundings as having the most positive impact on how they feel and behave while at work, whereas most students identified structural/functional features, such as teaching rooms, in the location of stairs” (CABE, 2005a, page 28).
Sensory Stimulation

Hamid (2002) evaluated the influence of acoustical treatment on the conditions of typical classrooms, in terms of material placement and absorption characteristics and at the same time, and the effect of noise generated by instructional equipment on speech intelligibility (SI). Measurements were carried out in traditional, as well computer, classrooms of King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia. The results suggest that using sound absorption material in classrooms is significant to speech interpretation, as it affects sensory stimulation in regards to hearing. It also showed the enhancement of speech conditions when appropriate acoustical materials are incorporated into the designer’s plan.

Technological Support

Technological support within the built environment may be dependent on the actual design. Veltri, Banning, and Davies (2006) focused their research on students’ behavior and performance in a more technologically-advanced classroom. This research incorporates a distance-learning component. The research evaluated what physical learning environment aspects impacted participants’ learning experience; it also evaluated students’ wish drawing of the ideal classroom (Veltri, Banning, & Davies, 2006). The rural community college used for the study was established in 1925, and its first classes were held in the local high school. Property was purchased for the campus in 1935 that included land and a building that housed five classrooms, a library, and an administrative office. The campus is currently situated on 17 acres and includes 16 major buildings. During this growth period of nearly 70 years, new buildings have been built and original buildings have been renovated. These two separate classrooms were chosen for the 520 College Student Journal study because they were similar in design and usage; both of the classrooms utilized Picture Tel compressed video technology, had
amphitheater-style tiered seating, carpeting, and similar audio-visual technology availability. The participants for this study were the students who had attended classes in these two classrooms and who answered the call for participation. Students who volunteered for the study participated in focus teams to discuss their perceptions of the built environment. Once the focus teams were concluded, students were asked to draw their ideal classroom. (Banning & Davies, 2006)

**De-centeredness**

De-centeredness may be affected by numerous variables. Fielding (2006) conducted a study to see the effect lighting and color have on learning in a classroom setting among schools and universities in the 21st century. The study highlights the need for designers to have strong logical and analytical skills in order to create holistic designs. As more and more advanced degree students enter the design profession it transforms into a commodity profession (Fielding, 2006). Learner-centered modes of education delivery are replacing teach or curriculum-centered classroom pedagogy. Fielding’s main construct was the different modes of delivering education in traditional classrooms. Fielding concluded that designers need to develop emotional, kinesthetic, and visual criteria in order for the designer to see the big picture or holistic design. This may result a more competitive and relevant designer for the 21st century.

Designers are better-served understanding there are nuances with regard to color and light when designing classrooms for 21st century students. Designing with holistic goals does not always incorporate the same specifications of the past specific to color and light. Criteria changes and designers need to stay current when designing 21st century classrooms. Ultimately this will create learning environments that adapt to the changing teaching theories or pedagogies.
This literature appeared to only address the general built environment and pedagogy. However, it may be that broader versatility is required in order to have a multidisciplinary technology classroom that provides for movement and de-centeredness.

**Technology**

Designing a multidisciplinary technology classroom may require incorporating contemporary technology that meets the needs of today’s users, as well as being flexible to adapt to future needs without the need for redesigning or reconstruction. This literature review section is written to give a background of the possible intersections between classrooms and technology. The technology component in this section addresses the 1) Internet, and 2) present-day technology within computer classrooms. The literature review is written to highlight positive examples of technology that may translate to the multidisciplinary technology classroom. There are some case studies to add background to the history and present day technological component within the classroom.

**Internet**

Portable computers with wireless Internet access can enhance the teaching and learning process in both local and widespread networks, specifically to see the effect of portable handheld computers with wireless Internet access and their effect on teaching and learning in network environments (Yang, 2012). Yang (2012) further provided a summary of design development, while defining *M-Education*, which is architecture of incorporating wireless technologies use in a prevailing common space in Yangtze University, China. The conclusion was that these educational environment users were able to work with their peers who are utilizing either the portable computers or the desktops while examining and modifying online collective information community. The study demonstrated that wireless classroom instructors and learners were
cooperating effortlessly with their colleagues in a desktop environment. They were also able to observe and adjust shared data maintained in the online community.

**Virtual Reality**

Zhu and Wang (2012) investigated the impact of virtual reality (VR) on education in classrooms, looking at how different professions are now using this technology to improve their respective practices - surgeons to real estate agents. According to the authors, who sent surveys to 800 university undergraduates, the virtual reality modeling language (VRML) allows for improved portability of files and smaller file sizes. This technology works within Internet browsers so accessibility is not as limited (Zhu & Wang, 2012). While this technological component may not be used immediately, it is now used often in the workplace and areas of leisure. Virtual reality presents an opportunity to increase student and professional training and knowledge in their chosen professions or areas of study. It provides for thorough and robust training that leads to improved thesis project design, test results, and safety awareness. The VR allows users to see mistakes or possible incidents that might be missed using traditional two-dimensional (2D) tools and instruments. The VR teaching instrument may improve the role of distance learning and teaching.

**Summary**

Classroom pedagogy and built-environments are adapting to a rapidly changing technological paradigm. Recent research and literature demonstrates the effect on pedagogy as the classroom has experienced in many cases a shift from teaching centered modes to learner centered modes (Roehl, Reddy, and Shannon, 2013). The results from this pedagogy shift have rendered positive attitudes to learner centered modes. It has provided classroom settings that are open to multidisciplinary curriculums. Design of classroom built-environments are shifting to
provide more flexibility from traditional lecture style built-environments (Yildirim, Capanoglu, and Catagay, 2011). The technological variable works to glue pedagogy and built-environments to form a new classroom paradigm that forms this research’s multidisciplinary technology classroom. The classroom will start to shift from a static to dynamic setting that is, perhaps, more in line with the workplace or outside world (Yang, 2012). Therefore, this change may produce students that can seamlessly enter their respective professions or careers. Professions now compete globally, so, students from schools that employ multidisciplinary technology classrooms may experience improved results from their education when competing against other recent graduates from around the world.

This literature review demonstrates that there is still additional research necessary to determine the effects a multidisciplinary technology classroom has on students with cognitive or physical limitations or disabilities. Therefore, the classroom of the future that we are designing will need a post occupancy survey to determine the effects on students and teachers. This thesis project took existing literature to inform design of the built-environment and apply technological components to provide an extensive classroom environment that supports evolving pedagogies.
CHAPTER 3

METHODOLOGY

Preparing twenty-first century students to work in the twenty-first industry can be a challenge. The purpose of this graduate thesis project was to design a classroom of the future (COTF). The COTF has been referred to as multidisciplinary technology classroom because it needs to accommodate multiple curriculums, and quickly changing technologies. The goal of this thesis project was to provide a model setting, the built environment for the future.

The Management Model: Input-throughput-output

The Team and Meetings

The COTF methodology was completed with our meetings component. This thesis project has been a collaborative effort that includes: our team, CIT students department, Steelcase, and department chairs. The initial meeting with Dr. Anu Thakur took place on August 26, 2014 where we discussed the construction of the Extended Learning Center. The construction included a classroom designated as the COTF which was left to Family Consumer Sciences graduate studies to design. Our team was asked to participate in designing the COTF and use it as our Graduate thesis project. We attained valuable information about the COTF in this initial meeting as it prepared us for developing the scope of work and thesis project writing.

Once our team agreed to participate and lead this thesis project we hit the ground running by meeting on September 3, 2014. This meeting consisted of selecting articles for the literature review. The meetings generally took place at the materials library of Sequoia Hall within the Family and Consumer Sciences department. The September 24, 2014 meeting was designated as an opportunity to compile articles and provide a gauge of the literature review.
In October there were four meetings within our team, Steelcase, and Dr. Anu Thakur our committee chair. The first meeting of October was held on October 1, 2014. It worked as a status meeting for our literature review and to start forecasting a timeline for our COTF thesis project. In the process of compiling our literature review it was determined that compiling annotated bibliographies for each article selected would create a foundation of writing that would provide vast amounts of written work for the team’s literature review. Alejandro was selected to do the writing for our COTF thesis project leaving most of the drawings to Niloofar. These decisions were made on October 8, 2014. The first formal meeting with the preferred vendor, Steelcase, was held on October 13, 2014 at their downtown Los Angeles office. It was the first opportunity to see the seating arrangements that would be utilized for the COTF and satisfy our comfort and de-centeredness goal. The conclusion was that the project utilizes the verb and node Steelcase products as furniture components in our COTF. The final team meeting of October was held on October 22, 2014 where we first addressed the CAD files provided by the architecture firm, LPA, chosen to design the Extended Learning Center where the COTF is located. This meeting included the CIT department students who are responsible with designing the wireless environment within the COTF.

November, December, and January were months generally concluding the semester and the commencement of a new semester. In these months the team met five times. By this point in our thesis project we were confident our articles were properly selected and the floor plan for the COTF was finalized. There were two notable meetings with Dr. Thakur to provide an update to our floor plans and literature review. The meeting on November 19, 2014 was the first and the second was the meeting on January 28, 2014 which was rescheduled to February 3, 2014.
On February 4, 2014 we met with the CIT students to begin the process of melding their technology with our design. We were able to understand the potential technical limitations of the COTF for the immediate future. March 12, 2014 we had our 2\textsuperscript{nd} and probably final meeting at Steelcase where some of our design questions and concerns were addressed and answered. March concluded with the 3\textsuperscript{rd} meeting with the CIT department students. This meeting took place on March 18, 2014.

The site location for this thesis project is part of a larger department construction and an Extended Learning Center and one classroom was allocated for our team to design a COTF. Technological guidance and support was contributed by students in CSUN’s Computer Information Technology (CIT) department. Their support for this thesis project is incorporated but not fully detailed in this methodology.

**Design Concept Development**

The team conducted an extensive literature review process to collect articles that referenced pedagogy, built-environments, and technology. The articles were specific to their correlation to educational classrooms encompassing different curriculums. The goal was to discover and understand these three areas and to apply them to our design of the COTF.

The first section, pedagogy, informed our thesis project that early and traditional pedagogy concentrated on an “Instruction paradigm” (Barr & Tagg, 1995). This pedagogical structure is in contrast to our goal of a “Learning paradigm” or “Flipped learning”. Thus, this shifted paradigm best fit our classroom of the future. Fox (2013) refers to this pedagogy as proactive, as he believes it supports utilizing modern technologies and encourages collaborative research and studying methods. These articles provided enough evidence that flipped learning would be the best suited pedagogy for our COTF.
The second area of literature that informed our design included articles that addressed the built-environment. As designers, we understand the behavioral effects of interior design. We researched articles to address five subcategories that we felt were the most significant to design the COTF. The areas of focus were: 1) flexibility, 2) comfort, 3) sensory stimulation, 4) technological support, and 5) de-centeredness.

Flexibility is a significant component in our design. Research suggested that the standard computer classroom desks and tables, equipped or covered with computer equipment, may diminish students’ flexibility. To progress toward this thesis project goal, the classroom design houses all computer equipment below the desks or tables. Walden (2009) informed the importance of olfactory, so we added a green wall with natural foliage to contribute to the olfactory perception of our classroom. Oreidat and Al-Share (2012) noted that lighting needs to be flexible as it is considered one of the most important features of their study. We designed lighting that provides flexibility as it uses natural and artificial light while adhering to existing lighting codes.

Research about the importance of comfort helped guide our design, as well. Spatial conditions have a significant effect on students’ levels of comfort (Yildirim, Capanoglu, & Catagay, 2011). To achieve a setting based on the variable, “comfort”, we are using Steelcase ergonomic products that accommodate the spatial conditions that are most conducive to improving comfort. Emmons and Wilkinson (2001) suggested that ergonomics are important to comfort for students and teachers.

Appropriate sensory stimulation guided our design to include acoustical treatments that could enhance, positively, students and teachers experience within the COTF. Therefore, we paid special attention to flooring and ceiling treatments. We designed our ceiling to reflect a
pattern and style that is promoting of the COTF theme while providing for sound absorption. This is important because the COTF will utilize teleconferencing that may encounter issues with echoing. The flooring had an aesthetic quality that provides a pattern design and guide for returning tables to their collaborative style setting or arrangement while providing for additional sound absorption. Fielding (2006) informed our design that occasionally it is advantageous to design a wall with a view. Our COTF has clerestory windows above the green wall that may be a feature that allows students to an opportunity to temporarily focus their sight in order to reset their concentration.

Technological support research led us to the conclusion that the COTF may need capabilities for past, existing, and future technological features. Steelcase exemplifies some of the most technologically advanced methods for our COTF. However, it is important to utilize technology that is physically convenient. The solution for this was to incorporate an abundance of Steelcase’s individual and large triangle dry erase boards that allow for quick sketches or idea demonstrations without the need for electrical power. To accommodate existing technology, the COTF will be equipped with ten (10) HDTV’s to project curriculums, student work, and instructor guidance. To complete the technological support within the COTF, we designed breakout areas to accommodate the use of virtual reality (VR). VR is further detailed in the technology section of our methodology.

De-centeredness research guided our design to support the recommended flipped learning pedagogy. Fielding (2006) stressed the importance of lighting and color. Those features contribute to a holistic design that encompasses the idea of de-centeredness. This provided the justification for the selected Steelcase furniture and the breakout zones in our design. In addition, the main part of the classroom is dedicated to implementation of flipped learning.
Therefore, we added two individual corner zones for individual study, teleconferencing, and curriculum work. To complete the holistic approach we designed a relaxed team collaboration zone at the east end of the COTF. It is our hope that these features support the de-centeredness of the COTF while supporting Fielding’s (2006) holistic idea. This completed our built-environment methods.

Appropriate technology was very important to the COTF. The students from the Computer Information Technology department at CSUN provided the predominant portion of the behind the scenes technological component. It was our team’s goal to employ technology within the built-environment or design of the COTF.

Further team research confirmed the importance of incorporating the Internet within the design. Yang (2012) provides support of wireless Internet access that allows for portable computers. Our design supports wireless technology with the premise of using tablets within the flipped learning pedagogy and built-environment. This is possible because our workstations and tables will be clear of any obstructions. Therefore, wireless connectivity to the Internet will be an easy practice. Additionally, projecting information, pictures, and videos from the Internet should be easily achieved.

Virtual reality (VR) technology is rapidly changing professions like Real Estate and Architecture. We designed the COTF to incorporate breakout zones to accommodate the space necessary for use of VR. This technological variable utilizes VR goggles that allows the viewer or user to experience spaces as if they were physically there. The COTF is designed to accommodate multiple curriculums and disciplines. It was felt that the VR feature would be incorporated in the future as new and different applications are discovered and implemented.
CHAPTER 4

FINDINGS

The classroom-of-the-future thesis project gave our team insight into the many components that can affect classrooms designed to accommodate multiple disciplines and advanced technologies. The thesis project consisted of one classroom in the new Extended Learning Center at California State University, Northridge (CSUN). Once the literature review was conducted, the team met and determined the scope of work and program for the classroom of the future which guided the team’s design decisions.

The final design included multiple areas designed to accommodate and encourage optimal classroom technology and pedagogies for multiple disciplines to be taught within the classroom. The classroom of the future was designed to be conducive to implementation of the recommended pedagogy, Flipped learning. Literature review informed the thesis project that flipped learning may be the best fit pedagogy for a classroom of the future (Roehl, Reddy, and Shannon, 2013). The built environment consisted of spatial allocation and furniture designed to support flexibility, comfort, sensory stimulation, technological support, and de-centeredness. It is anticipated that the thesis project’s design will be implemented in the classroom of the future’s actual construction. The scope of the architectural drawings was completed to the design development stage of design. The three variables affecting the classroom’s design (pedagogy, built-environment, and technology) completes the classroom’s design. Special attention was taken to accommodate past, present, and future technology. As an example, the classroom will utilize one-person single dry erase boards to virtual reality (VR) zones. The technology spectrum of the classroom of the future may be used to replicate in other projects designed to
optimize technology while accommodating multiple discipline curriculums (see Figures 1, 2, 3, & 4).
Figure 1. Illustration highlights the classroom's ability to arrange in a traditional setting.
Figure 2. Illustration highlights the classroom's ability to change into an arrangement conducive to Flipped Learning.
Figure 3. Illustration supports the thesis project goal to provide an arrangement that supports team work style configurations.
Figure 4. The classroom needs to open up for additional uses. Therefore, it can store away all tables but still provide a guide for returning to their original or desired placement. This depends upon the curriculum or teaching method.
CHAPTER 5

DISCUSSION

The purpose of this thesis project was to design a classroom of the future for one classroom located in the new Extended Learning Center at California State University, Northridge (CSUN). The classroom was also designed to accommodate a paradigm shift in pedagogy, built-environment, and technology. The classroom pedagogy design focused on shifting from “Instruction paradigm” to the “Learning paradigm”, or flipped learning, which may provide a more comprehensive collaborative learning environment (Barr and Tagg, 1995). This was seen as necessary due to the classroom’s expected utility as a classroom that would accommodate multiple disciplines and students spanning from Baby Boomers to Millennials. Upon determining the most appropriate pedagogy, the classroom built environment design considered spatial and furniture elements needed to fulfill these goals. Steelcase was determined and selected as the best fit for the spatial and furniture needs. The classroom’s technology component was designed to be dynamic. It was designed to be flexible enough that it would accommodate past, present, and future technology while avoiding the image of a static classroom unable to adapt to the constant change in technology. Upon completion of the design development drawings the administration and architectural professionals will implement relevant and appropriate designs of the thesis project in the construction of the classroom of the future.

Recommendations for Further Research

Evaluating the effectiveness of the classroom of the future may be necessary to assess whether or not the implementation improves the pedagogy, built-environment, and technology of a traditional classroom. It seems apparent that technology is evolving rapidly and resulting in an
increased technology savvy student population and labor force. Further research or post-occupancy surveys are recommended to measure whether or not the classroom of the future is improving student learning in the classroom.

Limitations

The main limitation of this thesis project was that it is in a conceptual phase. Designing this thesis project included addressing the three main variables affecting the main construct; pedagogy, built-environment, and technology. However, since it is yet to be built and experienced by students and teachers it does not have measurable results. Another limitation is that it is not known whether the thesis project will be built exactly to the specifications of the architectural drawings submitted. Modifications to the design elements might impact the effectiveness of the space. Further literature research may be necessary to determine specific technology needed for students with physical or cognitive disabilities. Notwithstanding these limitations, this thesis project may add to the body of knowledge for behavioral effects within built-environments using a combination of flipped learning (pedagogy), built-environments, and technology. This may constitute an about-face in designing classrooms of the future.

Implications

This thesis project will provide benefits to students, teachers, designers, and the administration. Students who use the classroom will experience a built-environment designed to promote collaborative work that mirrors some professions or public sector careers. Additionally, students will have an opportunity to experience, first-hand, technology they may not have used or could not afford. Teachers will participate in establishing curriculums that may set precedents in their respective professions or subjects. Designers and administrators will have a template which they may replicate for other similar projects. Ultimately, this thesis project is designed to
promote progressive thinking which is open to change and adaptability. In the process, it is hoped that student learning improves on many accounts, including grades and motivation.

Conclusions

Classroom built-environments have remained static for decades and possibly generations. Technological advances have been rapid and classroom design may not be at par with the technology incorporated in pedagogy. The purpose of this thesis project was to design a classroom of the future that employs state of the art technology. An extensive review of literature about active and flipped learning guided design decisions for a classroom that responds to future technology while providing for various teaching and learning styles in an adaptive, flexible environment.
REFERENCES


