EFFECTS OF DIFFERENT SEATING ARRANGEMENTS IN HIGHER EDUCATION COMPUTER LAB CLASSROOMS ON STUDENT LEARNING, TEACHING STYLE, AND CLASSROOM APPRAISAL

By

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This study investigated the physical arrangement of workstations, seating and equipment in computer lab classrooms and its effect on the social and physical settings of the classroom. The literature suggests that information technology (IT) encourages students to "learn by doing" and therefore affects student learning and teaching style within the technology-rich classroom environment. Zandervliet and Straker believe that the physical design of the seating, computer placement, and arrangement of space is often overlooked when IT is integrated into classrooms. However, no current research was found to support whether or not the physical design of higher education computer lab classrooms affects student learning, teaching style, and student and teacher appraisal of the classroom.

This study compared two differently arranged computer lab classrooms on the University of Florida campus. One computer lab classroom was configured in straight rows with a center aisle, while the other computer lab classroom was arranged in pods—

cross-shaped desks with a computer workstation at each end of the desk. Workstations and room arrangements were evaluated using measurements of the physical settings from the Computerized Classroom Environment Inventory (CCEI) instrument. A survey was conducted with 72 students and 5 teachers to appraise both the social and physical classroom settings.

The CCEI measures revealed deficiencies in the Computer, Workspace, and Visual environments in the straight row computer lab classroom, while the pod-arranged computer lab classroom only had a deficiency in the Computer workstation environment. Observations and student/teacher survey responses revealed that the students in the straight row computer lab classroom were off-task more often, had fewer student-to-teacher interactions, helped other students more often, and were distracted more often than the students in the pod arrangement. The frequency of student-to-student and student-to-teacher interactions indicated that the pod arrangement supported more collaboration than the straight row classroom. Nevertheless, over half of the students in both computer labs *liked* their classroom.

Further research is required to clarify the interactions between students and teachers in higher education IT classrooms. This study recommends that designers of IT classrooms (1), first, identify social intentions of the users and (2), second, design facilities to support student learning and teaching styles with appropriate equipment, furniture and physical layout.

CHAPTER 1
INTRODUCTION

> Technology is now the real environment shaper of school design.–Spurgeon, 1998: 46a.

Architects, designers, and facility planners are under both societal and academic pressure to design and build university classrooms that support rapidly emerging "technological learning environments" (Carlson, 2002; Kettinger, 1991; Report of the IT Review Committee, 2001; and Zandvliet and Straker, 2001). Their major goal is to consider "providing an environment designed to enhance a student's ability to understand, observe, and participate in active learning" (University of Washington Classroom Support Services, 1998, p 3). Increasingly, universities are struggling to invest in information technology (IT) and technology-rich classrooms in order to develop improved models of teaching and learning.

There is a growing body of empirical research about the impact of computers on student and teacher interaction and motivation (Zandvliet and Straker, 2001; Carlson, 2002). Some educators (Link to Learn: Technology Tutorials, 2000) believe that IT motivates individual students to learn by doing even though Liu, Macmillan, and Timmons (1998) found there was "no [measurable] effect on student achievement" (p 189). Additionally, technology-rich environments affect both the process of exploration and the teaching style or presentation of the content (Cohen, 1997). A less understood component of IT classrooms is the physical design of the seating, furniture, computer placement, and arrangement of space. Cornell (2003) believes that ergonomic comfort, safety, and health needs must be addressed in order to promote well-being. Long before technology and IT classrooms, Sommer (1967) found that the seating position that a student selected in a general-purpose classroom was highly correlated with their participation in the class. However, no current research was found to support whether or not and how the physical arrangement of space, furniture, ergonomic comfort, and computer placement in *computer lab classrooms* supports the interactions and the efforts of the students and the teacher.

Statement of Purpose

This study addresses one part of the changing IT classroom setting, specifically the physical arrangement of seating and furniture. Two differently arranged *computer lab classrooms* will be evaluated to understand the effect of the physical seating arrangement on (1) student and teacher interactions, as well as (2) their satisfaction with the classroom environment. The specific purposes of this study are to explore whether or not different seating arrangements of computer tables and computers in computer labs (straight rows versus pods shaped like a cross with computers at each end) affect:

1a. the amount of observed interaction among the students and teacher in a class;
1b. the reported style of teaching that is performed;
1c. the reported student's perception of their own learning in these classrooms; and
2. student and teacher appraisal with the classroom setting.

Rationale

There are claims that technology rich classrooms (1) promote student interaction with media learning tools, (2) foster interaction among students themselves, (3) support communication with teachers, and (4) motivate individual students to learn by doing (Carlson, 2002, and Zandvliet and Straker, 2001). Despite these claims, no significant research has confirmed them.

There are also beliefs that the physical environment plays an important role in the learning and teaching process. For example, Cornell (2003) believes that the shift from passive learning to active learning requires students to physically and mentally be more active. Therefore, the traditional "stand and deliver" method, which required long uninterrupted sitting, is becoming a more engaged process where students are allowed "greater movement and positioning" (Cornell, p 3). Cornell believes this more engaged process of learning reduces or eliminates drowsiness and muscle fatigue. However, no research has provided evidence of whether or not and how the physical arrangement of space, furniture and equipment in differently arranged computer lab classrooms supports the efforts of students and the teacher. A first step taken in this study is to systematically compare two computer lab classrooms at the University of Florida, each with a different seating arrangement, in order to evaluate whether or not and how these physical arrangements affect student and teacher interaction and satisfaction.

Significance

For decades, the term "classroom" was characterized as a rectangular room where the "focus was directed to the front where the instructor exercised complete control of the pace, content, and sequence of activities" by using a blackboard and overhead projector (Cornell, 2003, p 1). However since 1984, student computer use in all levels of instruction has almost tripled (CEO Forum on Educational Technology, 2001) and technology is currently an important part of the educational process from grade school thru higher education. Considering just how to integrate technological changes into current classroom settings is challenging administrators, faculty, designers, facility planners, and architects alike. Thus, educators, researchers, designers and facility planners, who specialize in school design, must learn how to create and renovate the "technological learning environments" that are slowly replacing the "one size fits all" classroom (Zandvliet and Straker, 2001). Teaching and learning is no longer about the teacher standing at the front of the room and the students sitting at their hard, uncomfortable desks. Rather, it is about these new, complex "technological learning environments" that are more concerned with the people-machine interaction. Additionally, they must recognize that behavior related to how humans teach and in turn learn is both linked to and affected by the physical qualities of the complex classroom environment (Gifford, 2002). Examining just one element of this rich environment, Swanquist (1998) found that comfortable classroom seating helped to improve the students' attention span and also increased their retention of information.

In addition to influencing the shape of the physical learning environment, the implementation of technology in higher education is challenging educators to reevaluate their social role as teacher as well as their instructional methods. Ultimately, technology is slowly changing instruction. The traditional teacher-centered style of instruction, where teachers deliver the information and students sit silently taking notes, is slowly being replaced with student-centered learning (Nair, 2000). Similarly, many believe that effective learning rarely occurs passively (Nair, 2000; Halpern, 1994).

> Educators have come to realize that effective instruction focuses on active involvement of students in their own learning, with opportunities for teacher and peer interactions that engage students' natural curiosity. (Halpern, 1994, p 11)

Neuman (2003) argues that information technology (IT) is forcing a revolution in how all of these players think about what makes a good "place of learning". The term "place of learning" recognizes that learning can take place in any environment where people are actively motivated to do so. Student–centered learning requires active and inquisitive students. Hence, courses and classrooms that emphasize collaboration, computer use, and social learning are replacing the passive model of learning (Cornell, 2003). Many educators believe it is important to make this switch away from memorizing a factual knowledge base to instead helping students learn the critical thinking skills required to produce knowledge. These higher order thinking skills include the mental abilities of interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 1996). Many believe that technology facilitates critical thinking skills by helping to motivate students and to retain their attention (Cohen, 1997; Enghagen, 1997; and Kettinger, 1991). Hence, learning environments should be designed in new ways that encourage the development of student-centered learning skills.

According to Kettinger (1991), "large sums of money are being expended to build and support computer classrooms, yet little research has been conducted to determine their value from either a teaching or cost/benefit point of view" (p 42). Therefore, a post occupancy evaluation of any new facility should be required to see if the technology and furnishings are being integrated properly within different classroom designs. Computer classrooms may only be effective in facilitating certain activities. Therefore, not all courses will require a fully equipped computer lab. Student outcomes should also be evaluated or compared to a course with similar goals that did not use a computer classroom. In other words, decision makers should ask, "What are the learning goals to which technology is applied?" (North Central Regional Educational Laboratory, 2003).

At the University of Florida—the setting for this research—from the 1996-97 school year to the 1998-99 school year, the IT and communications budget went from $50 million a year to $62 million a year resulting in a nineteen percent increase (Office of Academic Technology: Classroom Support, 2003). Most of this budget was spent on wiring classrooms for the teachers to use PowerPoint presentations as an instructional tool and to allow access to the World Wide Web. However, in 2000-2001, the University of Florida allocated about 3 percent of the IT expenditures to enhance four campus computer lab classrooms. A more significant budget output was unjustified because there is little or no evidence to ensure administrators that money spent to renovate existing classrooms into technology rich settings is effective. Therefore, empirical evidence is needed to find out whether or not IT classrooms that are designed to support a student-centered learning paradigm, actually satisfy students and teachers and perhaps ultimately improve student learning.

Examining the role of the physical environment and its effect on teaching and learning can provide universities, architects, designers, and facility planners with a better understanding of how to design computer lab classrooms. Chapter 2 examines the past decades of teaching methods and learning styles and the integration of IT into classrooms. Chapter 3 explores the physical and social characteristics of educational learning environments.

CHAPTER 2
PHILOSOPHIES AND PRACTICES OF TEACHING AND LEARNING IN HIGHER EDUCATION

Two thousand years ago school took place on the stairs of ancient Greek temples or in the shade of a farmer's wall (Castaldi, 1994) as teachers and students held their discussions when and where they could. As time progressed from the days of no chairs and desks, schools became places where teachers cited information and students recited it. This style of teaching and information exchange had its roots in religion. Telling parishioners what to think was practiced as preaching and the catechism (Castaldi). The 18^{th} and 19^{th} century industrial age school model also promoted lecturing where the instructor was the leader and the students were the passive receivers of information (Cornell, 1999). In the late 1890s, philosopher and educational reformer John Dewey proposed a change and called it "learning by doing" (Smith, 2002). With this model students actively engaged in creating their own learning experiences. Dewey's ideas, although ahead of his time, set in motion an educational reform movement called the Progressive era that is becoming even more relevant in the 21^{st} century.

The following chapter reviews the literature concerning: (1) the past decade of teaching methods; (2) the past decade of learning styles; and (3) the integration of information technology (IT) into classrooms.

Teaching Methods

Although teaching and learning activities coexist, they have very distinct characteristics. Hativa (2000) lists the following skills of teachers:

- Examine, interpret, and share learning;
- Understand how students learn;
- Learn the knowledge in their field;
- Conduct research on learning and teaching;
- Share their experiences.

Additionally, an effective teacher also understands how to promote a love for self-learning in students. Bess (2000) argues that "student preferences for teaching strategies are for active and challenging learning, where they are involved, where learning is connected to real life, and where there are opportunities for mutual responsibility" (p 53).

Scott-Webber, Marini, and Abraham (2000) have divided possible teacher-student relationships into different types of communication styles. They include one-on-one, presentation, teamwork, and discussion. The one-on-one communication style is associated with self-directed learning, learning through electronic tutorials, or teacher-to-student learning. The one-on-one style places an emphasis on the student's understanding and discovery (Hativa and Birrenbaum, 2000).

The most common communication style is known as presentation (Scott-Webber et al. 2000). This includes activities such as lecturing, sharing information, motivating, and performing demonstrations. Because students are less willing to learn in a lecture format and prefer a more active learning environment (Wolff, 2001), presenters must emphasize quality (Hativa and Birrenbaum, 2000). Cornell (2003) suggests that students are less willing to learn in a lecture format because they are fatigued and drowsy from sitting for long periods of time. They prefer an active learning environment because it is more physically and mentally stimulating. The implementation of technology software, such as PowerPoint, can help to create a stimulating learning environment that may aid the instructor in retaining the students' attention. Nonetheless, the student is still a passive observer.

Teamwork is increasingly becoming popular and is also referred to as collaborative learning. The activities involved with teamwork are intergroup work, shared discovery, brainstorming, and games. Therefore, the instructor becomes a facilitator of knowledge. This style allows students to be recognized as individuals with different strengths (Hativa and Birrenbaum, 2000).

The discussion style involves the exchange of information, making decisions, and meeting. The discussion style has similar teamwork style characteristics such as the sharing of information and brainstorming. Instructors also allocate certain amounts of discussion time in lectures or presentations in order to answer any questions that may arise from the lecture (Hativa and Birrenbaum, 2000).

These different types of communication styles will be identified in each computer lab classroom of this study. Both the students and teachers will be asked which communication style is performed most often. This will determine which communication style is most popular and whether or not the students and teachers perceptions are the same.

Learning Styles

On the other end of the spectrum is the learning process. For Light and Cox (2001), learning is "part of the whole of the academic enterprise", which includes the "personal, practical, and social dimensions of students' learning life" (p 63). According to Radloff (1998), learning must "promote understanding, application, and transfer" (p 1). Learning, as defined by Light and Cox, is "an active and meaningful construction of facts, ideas, concepts, theories, and experiences in order to work and manage successfully in a changing world of contexts" (p 63).

Bess (2000) believes "students' conceptions of learning are mediated by how well professors communicate their expectations to students and how they evaluate learning" (p 51). Therefore, if the professors poorly communicate their expectations, then the result of student learning outcomes will be poor and vice versa. According to Bess, there are certain teaching methods that are appropriate for particular learning outcomes. For example, if the learning outcome is to gain factual knowledge of principles and theories, then the most efficient teaching method is lectures and reading. On the other hand, if the learning outcome is to gain higher-order thinking skills, then the instructor should use a method that allows the student to become actively engaged and able to manipulate the principle learned. Combining these two teaching methods is becoming popular. For example, some research methods courses consist of a lecture class that meets three times a week and a computer lab class that meets once a week. The computer lab session allows the students to apply what they learned in the lecture by experimenting or demonstrating with computer technology. This is also known as enactive representation. According to Bess, this means that "students can actively manipulate objects or events, as in demonstrations or experimental learning" (p 52).

Over the years, there has been a vast amount of research on students' learning styles (Hativa and Birrenbaum, 2000; Light and Cox, 2001; Leider, 1998; and, Daley et al., 2001). Claxton and Murrell's (1987) model is basic. It informs this study because the categories of the model provide specific characteristics to look for during observations in the two different computer lab classrooms. The four main categories of the model are personality, information processing, social interaction, and instructional preference. Personality refers to the characteristics of the student along a continuum from introvert - a shy and reserved person - to extrovert - a sociable person. How a student receives and processes information is known as information processing. For example, some students may take notes whereas other students may process information just by listening or watching. Social interaction involves the interaction and behavior of a student during the lesson. Certain room layouts may restrict certain interactions among the students and teacher. Instructional preference concentrates on individual preferences for the media used, such as watching, reading, listening, and performing, when the learning occurs. Each student has a different instructional preference that allows them to effectively process and retain the knowledge.

Information Technology in Higher Education

Educational technology advanced rapidly after the invention of the chalkboard in the 19th century, and was accompanied by minor physical changes in learning environments through most of the 20th century (Castaldi, 1994). Such changes to the traditional lecture-style classrooms were generally made to support the latest technology. While some traditional lecture-style classrooms have been drastically converted into electronic laboratory-style classrooms supplied with hardware such as projectors, computers, and projection screens, most have only been moderately updated to afford the use of electronic instructional tools, such as PowerPoint. Therefore, it is important to understand how the design of computer lab classrooms supports the interactions between teachers and students and how the design of computer lab classrooms supports learning and teaching styles.

Computers are now being integrated into the classrooms and slowly transforming the way instructors teach and the way students learn. What began as a presentation tool for teachers has evolved into fully equipped and wired classrooms where each student has their own computer. For example, lecture classrooms and computer lab classrooms are increasingly becoming equipped with power supply outlets at each student desk for laptop computers or computer workstations for each student. Although the teacher still lectures or presents information to the students in the computer lab classroom, the students can now apply the knowledge they receive from the teacher during the instructional session. For example, the teacher will explain different statistical tests and then the students are given the opportunity to conduct a test on their specific topic using the computer and appropriate software programs. This additional dimension of learning also allows the teacher to play the role of facilitator. Leider (1998) argues that the integration of computer technology enhances student-centered education, as well as the communication among faculty and students (Enghagen, 1997). Unfortunately, neither author discussed how the physical environment of technology–rich classrooms impacts the learning process and interaction. For example, the assumption is that the computer alone is used in the computer lab classrooms, however, students still need adequate worksurfaces to write or take notes, otherwise they may become distracted or fall behind in the instructions.

From Cornell's (2003) perspective, the physical environment of technology-rich classrooms is focused towards a "user-centered" design, where the needs of the instructors and learners drive the design of the classrooms. Teachers need to be able to move throughout the classroom in order to provide guidance for their students. Students, large and small, should have adjustable chairs, workstations, and computers. Cornell suggests that there are "three factors that contribute to the need for adjustability: task duration, posture static-"ness", and availability of an adjustable height chair" (p 3). The adjustability of furniture allows the students to be comfortable for extended periods of time. Nonetheless, the complexity of technology-rich classrooms requires architects, designers, and facility planners to consider the ergonomic comfort needs of the user and their interactions with machines.

Several societal trends are important reasons to integrate information technology into higher education facilities. They include competition, career preparation, teaching and learning enhancement, and productivity (Enghagen, 1997). An increasing number of students enter college with computer skills and technology expectations (Enghagen). Today's students use computers daily and fluidly, and also learn with hands on activities (Carlson, 2002). Therefore, colleges compete with each other in order to provide the best technology resources for their prospective students (Enghagen).

Preparation for the 21st century labor market also plays an important role with the integration of information technology into higher education learning environments. A report from the CEO Forum on Education and Technology (2001) stated that the operation of the economy and society is being transformed by information technology. Universities must meet the demands of the future in order to prepare students for the digital age. Students must also be prepared for lifelong learning as technology continues to advance.

Another reason for the integration of information technology is to enhance curriculum and learning environments. Enghagen (1997) believes that "IT (information technology) can enhance classes and improve student learning" (p 31). According to Kettinger (1991), the use of computer technology in the classroom helps retain the students' attention and enables them to experiment with what is being taught. Some instructors believe that students get bored and lose interest if they do not use visual or active technology to grab their attention (Carlson, 2002). In Goddard's (2002) study, his question was how can educators best use technology to foster engaged learning. Goddard believed that "in order for engagement to occur, the teacher must create an environment that encourages student-teacher contact, cooperation among students, and active learning" (p 23).

Daley et al. (2001) explored the learning processes that students use in technology enhanced environments to determine how technology could be used effectively to enhance learning. They found that student learning is strongly influenced by technology, but could not demonstrate whether it is due to individual attitudes and perceptions of technology, learning tasks, peers, or facilitators. Once again, the physical environment was not a variable in their study.

For most instructors, there are two primary motivations for integrating technology: external and internal pressures (Maier, 1998). The external pressures include who and what is being taught and how others judge the teaching. The internal pressure is associated with improving teaching. A similar analysis has been made in the article "Plugging In" by the North Central Regional Educational Laboratory (2003) that states:

> There's a dynamic shift occurring as we move from traditional definitions of learning and course design to models of engaged learning that involve more student interaction, more connections among schools, more collaboration among teachers and students, more involvement of teachers as facilitators, and more emphasis on technology as a tool for learning. It is this type of learning that technology must support to be effective.

Therefore, it is assumed that high tech classrooms and technology will improve the communication among teachers and students, and enhance the teachers' instruction in order to retain the students' attention.

Productivity is the fourth reason given for the integration of information technology in higher education. Many colleges hope to gain increased enrollment, enhanced student and teacher outcomes, and increased participation through the investment in information technology (Enghagen, 1997). They also expect to improve learning and teach more often with applications of information technology.

Evidence for increased participation through the use of computer technology was found in a study conducted by Cohen (1997). Cohen investigated whether or not learning style would change after a year in technology-rich environments. Although learning styles did not change after a year, Cohen did discover that interaction among the students and teacher was more frequent and casual in nature. However, frequent and casual interactions among students and teacher could occur in non-technology rich environments. For the purpose of this study, the observation of interactions may determine whether or not the computer technology of one seating arrangement facilitates more frequent interaction than the computer technology of another seating arrangement.

Liu, MacMillan, and Timmons (1998) studied the effects of computer integration on student achievement and student attitudes. They perceived computer integration as an instructional system that impacts student learning. The computer lab and computer settings were considered a variable that impacted student learning. Although their study concluded that there were no significant effects of computer integration on student achievement, the students perceived the computer integration and usage "as having a positive effect on their learning" (p 189). For example, fifty-three percent of the students believed that the computers made their schoolwork easy. Other students believed that the computer integration helped increase their grades, helped the students be more creative, and increased their interest in the course. In the current study, students will be asked about their positive or negative perceptions of their own learning and satisfaction. Then it may be possible to determine whether or not there are more positive or negative perceptions in one computer lab seating arrangement or another.

CHAPTER 3
PHYSICAL AND SOCIAL CHARACTERISTICS OF EDUCATIONAL LEARNING ENVIRONMENTS

In some ways, 21st century education and facilities have evolved dramatically, but in many ways they remain mired in the past. Nonetheless, a growing number of current educators advocate the so-called "knowledge age school model" where the students actively engage in learning, and instructors facilitate and coach rather than lecture on stage. There are also a small but growing number of educational facilities that support this model with advanced informational technology (IT) (Castaldi, 1994). Blackett and Stanfield (1994) state that renovating old classrooms and designing new classrooms with IT in higher education settings is a top priority for current academic and facilities planners and designers.

The following review is organized in two separate but related issues central to this study: (1) the past decade of physical and social characteristics of educational learning environments, and (2) the theories and research about the effects of classrooms that are designed to use information technology (IT) on teaching styles and student learning.

Physical and Social Characteristics of Educational Learning Environments

A wider range of learning environments are needed in our college and university educational facilities in order to accommodate the diversity of both teaching and learning styles. This general concept is based on the theory that there are reciprocal interactions between people and interior space arrangements. For example, Wineman (1986) believes "the physical environment provides physical facilities and spatial arrangements that aid specific activity patterns" (p 8). For example, in a conference room the furniture can be arranged several ways in order to accommodate meetings, presentations, or luncheons. Within these physical environments, people may rearrange the furniture or lighting to suit their needs. Therefore, if the built environment influences human behavior, then "what do we need to know about the classroom in higher education settings that will provide designers with some direction to create positive learning environments?" (Scott-Webber, Marini, Abraham, 2000, p 17).

Physical Characteristics of Classrooms

According to Owu (1992), the classrooms of the 21st century deserve more than the out-dated chalkboards and old furniture. Likewise, the students and teachers who spend an average of 400 hours a year in classrooms deserve more as well (Owu). With the publication of the first edition of *Design of General Purpose Classrooms and Lecture Halls* in the mid 90's, attitudes began to change (Clabaugh, et al., 1996). College and university planners began to realize the importance of modern and well-equipped instructional facilities as a tool to "recruit and retain good students and faculty" (Clabaugh et al, p 1). Planners began to pay attention to the essential architectural quality of design elements for effective classroom environments. The physical elements that Clabaugh et al. felt needed attention from planners follows:

- Dimensions — room, aisles, ceiling heights, door widths
- Entrances — door location
- Windows — placement, treatments
- Finishes — walls, ceilings, floors
- Furnishings & Equipment — instructor's desk, display surface, student seating
- Voice Amplification
- Acoustics
- Accessibility
- Heating, Ventilation, & Air Conditioning
- Lighting
- Projection Requirements

Planners could see that if the guidelines about these design elements were followed, they might enhance the physical qualities of classroom function, focus, aesthetics, and flexibility (Owu). Accordingly, each type of classroom could then be adapted to facilitate the type of instruction to be performed. For example, a lecture hall with rows upon rows of desks and chairs could facilitate the necessary purposes of an instructor who lectures or transmits primary information to their students. Next, the classroom design must attempt to focus the student's attention on the learning activities. According to Owu, "focus is achieved through the arrangement of architectural elements, proper acoustics and lighting, and the absence of visual distractions" (p15). Also, the aesthetics of a classroom could help to enhance students' enjoyment of their learning experience.

Flexibility is also critical for an efficient classroom design. Although Neuman (2003) suggests that there are basically two types of classrooms, "those with flat floors and those with sloped or stepped floors" (p 95), he believes that there is a variety of classrooms, or subcategories, within the two broad types of classrooms. Therefore, classrooms should accommodate multiple uses and technological advancements. The adjustable classrooms could allow for a variety of teacher-centered as well as student-centered approaches within the space (Jamieson, 2000). Blackett and Stanfield (1994) believe "flexibility is vital so that a college does not get locked into one technology, and so that the classrooms can be reconfigured as new technologies are developed" (p 26). A flexible classroom environment that consists of a variety of ways to present information promotes interchanges among the teacher, students, and information (Conway, 1996).

Computer Lab Classrooms

Ergonomics plays a significant role in computer integration and classroom design for creating positive social environments. Ergonomics is defined as the relationship between the human body and its dimensions as it relates to the physical environment (Panero and Zelnik, 1979). Too often, classrooms are renovated with inappropriate furniture and equipment, which defy ergonomic principles (Jamieson, 2000). If ergonomics is not enforced, then good posture is compromised, making the user uncomfortable (Computer Classroom Design, 1995). Therefore, items such as chairs and keyboards should be adjustable so that any body shape or size will be comfortable (Knirk, 1992). Knirk firmly believes "Incorporating ergonomic design requirements into the design and refurbishing of teaching and learning areas will create a more effective and positive learning and information handling environment" (p 32).

Kettinger's (1991) research identified a variety of ways that technology could be used in higher education. He envisioned both computerized lecture halls and computer labs. Blackett and Stanfield (1994) explained that the computer lab "began as a lecture on computer techniques and exercises, followed by individual student application at stations in a computer center, and has evolved into new instructor podiums with a built in computer" (p 28). The computerized lecture hall teaches students computer programs that may begin with an instructional tutorial or demonstration, followed by limited hands-on experience by the student. "This allows students to experiment with the lesson that is being taught" (Kettinger, 1991, p 38). However, there is a disadvantage to this style. Some instructors believe that in this type of classroom, students tend to focus more on the computer rather than the instruction, therefore diminishing learning as opposed to enhancing it (Blackett and Stanfield). If the students are not productively engaged in the lesson, they may select other options, such as surfing the net (Schwartz, 2003).

Another type of computerized lecture hall is the Math Emporium at Virginia Polytechnic Institute (VPI) and State University. In 1997, VPI converted a 58,000 sq ft department store into a mathematics computer lab with 500 computers (Neuman, 2003). The students work at their own pace on different course materials and may ask for faculty assistance during scheduled hours. Therefore, the faculty plays the role of coach or tutor rather than lecturer. According to an article in the Virginia Tech Magazine, VPI intends to use the Math Emporium as a case analysis of: faculty challenges; students' perceptions of the emporium; and students' grades, persistence, and retention rates over time. According to Neuman, students prefer the Math Emporium over the lecture format, student learning has increased, and faculty has willingly taken on the role of tutors rather than lecturers. It has proven to be a successful example of a technology-assisted approach to "increasing individualized instruction and improving student performance through interactive, self-paced, and self-directed learning" (Neuman, 2003, p 99).

The University of Washington Classroom Support Services (1998) characterizes the computer lab classrooms as being smaller than large lecture halls and accommodating up to 30 individuals. According to Fawson and VanUitert (1990), the method of instruction and student interaction required should influence the equipment specified and the physical facility designed. The computer lab should be equipped with a presentation system, audio system, and network connections. All computer labs require a teaching station, movable chairs, and flexible seating arrangements. Some of the arrangements may resemble a U or V shape, clusters of computers, or a conventional, parallel row configuration (University of Washington Classroom Support Services). In summary, the guidelines stress that different classroom layouts facilitate different teaching styles and learning activities (Niemeyer, 2003).

Several decades ago Sommer (1967) found in the traditional classroom that the nature of student activity, instructor's teaching method, and the physical dimensions and shape of the room are all factors that should influence the functional spatial arrangement of the room. Niemeyer (2003) currently recommends that within a computer lab classroom, the U or V shape shown in figure 3.1 allows the presenter sight of all of the students' computers. He believes that this design is beneficial to computer-enhanced courses that use instructional methods such as computer-based independent work, lecture, group discussion, and presentation.

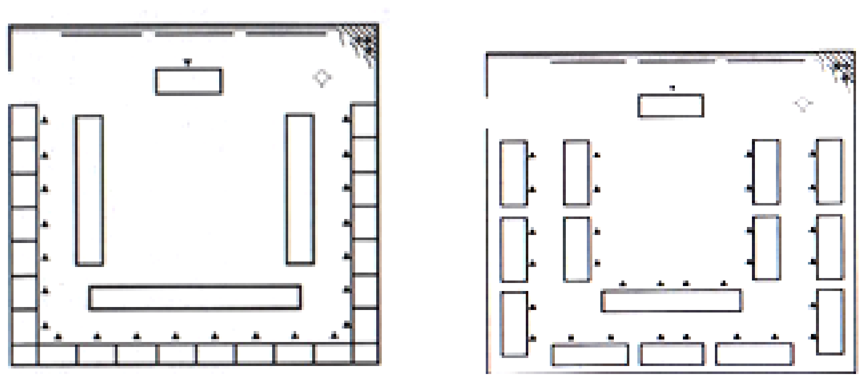


Figure 3-1. U or V computer lab seating arrangement.

The cluster arrangement shown in figure 3-2 is similar to the conventional straight row layout. The main difference is that the computer tables are placed perpendicular to the front of the room. This layout is ideal for small groups, collaboration, and dialectic instruction (Niemeyer).

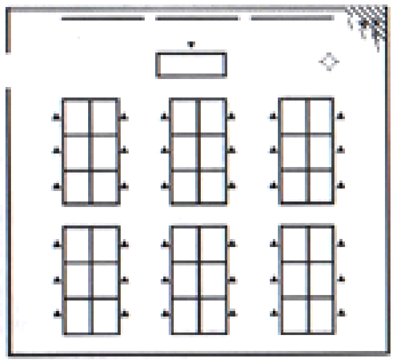


Figure 3-2. Cluster seating arrangement.

The conventional straight row layout shown in figure 3-3 resembles a standard lecture classroom. This configuration consists of rows that are parallel to the front of the classroom. These layout characteristics allow for collaboration among students or the typical lecture/training method. Typically, the teacher presents at the front of the room. The disadvantage of the front lectern station is that the instructor cannot see the students' computer screens. Therefore, the ideal setup would provide a front and rear lectern (University of Colorado, 2003).

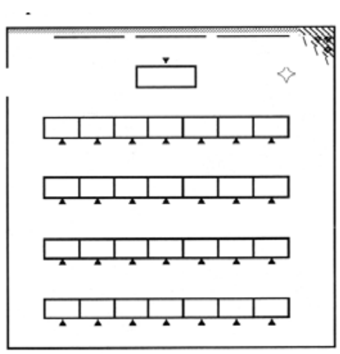


Figure 3-3. Conventional straight row seating arrangement.

Most of these general characteristics can be found in the computer lab classrooms on the University of Florida campus. The exception lies in the flexible seating arrangements that the campus currently provides in two recently renovated computer lab classrooms. Currently, the campus computer labs have either the conventional layout with a center aisle or a pod configuration shown in figure 3.4. Review of research indicates that the instructional purpose of the pod layout is intended to support collaborative computer-based work (Spectrum Industries, 2003; CIRCA Computer Lab Classrooms, 2003).

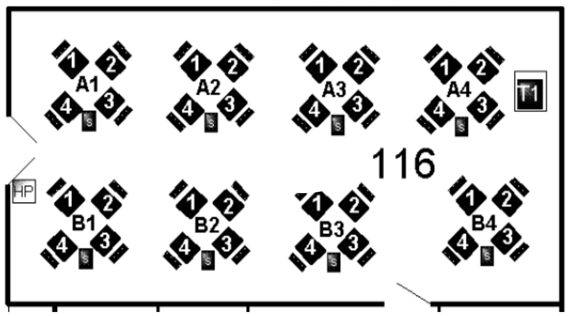


Figure 3-4. Pod seating arrangement.

As faculty and students become comfortable with technology, higher education planners will continue to explore ways to integrate it into the classroom environment. The design of the 21st century classrooms should rely heavily on the user's needs and the desired interactions for supporting learning within the space. It will take ongoing collaboration among educational an environmental behavior researchers, architects, designers, facility planners, faculty, and users to design classrooms that effectively support teaching and learning.

Physical Characteristics that Support Learning Environments

Sommer (1967) compared the relationship between seating arrangement and the amount of student participation in a traditional classroom with a seminar-style arrangement and a classroom with straight rows. In the seminar-style classroom, students across from the instructor participated more than students at the sides of the instructor. The study of the straight row arrangement found that students near the front and center of the straight row classroom participated more than students in the rear and at the sides.

However, most studies have shown that seating position is more closely related to personality variables of the students (Stokols and Altman, 1987). No studies have looked at whether or not the ergonomic comfort or the arrangement of the furniture influences the IT higher education learning environment.

McAndrew (1993) argued that college and university students deserve functional classrooms that facilitate learning experiences. Babey (1991) monitored campus classroom environments at the University of California, Davis and conducted a survey among the faculty and students to determine classroom quality. Some of the questions asked related to the aesthetic quality of the classroom, user preference, and ratings of the design features. Thirty percent of the faculty reported that classrooms were "ill-suited for their teaching purposes" (p 1). However, the students' ratings were higher. The students made comments like "the room is ugly and the windows do not open" and "this room is uninspiring for learning." A question addressed in Babey's (1991) survey was seating arrangement preference. The results showed that half of the faculty preferred fixed seating, which can be repetitive and unexciting, and the other half preferred movable seating, which can occasionally be changed to promote different activities. The students' main concern with seating addressed issues such as the size of the writing surface, crowding, storage space, and the spacing between desks. However, the only variety within the surveyed classrooms was lecture halls with either fixed seating or movable seating. No computer lab classrooms were evaluated.

Sleeman and Rockwell (1981) believe that positive and/or negative physical environmental stimuli exist in each classroom. McAndrew (1993) also suggests that a good predictor of teacher and student satisfaction is the fit between teaching style and positive environmental stimuli. A few of the stimuli are time of day, furniture, teachers, and seating arrangements (Sleeman and Rockwell). A “hard classroom”, as defined by Knirk (1979), is considered a formal environment due to the presence of cement or tile floors, hard plaster walls and ceilings, and hard-surfaced furniture. Knirk (1979) believes that hard finishes decrease student interactions and encourage students to be passive learners. He noted that a hard classroom environment can be intimidating, discouraging, and uncomfortable. Previous research has shown that students and faculty prefer warm, intimate, and attractive classrooms as opposed to cold, windowless, and colorless classrooms (University Info: Smarter College Classrooms, 2003, Babey, 1991). According to Babey (1991), the number one problem area in higher education classrooms was the lack of appealing aesthetic qualities. In the teaching/learning process there is a “need to create environments that are suitable for living and working” (p 3). Babey also believes the levels of communication and user productivity are influenced by the characteristics of the instructional space. To summarize these findings, students and teachers prefer comfortable classrooms that functionally support and promote faculty-student exchanges.

In 1980, Sommer created an alternative classroom using soft materials. He took a traditional rectangular shaped classroom with 30 tablet arm desks and converted it into a softer learning environment. The hard-surfaced desks, floors, and walls were replaced with cushioned bench seating, carpeted floors, and curtained walls. He found a noticeable rise in participation of students in the soft classroom when compared to a straight row hard surfaced classroom. There was also an improvement in the preference ratings for the soft room. However, this drastically renovated classroom is not functionally appropriate for all courses or users. In the current study, the different finishes of materials and furnishings used within the two different computer lab classrooms will be compared in order to determine students and teachers' satisfaction.

Scott-Webber, Marini, and Abraham (2000) set out to determine student and faculty use and opinions about several university classrooms. A majority of the subjects felt that the general-purpose classrooms were adequate, however they "had little desire to stay in the rooms" (p 16). Faculty suggested that the classrooms lacked support for social interaction. Therefore, Scott-Webber et al. came to the conclusion that the general-purpose classrooms of Virginia Polytechnic Institute and State University "do not meet all the needs of faculty and students" (p 16). Once again, this study focused on general-purpose classrooms. With the growing use of computer lab classrooms and the variety of layouts provided on the University of Florida campus, it is necessary to determine whether or not University of Florida computer lab classrooms meet the needs of our faculty and students.

Zandvliet and Straker (2001) evaluated the physical and psychosocial environments of information technology (IT) rich classrooms in order to determine the extent to which 'technological classrooms' created a positive learning environment, for 10-17 year old children. They believe a positive learning environment is one in which students are not distracted by physical characteristics or psychosocial factors. This study was one of the first to look at a new learning environment, the 'technological classroom', which has been created by the implementation of information technology (IT). Zandvliet and Straker recognized that physical factors in IT classrooms effect learning, comfort, and safety issues of students. Overall, they found many significant links between physical and social factors that influence student *satisfaction* with learning in IT rich classrooms.

One of the conclusions made by Zandvliet and Straker's study was that the most common layout found and preferred by teachers was the peripheral arrangement. This arrangement locates the computers along the peripheral walls of the classroom. However, there was no investigation of students preferences related to physical layout since the student learning, and not the physical room arrangement, was the main concern in their study. There was also no investigation of the relationship between the physical space arrangement and the teachers' style of instruction or preference for student learning activities. For example, individualized learning, cooperative learning, and higher order thinking skills often associated with IT settings were not examined.

The main similarity between Zandvliet and Straker's study and this current study is the focus on how the physical learning environment may affect student learning and satisfaction. There are many differences, however. They observed a classroom school setting for ages 10-17 year old children, and this study focuses on computer lab classrooms in higher educational settings. This study focuses on how two different seating arrangements of the environment, a pod layout and straight row layout, affects learning and teaching satisfaction. In other words, assuming that student interaction is a positive factor for the instructional style, it is important to determine if certain seating arrangements affect student learning by either facilitating or not facilitating interaction among students and teachers for group discussions or individualized help. It is also important to discover if a specific seating arrangement is associated with reported distractions during the learning process. For example, in a pod layout, the placement of seating and equipment may not always allow students a direct view of the projection screen when there is a need to follow the teacher's instructions or a tutorial. This may also affect the teacher's satisfaction with the classroom seating arrangement by creating an environment that may frustrate the students and require unnecessary repetition by the teacher. Teacher satisfaction with the appropriate seating arrangement that allows for ease of movement and a variety of styles of instruction is another important factor in this study.

Sleeman and Rockwell (1981) propose that the physical design of classrooms "should be considered as a subsystem in the process of producing effective, efficient, and predictable learning" (p 169). The range of desired activities should be determined before the design is implemented (Sleeman and Rockwell). Becker, Sommer, Bee, and Oxley (1973) believe that the arrangement of classrooms reveal information about the learning process as well as instructional and behavior methods that may be facilitated. Through the study of environmental psychology and research about classroom ecology associated with seating arrangement, designers and planners can understand how the classroom environments affect the users and how their relationships with other people are influenced by the physical environment (McAndrew, 1993).

Social Characteristics of Classrooms

Understanding the concepts of environmental psychology is important for understanding the social characteristics of learning environments. McAndrew (1993) defines environmental psychology as "the discipline that is concerned with the interactions and relationships between people and their environments" (p 2). In learning environments, classroom furniture arrangement, crowding, seating position, and noise are environmental variables that influence behavior, learning, task time, and achievement

(Lackney, 1987). Additionally, these variables influence how a teacher arranges either a lecture-style classroom or a computer lab classroom layout to make it suitable for particular learning activities. In other words, if given the choice, an experienced teacher learns to choose a positive classroom environment that supports selected behaviors, interactions, and learning objectives. Oddly enough, the physical design of higher education classroom environments has lagged behind those in K-12. For example, 95 percent of the classrooms at the University of Florida are arranged as the traditional lecture-style classrooms (Office of Academic Technology: Classroom Support, 2003).

Social Settings that Support Learning Environments

In a study conducted by Becker, Sommer, Bee, and Oxley (1973), the frequency of interaction was measured in a computer laboratory classroom setting. Verbal exchanges among students and instructor were the measurement of interaction. The results concluded that on average, 73% of each class had student-to-student interaction, and over 65% of the students had student-to-teacher interaction. Other variables that the observer recorded in this study were "size, arrangement, and level of the class, as well as the primary participation pattern of the instructor: walk and comment, lecture, leave, sit and wait" (p 519). According to Knirk (1979), "The learning environment must facilitate the perception of desired (tension-reducing, pleasure-producing) stimuli and inhibit undesired (confusing, unordered) stimuli" (p 23). Designers and facilities planners who take into account relevant social science research on educational facilities will be prepared to create effective learning environment for the users.

In summary, numerous researchers have found that the physical environment plays an important role both in learning and teaching processes (Lackney, 1987). However, there is little research on IT classrooms in higher education settings. There are many relationships between the physical environment, pedagogical, and social variables yet to be explored and understood (Lackney). The specific variables related to seating arrangement in computer lab classrooms has yet to be recognized for its role in supporting both learning and teaching in a university setting.

CHAPTER 4
RESEARCH METHODOLOGY

The purpose of this investigation is to compare the effects of two types of computer lab classrooms with different seating arrangements on both self-reported teaching style and self-reported student learning. A multi-method approach was used to collect information about the physical settings, the social settings, as well as the students' and teachers' appraisal, or impression, of the two classroom arrangements. Gifford defines (2002) appraisal as "liking, goodness, quality, and preference" (p 69) for a physical setting. Three methods were used to collect data for this study. The first method for evaluating the appropriate physical qualities of the rooms included a Computerized Classroom Environment Inventory (CCEI) (Zandvliet and Straker, 2001) and an examination of the spatial arrangement using an isovist analysis of the visual field from each seat in the two classrooms. The second method for observing the social setting of the classrooms included participant observations of student-to-student interaction, student-to-teacher interaction, and on-task student behavior during class sessions. The third method for appraising the social setting involved a survey of the users' perception of the qualities of the classroom setting and a self-report about their classroom learning experiences. A description follows of the research setting, the respondents, and the study instruments.

Research Setting

This study was conducted on the University of Florida campus in two different computer lab classrooms in two separate buildings. One undergraduate research methods course in the Sociology Department and one undergraduate research methods course in the Criminology Department were selected for this study because a large number of sections of these courses are held each semester in computer lab classrooms. The study concentrated in four sections: two of the sections (Methods of Social Research) were held in a conventional straight row computer lab—Weil Hall 410 (Classroom A), while the other two sections (Research Methods in Criminology) were held in a computer lab arranged in pods—CSE E211 (Classroom B). The computer lab classrooms in both settings provide each individual student with a desktop IBM computer and flat-screen monitors. The material selections of ceiling, carpet, and wall color are identical within the two different classrooms. All of the computer lab classrooms have general fluorescent lighting fixtures. In addition, Classroom A has some natural lighting from windows on one wall. In this lab, the shades are almost always closed to avoid glare on the computer screens and the color of the shades blend with the neutral wall color. Classroom B had general fluorescent lighting for the classroom as well as task lighting at the instructor's podium, lighting for the chalkboard, and direct lighting for the projection screen. The chairs in Classroom A and B were dissimilar. The chairs in Classroom A were a collection of stationary chairs as well as many different chairs on rolling casters, but lacked adjustable height and back support. All of the chairs in Classroom B were adjustable and on rolling casters with back support.

The major difference in the two classrooms are the workstations and seating arrangements. Classroom A (approximately 700 square feet) has a conventional straight row seating arrangement with a total of nine rows. Each row contains three computers for a total of 27 computers shown in figure 4-1A. Classroom A is configured in straight rows with three workstations per row separated by a center aisle. The teacher's lectern is located in the front of the classroom near one doorway. The two entrances are located on the south side of Classroom A. The second computer lab classroom, Classroom B (approximately 750 square feet) shown in figure 4-1B, is configured as a pod seating arrangement. Classroom B has seven pods with a total of 28 computer workstations. The teacher stands at the podium located along the wall with the projection screen. Classroom B had two entrances located opposite the wall with the projection screen.

A B

Figure 4-1. CIRCA classroom floor plan. A) Weil Hall 410 (Classroom A). B) CSE E211 (Classroom B).

During class sessions, the pods seat four students at each station shown in figure 4-1B. The furniture manufacturer, Spectrum Industries Inc., designed the pods for cooperative learning situations using computers. According to McCallister (2003), the University of Florida Assistant Director of the Office of Academic Technology, the pod arrangement facilitates flexibility in teaching style and the collaboration of students at the computers. The renovated computer labs are labeled as "Collaborative Classrooms" because the arrangement allows more than one student to sit at a computer and to work with other students collaboratively (CIRCA: Computer Classrooms, 2003). According to McCallister (2003), there is no research to support the connection between workstation and seating arrangement and collaborative learning, nor is there any research to support the claims that a "Collaborative Classroom" design facilitates a specific teaching style.

Respondents

The University of Florida undergraduate fall semester (2003) courses, scheduled to be taught in computer labs, were examined to find classes that fit the model of "learning by doing." Therefore, the study respondents selected represent a convenience sample that allowed for comparisons based on seating arrangement. Four sections of Methods of Research were finally selected based upon the Undergraduate Catalog Course Descriptions, 2003. Two were offered by the Sociology Department and two were offered by the Criminology Department. Both of these courses consist of a lecture session that meets three times a week as well as a computer lab session that meets once a week. According to the Boyer Commission Report (2003: 1), "at many universities, computer networks and wired classrooms are used to bring recent research findings and methods directly into the classroom." In the computer lab session, the students are taught how to use Statistical Packages for the Social Sciences (SPSS) to aid learning the scientific method in social science research. The Research Methods in Criminology course also focuses on scientific methods, research design and data analysis. They also used SPSS and other statistical programs. Ultimately, the students apply the knowledge they acquired in the lecture to the exercises or demonstrations they perform in the computer lab. This study focused on the computer assisted lab sections of these methods courses. The lecture portions of these courses were not included in this study.

Four different sections of the two courses, each taught by a different teacher, were included in both observations and surveys. As stated before, two sections were held in a straight row configured classroom—Classroom A (Methods of Social Research), and two sections were conducted in a pod-configured classroom—Classroom B (Research Methods in Criminology). There were a total of 5 teachers that participated in this study. Although there were only two sections of Classroom A observed and surveyed, three teachers taught students in Classroom A. One of the sections had two teachers—a teacher and a graduate teaching assistant. The two sections taught in Classroom B each had graduate teaching assistants. All five teachers had undergraduate teaching assistants who either stood at the back of the classroom or walked around the classroom to help assist the students. A total number of 30 students were observed and surveyed in the straight row computer lab and 42 students were observed and surveyed in the pod computer labs (Table 4-1).

Table 4-1. Number of students and teachers in each classroom.

Classroom	Number of Students	Number of Teachers
A-Straight Row	30 (2 sections)	3
B-Pod	42 (2 sections)	2
Total	72	5

Procedure

This exploratory study aimed to compare the social behavior and classroom appraisals of the students and teachers in the two different computer lab seating arrangements. Observations were made of student and teacher interactions. A survey was administered to students and teachers at the end of the observation period. The study took place over a six-week period. Once the project was approved by the University of Florida Institutional Review Board, the research project was explained to each professor and a consent form was presented and signed. In order to prevent any biases, the students were not informed of the study until they were given a consent form when their survey was administered.

This study was conducted across different days and times of the six-week period. The two sections of the Methods of Social Research course included in this study were taught in Classroom A, the straight row computer lab classroom. One section was taught on every Tuesday from 3:00 pm to 3:50 pm, and the other was taught on every Wednesday from 3:00 pm to 3:50 pm (Table 4-2). The second course was Research Methods in Criminology, and it was taught in Classroom B, the pod arrangement. This course was taught every Wednesday from 10:40 am to 11:45 am and every Wednesday from 1:55 pm to 2:45 pm (Table 4-2).

Table 4-2. Classroom schedules.

Classroom	Tuesday	Wednesday
A - Straight Row	3:00pm to 3:50pm Social Research	3:00pm to 3:50pm Social Research
B - Pod		10:40am to 11:45am Criminology Research 1:55pm to 2:45pm Criminology Research

Instruments

Before classes began, the Computerized Classroom Environment Inventory (CCEI) (Zandvliet and Straker, 2001) was administered in each classroom setting. Many physical variables were measured by the researcher using an inventory sheet (See Appendix A) that included: Workspace Environment, Computer Environment, Visual Environment, and Spatial Environment. The Computer Environment measures physical characteristics such as the keyboard height, angle of the computer monitor, and computer software displays (dark text on a light background). The Workspace Environment consists of measurements that pertain to computer screen depth (front of screen to table edge), adequate workspace for books, adjustable chairs, and screen height. The Visual Environment contains the measurements of glare or reflection of light on computer screens, overall light quality, and color contrast of work surfaces. The Spatial Environment measures factors such as ease of movement among workstations, the number of workstations provided, and aisle widths between desks. No acoustic measurements were made, however observations and student and teacher appraisals of each computer lab classroom provided the researcher with insight about acoustic quality within each computer lab classroom based on the impressions of the students and teachers.

The main purpose of the CCEI scale is to compare the existing physical measurements of the technological learning environments with the guidelines provided by the scale. Each environment in the inventory had five physical items for the researcher to measure. Each item in the inventory had a possible score of 5, which denotes a maximum score of 25 percent for each environment that was measured. Therefore, each computer lab classroom had a possible score of 100 percent compliance with the inventory scale. The researcher will also note the number of computers in each classroom and make a diagram of the room layout.

In addition to the CCEI instrument, a measure was taken of the isovist fields. According to Benedikt (1979),

> An isovist is the set of all points visible from a given vantage point in a space and with respect to an environment. The shape and size of an isovist is liable to change with position. Numerical measures are proposed that quantify some salient size and shape features. These measures in turn create a set of scalar isovist fields. Sets of isovists and isovist fields form an alternative description of environments. The method seems relevant to behavioral and perceptual studies in architecture, especially in the areas of view control, privacy, ‘defensibility’, and in dynamic

> complexity and spaciousness judgements. Isovists and isovist fields also shed light on the meaning of prevalent architectural notions about space (p 47).

For example, in the diagram below (Figure 4-2) the circle represents a person standing in a space with barriers such as walls and doorways. In this case, the person is stationary and looking straight ahead at the wall in front of them. However, their peripheral vision only allows them to see a certain extent past the wall and through the doorway. Therefore, the lined areas are the extent to what the person can see in their peripheral vision.

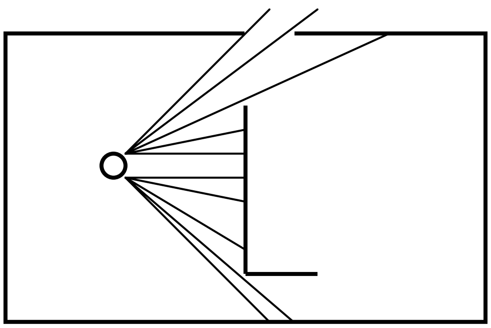


Figure 4-2. Isovist field of vision—plan view—adapted from Benedikt (1979).

The importance of an isovist analysis is to give the researcher and reader a perspective of what the student's view is from their chosen seat, and what the teacher's view is from their lectern. The results of the analysis will show which workstations have restricted views of the teacher, the projection screen, or other students. The students' adjustable computer screen will not be considered a barrier in the isovist analysis because this study was more concerned with the amount of student-to-teacher active engagement rather than the traditional teacher-centered education. The isovist measure provided a visual evaluation code for each workstation on position in relationship to the projection screen located at the front of the room (See Appendix B). Each seat in the two computer lab classrooms was coded as (1) best view, (2) good view, (3) poor view, or (4) difficult view.

During the observations, which are discussed next, the researcher used the floorplan to note the adjustment and movement of computer screens by the students in order to improve the view of the teacher and projection screen. Some monitor screens were adjusted slightly while others were turned 90 degrees from the screen's original position. This isovist analysis was used to compare the adjustments students make at their seat in relationship to where they chose to sit and their responses to the physical and social statements in the survey. For example, how often did a student sit in a seat that required adjustments to the monitor screen by 90 degrees versus seats that have a best view? The physical measures of the isovist analysis constitute one of the independent variables in this study.

The researcher attended each computer class session and conducted observations during class time over a period of six weeks. The students were told that the researcher was conducting a study in the computer lab classroom, but they were not informed about the specific details of the study. Two separate classes a week were held in Classrooms A and B, and each class session was 50 minutes long. The first week of observations served as a pilot study and allowed the researcher time to become familiar with the class and to adjust all instruments. A behavioral mapping technique was employed as the observational tool to record interactions among the students in the two different settings. Behavioral mapping is often used to record and determine behavioral activities of people and how they use their space (Bechtel, 1987). For example, the observer took a map or floorplan of the room being observed and noted how many verbal interactions were made with reference to where the person was sitting and with whom they interacted (See Appendix C). The verbal interactions recorded usually involved students helping each other with course instructions and students answering the instructor's questions or requesting help with the program software. The purpose of behavior mapping was to determine if one seating arrangement facilitates or promotes more interactions over another. The observer also noted when students were off task. Off task activities included surfing the web or chatting online with a friend.

A study conducted by Becker, Sommer, Bee, and Oxley (1973) contained a similar method of participant observations. The purpose of their study was to determine if the classroom participation was related to seating arrangement. During their observations, they noted interactions such as verbal exchanges between students and student and teacher interactions. In this current study, these behaviors will be noted as well as one-on-one interaction between teacher and students. These behavioral observations were used to determine if one classroom arrangement facilitates more interaction among the teacher and students. Becker, Sommer, Bee, and Oxley concluded that the further the distance from the instructor, the lower the grade; and the seat a student selects more often reflects their personal goals. However, seating choice could also depend on how early or late a student arrived to class. They also suggest that there is an "important difference between advocating a particular kind of seating and demonstrating that it will produce more participation, raise moral, or increase learning" (p 515). However, Becker, Sommer, Bee, and Oxley did not conduct observations in computer lab classrooms because computer lab classrooms did not exist at the time of their study. The increasing use of information technology and computer lab classrooms in higher education facilities of today necessitates the replication of their study using computer lab arrangements.

Finally, there was one self-report survey instrument for students (See Appendix D) and one for instructors (See Appendix E). The student survey included basic demographic information such as gender, age, ethnicity, grade point average (GPA), and their midterm grade in the methods course. The teacher's survey included questions pertaining to which course they taught, whether or not they had taught in a straight row computer lab or pod arranged computer lab, and which computer lab arrangement they preferred. Otherwise, the survey questions asked both the teachers and students about the social environment pertaining to teaching style, the amount of group work facilitated in the class, if the students help each other with assignments in class, and whether or not the students are allowed to move about the classroom. These questions and statements were adapted from Zandvliet and Straker's (2001) questionnaire, 'What is Happening in this Class?' This researcher added additional questions about the students' and instructors' appraisal with the physical aspects of the classroom. For example, both teacher and student were asked to appraise their view of the projection screen, whether or not there was adequate aisle width between desks, and whether or not the classroom facilitated assistance and interaction among students and the teacher. Three types of questions were used: (1) close-ended, (2) open-ended with short answer questions, and (3) statements rated on a likert scale.

CHAPTER 5
FINDINGS

The purpose of this exploratory study was to compare the effects that two differently arranged computer lab classrooms had on both self-reported and observed teaching styles and self-reported student learning. The review of literature revealed that there are a variety of recommendations about how a computer lab should be physically arranged in order to maximize its potential for student learning and teaching style, and to facilitate a variety of styles of teaching. However, there was no empirical research found regarding the physical seating arrangements of a computer lab classroom and its effects on teaching style and student learning. A multi-method research approach was used to collect data about the physical settings, the social settings, and the students' and teachers' appraisal of the two computer lab classroom's physical and social arrangements.

Evaluation of the Physical Setting

The computer lab classroom physical setting characteristics were evaluated using measures from the Computerized Classroom Environment Inventory (CCEI), the isovist analysis, and the students' self-report appraisals.

Computerized Classroom Environment Inventory (CCEI)

The CCEI developed by Zandvliet and Straker (2001) (Appendix A) has four categories of physical variables that were measured with no students or teachers present. These categories were the Workspace Environment, the Computer Environment, the Visual Environment, and the Spatial Environment. The purpose of the CCEI scale was to compare the existing physical measurements of the two differently arranged technological learning environments with the guidelines provided by the scale. Each environment in the inventory could acquire a maximum score of 25%. Therefore, each computer lab classroom had a possible score of 100% compliance with the inventory scale.

The Workspace Environment consisted of measurements that pertain to computer screen depth, adequate workspace for books, adjustable chairs, and screen height. The measurements of Classroom B (pods) met all guideline measurements. However, the measurements of Classroom A (straight rows) did not meet all of the guideline measurements. Classroom A failed to meet the guideline pertaining to adjustable chairs on rolling casters with back support. Therefore, Classroom B scored 25%, while Classroom A scored 20% in the Workspace Environment category.

The Computer Environment examined measurements related to the physical characteristics such as the keyboard height, angle of the computer monitor, and computer software displays (dark text on a light background). Both Classroom A and B met all requirements except for the adjustable inclination of the viewing monitor screen. Apparently, for security reasons, the monitors' angle of viewing was preset. Hence, both classrooms scored 20% in this category.

The Visual Environment contains the measurements of glare or reflection of light on computer screens, overall room light quality, and color contrast of work surfaces. Once again, Classroom B scored 25% while Classroom A scored 20%. Classroom A lacked good natural or indirect light quality. Classroom A had poor indirect fluorescent lighting, which contributed to uneven lighting throughout the room.

The Spatial Environment measured factors such as ease of movement among workstations, the number of workstations provided, and aisle widths between desks. In this category both computer lab classrooms scored 25%.

In conclusion of the CCEI, Classroom B scored 95% overall, and Classroom A scored 85% overall (Table 5-1). Classroom B had deficiencies in the Computer Environment while Classroom A had deficiencies in the Workspace Environment, Computer Environment, and the Visual Environment.

Table 5-1. CCEI scores of each computer lab classroom.

Classroom	Workspace Env	Computer Env	Spatial Env	Visual Env	Total
A - Straight	20%	20%	25%	20%	85%
B - Pod	25%	20%	25%	25%	95%

Isovist Analysis

An isovist analysis of the visual field was conducted in each computer lab classroom. The isovist analysis determined the teachers' restricted views of the students and their workstation, as well as the students' restricted views of the teacher, projection screen, and other students. Once again, the isovist analyses did not include the teachers' view of the students' screens because each teacher had teaching assistants who were able to view the students' screens while the teacher gave instructions. Also, this study was more concerned with the amount of active student-to-teacher engagement rather than the traditional teacher-centered education. The isovist measure provided a visual evaluation code for each workstation in relationship to the student's view of the projection screen located at the front of the rooms or the teacher's view of the seated students. Each seat in the two computer lab classrooms was coded with 1-best view, 2-good view, 3-poor view, or 4-difficult view.

The isovist analysis of Classroom A was quite different from Classroom B. For example, from the students' viewpoint or the teachers' viewpoint, there were no poor or difficult views. The reason for this is because all of the workstations face the front of the classroom.

The isovist analysis from the students' viewpoint identifies all workstations with either a best view or good view (Figure 5-1). The workstations with the good view were all the seats in Row J, the seats to the far left of Rows I, H, and G, and the far left two seats in Row F. All of the workstations in Row J were labeled as only good view seats because they were the furthest from the teacher and projection screen. The seats to the far left of Rows I, H, G, and F were labeled with just good views because of their acute angle to the teacher and projection screen. As the layout indicates, the teacher's podium is centered on the right side of the classroom, which creates an angled view for the students seated on the left side of the classroom. Unlike some of the seats in Classroom B, Classroom A had no poor or difficult student views.

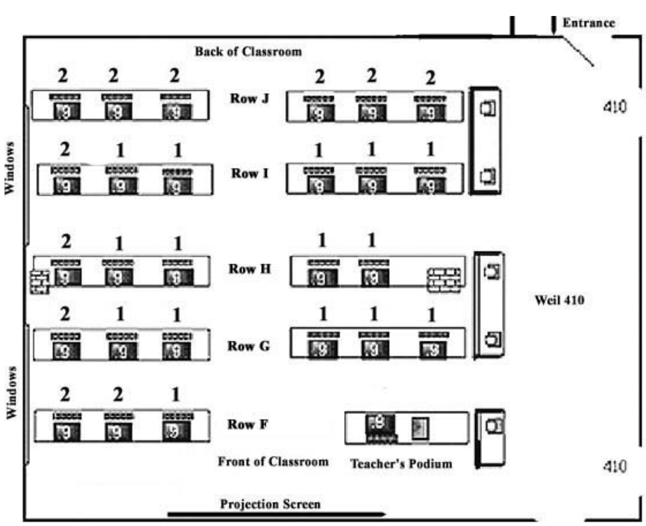


Figure 5-1. Student isovist analysis of Classroom A.

The isovist analysis of the teacher's viewpoint was slightly different from the analysis of the students' viewpoint. All of the workstations were labeled as best view except for the three seats in Row F (Figure 5-2). Once again, this refers to the acute angle of Row F in relation to the teacher's podium. Overall, the isovist analyses of Classroom A indicated more positive views from the students' and teachers' perspectives than those isovist analyses taken in Classroom B.

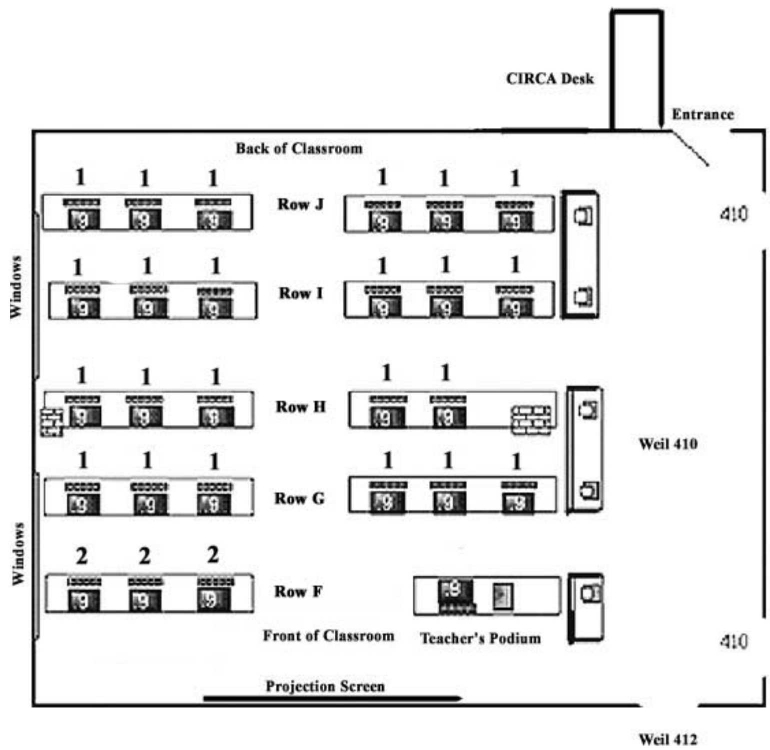


Figure 5-2. Teacher isovist analysis of Classroom A.

The floor plan of Classroom B (Figure 5-3) reveals the codes that were given to each workstation after the isovist analysis was conducted. Each pod had four workstations that were labeled with one of the four possible views. The students at workstations with a best view generally faced forward with a direct view of the teacher and projection screen. Opposite the students with the best view were the students with the difficult view, which were noted as having their backs to the teacher and projection screen. Coincidentally, the isovist analysis from the teacher's viewpoint echoed the codes of the students' viewpoints. Nonetheless, if the student can see the teacher's face, then the teacher can see the student's face.

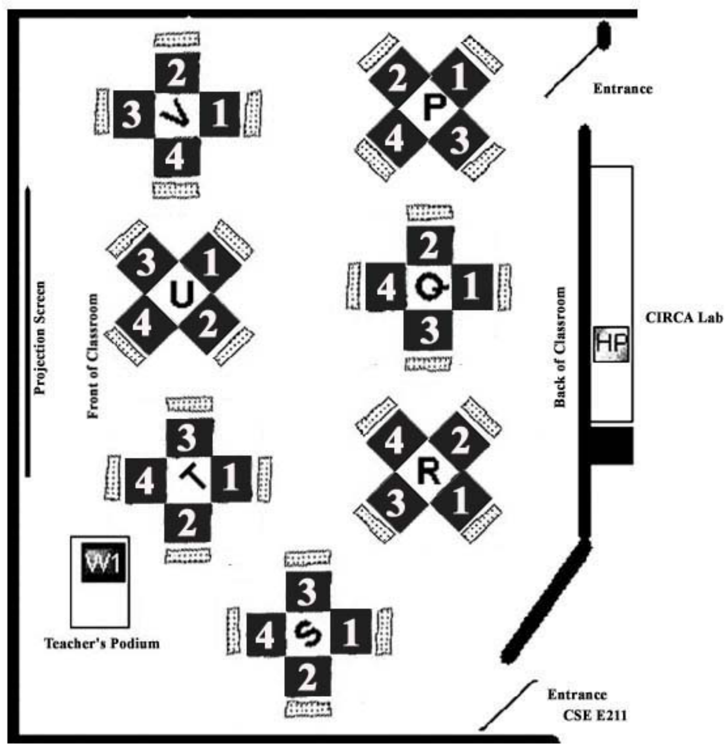


Figure 5-3. Isovist analysis of Classroom B.

Adjustment of Workstations

During observations, the researcher used each floor plan to note the adjustment and movement of computer screens and chairs made by the students in order to improve their view of the teacher and projection screen. In Classroom A, the monitor screens and chairs were rarely adjusted. On the contrary, some monitor screens and chairs in Classroom B were adjusted slightly while others were turned 90 degrees from the screen's original position (Figure 5-4). The floor plan illustrates the adjustments students made at certain workstations. The angle of the computer monitor and chair at each workstation is indicated by the single black line.

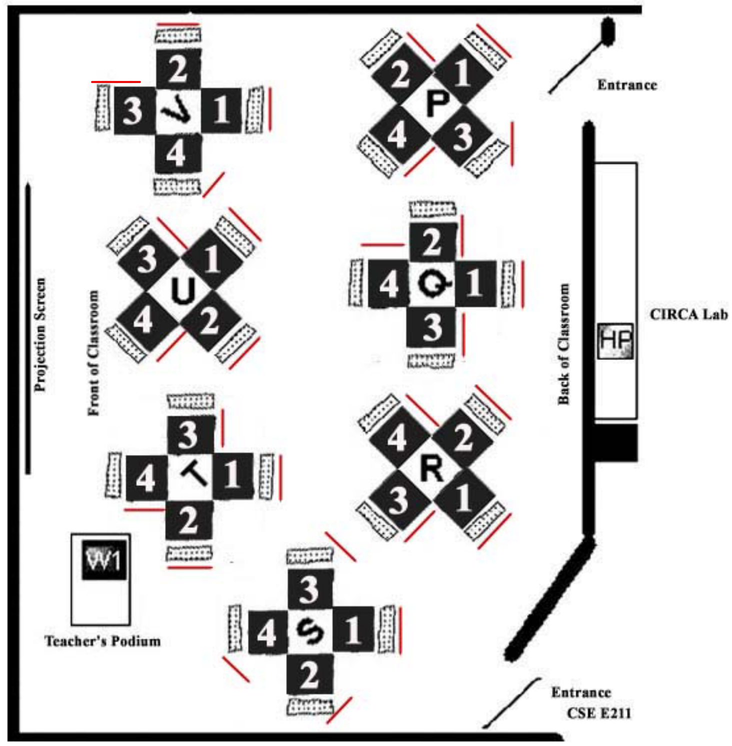


Figure 5-4. Adjustment of computer monitors in Classroom B.

Students' Appraisal of the Physical Characteristics

Students were asked if they liked their classroom arrangement. They were provided with the answers of absolutely, to some extent, or not at all. None of the students in either computer lab classroom answered 'not at all'. Most students in both computer lab classrooms, 56% in Classroom A and 52% in Classroom B, *absolutely* liked their computer lab classroom (Table 5-2). A number of students in each computer lab classroom gave reasons to support why they liked or disliked the classroom.

Table 5-2. Students' classroom appraisal.

Classroom	Absolutely	To Some Extent	Not At All
A - Straight Row	56%	44%	0%
B - Pod	52%	48%	0%

In Classroom A, there were 14 open-ended comments made about the classroom. Forty-three percent of the comments were negative comments (Table 5-3). However, the positive comments of the computer lab classroom received the most votes. For example, numerous students liked the classroom because they could see the projection screen and teacher, they had enough personal space, and they could interact with other students and the teacher. The negative comments of the classroom were that it was too "clustered", it was difficult to see the projection screen, and it was difficult to hear the teacher. The survey responses reaffirm the deficiency in the Visual environment of the CCEI due to the fact that many students in that classroom commented on how hard it was to see the projection screen. In conclusion, 57% of the students made positive comments about Classroom A.

Of the 17 different open-ended comments made by the students in Classroom B, only 29% of the comments were dislikes of the classroom (Table 5-3). The most positive comments about the computer lab classroom were that the students liked having their own personal space as well as the comfortable spacing and feeling of openness. However, there were two negative comments that quite a few students agreed upon. Twelve percent of the students in Classroom B said that the desk space was cramped, making it awkward for writing and taking notes. It is assumed that the students were comparing the computer lab classroom to a lecture hall where students normally have a sufficient worksurface for writing. Another negative comment of the classroom made by 7% of the students in Classroom B was that it was hard to see the projection screen. Classroom B scored well with this variable because of its many forms of lighting. There was general lighting for the classroom, task lighting at the instructor's podium, lighting for the chalkboard, and direct lighting for the projection screen. Overall, 71% of the students' comments were positive.

Table 5-3. Students' open-ended positive and negative comments.

Classroom	Positive Comments	Negative Comments
A - Straight	57%	43%
B - Pod	71%	29%

Teachers' Appraisal of the Physical Characteristics

The statements regarding the teachers' evaluation with the physical characteristics of each computer lab classroom revealed strong contrasts among teachers in the same computer lab classrooms. For example, two teachers in Classroom A stated that students *seldom* have trouble viewing the projection screen, while the third teacher stated that students *always* have trouble viewing the projection screen. The teachers in Classroom A disagreed on other statements as well. For example, one teacher believed there was *always* glare on the computer screens and the other two teachers believed there was *never* glare on the computer screens.

The two teachers in Classroom B also opposed each other. One teacher believed the seating arrangement *seldom* allowed for ease of movement and the other believed the seating arrangement *always* allowed for ease of movement. However, that was not the only statement where the two teachers in Classroom B opposed each other. One stated that they *never* could see every student from the podium, while the other teacher said that they could *always* see the students from the podium

The last few questions that the teachers answered were related to whether or not they had taught in a straight row computer lab or a pod arranged computer lab and which computer lab arrangement they preferred and why. Neither teacher in the Classroom B had taught in a straight row computer lab, nor had any of the teachers in Classroom A taught in a pod arranged computer lab classroom. However, two of the three teachers in Classroom A preferred the pod arranged computer lab even though they had never taught in one. When asked why they *would* or *do prefer* the pod arranged computer lab, their response was because they could move around easily to help students and their ability to see more computer screens.

One of the teachers in Classroom A had more to say about the classroom. This teacher did not like the classroom for many reasons, and has also been requesting Classroom B for at least two semesters. This teacher believes that glare on the computer screens and the projection screen is a problem and the acoustics are "dismal." According to this teacher, the dry erase board is difficult to see clearly from the back of the classroom and a chalkboard would work better. However, this teacher believed there was an advantage to the straight row arrangement. The advantage was that from the back of the room he could see all of the computer screens and thus make sure the students were following along with the tutorial. Yet, the teacher felt that the straight row arrangement did not promote ease of circulation between aisles.

Teachers' and Students' Appraisal Comparisons

There were a few disagreements among teachers and students concerning the physical characteristics of the classroom. Although the two teachers in Classroom B thought the seating arrangement *seldom* facilitated guidance of the students' work, 71% of the students in Classroom B thought that the seating arrangement *often* facilitated guidance of their work. Another difference in perception between teachers and students in Classroom B involved how frequently the students had trouble viewing the projection screen. The two teachers believed students *often* or *always* had trouble viewing the projection screen, while 90% of the students say they *seldom* had trouble viewing the projection screen.

A variety of perceptions were found about Classroom A as well. Ninety percent of the students said the seating arrangement *often* or *always* allowed for ease of movement around the workstations, yet two of the three teachers believed the seating arrangement *seldom* allowed for ease of movement. Another difference involved whether or not the computer tables provided adequate workspace for writing. Two of the teachers said the tables *seldom* provided adequate workspace, while 70% of the students believed the tables *often* or *always* provided adequate workspace. Variations in these responses indicate that what the teachers perceive about the students' environment is not always what the students perceive about their environment.

Evaluation of the Social Setting

The social characteristics of the two different computer lab classrooms were evaluated using a behavioral mapping observation tool. Verbal interactions and students' off-task activities are organized as classroom observations. The student and teacher self-reported appraisals concerning the social characteristics of the classroom are organized as students' self-reported appraisals, and teachers' self-reported appraisals.

Classroom Observations

Students and teachers were observed by this researcher in both computer lab classrooms A and B. Verbal interactions between students and between teacher and student were recorded on the floor plan with reference to where the person was sitting and with whom they interacted.

Off-task activities included students who were surfing the web or chatting online with a friend. In Classroom B, there was an average of five off-task activities made per class session. Classroom A had an average of eight off-task activities per class session. However, no significant differences between each classrooms off-task activities were found.

Verbal interactions recorded usually involved students helping each other with course instructions and students answering the teacher's questions, or students requesting help with the program software. The average number of student-to-student interactions per class in Classroom A was eleven, while the average number in Classroom B was eight. Therefore, both classrooms had a similar number of student-to-student interactions per class session. However, the number of student-to-teacher interactions per class session in Classroom B was more than twice those in Classroom A, yet there was no significant difference found after performing a chi squared and t-test among each computer lab classroom. Classroom A had an average of ten student-to-teacher interactions per class session, while Classroom B had an average of twenty-four student-to-teacher interactions per class session.

Students' Self-Reported Appraisals

Responses from a total of 72 students provided an understanding of how the physical seating arrangement and workstation attributes of two computer lab classrooms effected the students' perception of their own learning. Responses also noted the students' appraisal with the overall classroom setting, as well as the social and physical environments of their classroom. There were a total of 30 responses collected from Classroom A, the straight row computer lab classroom. Classroom B had 42 responses.

Students' perception of teaching style performed. Students were asked how often their teacher used one-on-one teaching, presentation or lecture, teamwork, or discussion as a style of teaching. Seventy-eight percent of students in Classroom B stated that the teacher *often* used the one-on-one teaching style, while only sixty percent of students in Classroom A believed their teacher used the one-on-one teaching style. Results of the two computer lab classrooms regarding the presentation style of teaching were very similar. Eighty-eight percent of students in Classroom B and ninety percent of students in Classroom A thought that their teacher *often* or *always* used the presentation style of teaching. More than half of the students in each computer lab classroom also stated that their teacher *never* or *seldom* used the discussion style of teaching or the teamwork style of teaching.

A t-test comparing the students' perception of teachers using the one-on-one teaching style in the two computer lab classrooms showed a significant difference ($p<.05$). As seen in Table 5-4, the standard deviation indicates that there is a significant difference in the frequency of the one-on-one teaching style performed with relation to the computer lab classroom.

Table 5-4. T-test of students' perceptions of teaching style used.

One-on-One Teaching Style	N=	Mean	Standard Deviation
Classroom A	30	2.9	0.712
Classroom B	42	2.98	0.468
P=.02, P<.05			

Students' perceptions of students helping each other. Students in both computer lab classrooms were asked whether or not students helped each other in the class. A chi-squared test comparing the two different computer lab classrooms showed a significant difference ($p<.05$) in the students' answers (Table 5-5). Fifty-six percent of the students in Classroom A thought that students *often* help each other, whereas fifty-four percent of the students in Classroom B thought that students *seldom* help each other in class.

Table 5-5. Chi Squared of students' perceptions of students helping each other.

Students Help Each Other		never	seldom	often	always	Total
Classroom A	Count	0	8	17	5	N=30
	%	0%	26.60%	56.60%	16.60%	
Classroom B	Count	1	23	14	4	N=42
	%	2.30%	54.70%	33.30%	9.50%	
Total		1	31	31	9	72

Students' perceptions of students working in groups. Students were asked how often they worked in groups as an indicator of student collaboration in each computer lab classroom. A t-test showed that there was a significant difference ($p<.01$) between the perceived amount of group work in the two computer lab classrooms (Table 5-6). More students in Classroom A believed that they *never* worked in groups when compared to the students in Classroom B.

Table 5-6. T-test of students' perceptions of student group work.

Students Work In Groups	N=	Mean	Standard Deviation
Classroom A	30	1.70	.702
Classroom B	42	2.07	.513
$p=.002$, $p<.01$			

Students' perceptions of students getting distracted. When students in both computer lab classrooms were asked how often they are distracted in class, a t-test showed a significant difference ($p<.10$) between the two computer lab classrooms (Table 5-7). Twice as many students in Classroom B than Classroom A believed they were seldom distracted.

Table 5-7. T-test of students' perceptions of student distraction.

Students Help Each Other	N=	Mean	Standard Deviation
Classroom A	30	2.9	0.662
Classroom B	42	2.5	0.707
$p=.07$, $p<.10$			

Students' perceptions of mid-term grades. Although, there were no significant differences between the two computer lab classrooms students' mid-term grades, the criminology students in Classroom B appeared to have grades that were generally higher with a range between A/A- to C+/C. However, the sociology students in Classroom A had an even spread of grades from A/A- to D or below.

Teachers' Appraisal of Social Setting

The responses from the teachers' surveys were analyzed qualitatively because there were only 5 teachers surveyed. There were 2 teachers surveyed in Classroom B and 3 teachers surveyed in Classroom A.

The teachers' responses to the teaching style they performed varied by teacher. However, all five teachers surveyed thought that they *often* used the one-on-one teaching style. All teachers also believed they *often* or *always* used the presentation style of teaching. According to the teachers, the teamwork teaching style was *seldom* or *never* performed in either computer lab classroom. However, the students in Classroom B believed that their teachers did use the teamwork style of teaching. The last teaching style, discussion, had various responses. One teacher in Classroom A believed the discussion teaching style was performed *often*, while the other two teachers in Classroom A believed the discussion teaching style was *seldom* and *never* performed by them. The two teachers in Classroom B believed they *seldom* and *never* performed the discussion style of teaching.

The teacher responses concerning their perception about the social characteristics of their classrooms varied across statements. Teachers in both styles of computer lab classrooms did agree that the students *often* or *always* ask the teacher questions and *seldom* or *never* give their opinions during class. When asked how often the students help each other during class, one teacher in Classroom A believed students *seldom* help each other while the other four teachers (2 from Classroom A and 2 from Classroom B) believed that students *often* help each other during class.

The three teachers in Classroom A stated that students *seldom* or *never* work in groups, while one teacher in Classroom B stated that students *seldom* worked in groups and the other stated that students *often* worked in groups. Two of the teachers in Classroom A believed that they *often* decided how much talking and movement was allowed. However, the third teacher in Classroom A, and the two teachers in Classroom B believed that they *seldom* decided how much talking and movement was allowed in their class.

The teachers were oddly divided when they were asked how often the students work at their own pace. Two teachers in Classroom A and one teacher in Classroom B stated that students *seldom* worked at their own pace. This left one teacher in Classroom A and one in Classroom B that both believed students *always* work at their own pace.

The teachers were also asked if the seating arrangement facilitated their preferred style of teaching (Table 5-8). The teachers in Classroom B responded with yes and the teachers in Classroom A responded with no. However, when the teachers in Classroom A were asked if the seating arrangement met their needs, one teacher stated *seldom* while the other two teachers stated *often* (Table 5-8). Both teachers in Classroom B believed that their computer lab classroom arrangement met their needs. When the teachers were asked how they perceived student learning, all five teachers stated that their students 'learned by doing' rather than learning passively (Table 5-8).

Table 5-8. Summary of teachers' appraisals of seating arrangements.

Variable	A - Straight	B - Pod
Seating Arrangement Facilitates Style of Teaching	no	yes
Seating Arrangement Meets the Teachers' Needs	1-no 2-yes	yes
Teachers' Perception of Student Learning	'Learn by Doing'	'Learn by Doing'

Teachers' and Students' Appraisal Comparisons

There was a difference in perception found among teachers and students about the frequency of how often students worked at their own pace. Sixty-six percent of the students in Classroom B believed they *often* work at their own pace. However, one of the two teachers stated that students *seldom* work at their own pace.

Teachers and students in Classroom A disagreed about student distraction during class. Seventy-seven percent of the students said they *seldom* or *never* get distracted during class. On the contrary, two of the three teachers believed the students *often* get distracted.

Disagreement was found among teacher and student survey responses on three social characteristic statements (Table 5-9). First, 70% of the students in Classroom A believed that the teacher *never* or *seldom* decides how much movement and talking is allowed in theclassroom, whereas two of the three teachers in the Classroom B believed that they often decided how much movement and talking is allowed in the classroom.

Table 5-9. Teacher and student response comparisons.

Variable	Teachers	Students
Students Get Distracted (A-Straight)	2 of 3 say often	77% say seldom
Students Work at Own Pace (B-Pod)	1 - always 1 - seldom	66% say often

In summary, the evaluation of Classroom A's physical setting revealed more deficiencies in the Workspace, Computer, and Visual Environments than in Classroom B. However, more than half of the students in each computer lab classroom *absolutely* liked their classroom aside from the few negative comments. The evaluation of the social setting reported more student-to-teacher interaction in Classroom B and more off-task activities in Classroom A. It was determined that the teaching style most often used in both classes was the presentation and one-on-one styles. The evaluation of the students' perception of the social setting also revealed more students helping each other in Classroom A, more group work in Classroom B, and more student distraction in Classroom A. Overall, the students' and teachers' appraisal of the social setting was positive. The following chapter discusses the effect that the physical and social settings have on each other as well as their relation to other previous studies.

CHAPTER 6
DISCUSSION AND CONCLUSIONS

Advances in technological learning environments are pressuring university facilities planners to consider designing new classrooms or to renovate existing ones to facilitate new methods of teaching and styles of learning using computers. Many of these changes are done without addressing the needs of the users. Nonetheless, research is beginning to indicate that computer lab classrooms should be designed specifically to support and enhance particular teaching styles and learning processes. The shift from passive learning to active learning requires students to physically and mentally be active, and therefore a need for greater movement and flexibility is required (Cornell, 2003). In addition, it is important that the physical setting is designed to facilitate the needs of the user and the activities of the social setting in order to enhance the learning objectives and teaching process.

The purpose of this study was to examine the effects of two types of computer lab classrooms with different seating arrangements on both teaching style and student learning. Information about the physical setting was collected using a Computerized Classroom Environment Inventory (CCEI) (Zandvliet and Straker, 2001) and an isovist analysis of the visual field. Information about the social setting and the students' and teachers' appraisal was collected from a student and a teacher survey of satisfaction with the physical characteristics and social characteristics of each computer lab classroom. Participants in this study included seventy-two undergraduate students and their five teachers.

This study was conducted on the University of Florida campus in two different computer lab classrooms. Two sections of a research methods course in the Sociology department were held in Classroom A—straight row arrangement, and two sections of a research methods course in the Criminology department were held in Classroom B— pod arrangement. The two sections of Classroom A provided the study with a sample of thirty students and three teachers—one section had a professor and a graduate teaching assistant. Two of the three teachers shared one section of the research methods course. Classroom B had a sample of forty-two students and two graduate teaching assistants.

Physical Setting Observations and Appraisals

Evaluation of the physical setting revealed that both types of computer lab classrooms contained deficiencies. Classroom A had deficiencies in the Workspace, Computer, and Visual environments. Classroom B revealed a deficiency in the Computer environment.

Isovist analyses of student computer screen adjustments and views in both settings were in agreement with the researcher's own coding of each workstation screen adjustment and views of classroom activity.

Student survey responses showed significant differences concerning satisfaction with the physical setting. There were different opinions expressed among the teachers about whether or not the computer lab classroom seating arrangement facilitated their style of teaching. A detailed explanation of study findings follows.

CCEI Observations

Classroom A failed to meet the guideline measurements of the CCEI in three categories. Classroom A was deficient in the Workspace environment because the chairs were a collection of stationary chairs as well as many different styles of chairs on rolling casters, but without adjustable height and back support. Both Classrooms A and B were deficient in the Computer environment for the same reason—the adjustable angle of inclination of the monitor screens were preset. Classroom A was deficient in the Visual environment because it had poor indirect fluorescent lighting. Researchers (Swanquist, 1998; and Cornell, 2003) believe that deficiencies such as these contribute to muscle fatigue and drowsiness resulting in short attention span and lack of active engagement.

Isovist Analysis Compared With Observations

During observations, the researcher noted how the students adjusted their computer screens and chairs. These computer screen and chair adjustments were compared to the predetermined codes from the isovist analyses. When the degree of computer screen and chair adjustments made by the students were compared to the researcher's codes of each workstation isovist view, the degree of adjustment coincided with the researcher's assigned codes. Therefore, it seems that the isovist analysis is a useful tool for designers to use for evaluating the quality of the quality of the views and the classroom activities. Isovist analysis allows the designer to consider the important views from the end users' perspective.

Student and Teacher Self-Reported Appraisals

According to all of the teachers, the style of teaching that they most often performed was the one-on-one and presentation styles of teaching. Teachers' responses showed that the seating arrangement in Classroom B facilitated the teachers' preferred style of teaching. The teachers in Classroom A felt that the seating arrangement met their needs. Yet, when the teachers in Classroom A were asked if they preferred a straight row arrangement versus a pod arrangement, two of the three teachers preferred the pod arrangement even though they had never taught in one before. Their reasons for choosing the pod arrangement were the ease of movement throughout the room and their ability to see more computer screens.

Students' preferneces for their computer lab classroom revealed that more than half of the students in each computer lab classroom absolutely liked their classroom. However, architects, designers, and facility planners should also acknowledge the students' and teachers' suggestions. For example, students in both Classrooms A and B felt that they were "too clustered." If architects, designers, and facility planners abide by the essential design elements suggested by Clabaugh et al. (1996), then they should provide each student with 20 square feet per student and at least 150 square inches of writing surface. Both Classroom A and B provided each student with at least 20 square feet. However, Classroom A only provided the students with approximately 90 square inches of writing surface, while Classroom B provided students with approximately 150 square inches of writing surface. Clabaugh et al. also suggests that teachers should be provided with an 18 by 24 inch table surface or podium along with a stool or chair.

Another negative comment in both Classroom A and B concerned the students' view of the projection screen and marker board—14% of students in Classroom A and 7% of students in Classroom B. Negative comments about Classroom A may be attributed to the poor lighting as noted in the CCEI. Negative comments about difficulty viewing the projection screen in Classroom B may be attributed to the seating position of each individual student. For example, although the pod workstations are flexible, at least one or two students at each pod had to adjust their monitor screens and chairs in order to view the projection screen. Even with the monitor screen and chair adjustments, the students were still angled toward the projection screen. According to Clabaugh et al.

(1996), if the lights are dimmed, there must be at least 5 to 10 footcandles at the student worksurface, plus 10 to 15 lumens should be distributed across the chalkboard or marker board. These recommendations were not followed in the design of Classroom A.

Social Setting Observations and Appraisals

Observations and responses from the teachers' and students' survey provided insight about the social setting in the two different computer lab classrooms. Analysis of these observations revealed that one computer lab classroom had more off-task activities per class session, and one computer lab classroom had more student-to-teacher verbal interactions per class session. The survey responses of students in Classrooms A and B revealed significant differences between the social settings of the two different computer lab classrooms. These differences are discussed below under the categories of observations of the social setting, and students' and teachers' appraisals.

Observations

Although a t-test showed that there was no significant difference between off-task activities or student-to-teacher verbal interactions in the two different computer lab classrooms, observations suggest a trend in another direction (Table 6-1). Classroom A had 63% more off-task activities per class session than Classroom B. Therefore, Classroom A appeared to be teacher-centered where the students are passive learners and are less actively engaged than students in Classroom B. The less active students become distracted and participate in off-task activities. Observations also noted that the majority of the students who participated in off-task activities sat in the back of the computer lab classroom. Additionally, student-to-teacher verbal interaction occurred more in Classroom B by 41%. Hence, Classroom B appeared to be more conducive of student-to-teacher interactions and more conducive of the teacher carrying out the role of the facilitator or coach. The increased amount of student-to-teacher verbal interaction supports Cornell's (2003) claim that classrooms that emphasize collaboration or interaction, computer use, and social learning show potential for replacing the passive model of learning. Therefore, in this study Classroom A seems to be teacher-centered and Classroom B seems to be student-centered.

Students' Appraisals of Classrooms

A t-test comparing the students' perception of teachers using the one-on-one teaching style in the two computer lab classrooms showed a significant difference ($p<.05$). The significance suggests that the teacher plays the role of facilitator, therefore creating a more active environment. This is also believed to enhance the students' creative thinking skills. Therefore, the physical setting of Classroom B encourages an active, student-centered, learning environment.

There was significant evidence ($p<.05$) from the chi-squared test that the frequency of students helping each other was dependent on the style of computer lab classroom. Over half of the students in Classroom A thought that students often help each other. Fifty-four percent of the students in Classroom B, the "collaborative" computer lab, thought that students seldom help each other in class. This would be the opposite of what someone may expect from a "collaborative" classroom. Researchers (Cohen, 1997; Enghagen, 1997; and Kettinger, 1991) who believe that technology helps to motivate students and retain their attention should also recognize the concurrent impact of the physical characteristics of the room. If the technology and the physical design complement each other, then the learning environment will encourage group work, cooperation among students, and active learning (Goddard, 2002). Therefore, the learning environment can be designed to support student-centered learning skills or teacher-centered learning. However, another reason why students in Classroom A believe that they help each other more often could be due to the fact that they were seated closer together or more students in Classroom A than Classroom B were off-task. Hence, more students needed help because they were distracted and missed the teacher's instructions.

A t-test showed that there was a significant difference ($p<.01$) between the perceived amount of group work in the two computer lab classrooms. Students in Classroom B more often worked in groups than students in Classroom A. Perhaps the ergonomic comfort and flexible workstations facilitated a more active learning environment.

A t-test showed that the frequency of students being distracted was significantly different ($p<.01$) in the two computer lab classrooms. Twenty percent of the students in Classroom A were often distracted compared to the four percent in Classroom B. This significant evidence also supports the higher frequency of off-task activities in Classroom A. When students get distracted or are not actively engaged, they surf the web or chat online (Carlson, 2002).

Limitations and Assumptions

Several factors, no doubt, impacted the results of this exploratory study. First, the teachers varied by course. The two teachers who taught the Criminology research methods course in Classroom B were both teaching assistants. Further, neither one had taught in a straight row computer lab classroom before. They had no experience with the two types of classrooms, thus there was little grounds for their preference of one type of classroom over the other. Of the remaining three teachers who taught the Sociology research methods course, two were teaching assistants and one was a professor.

Although this odd number of teachers provided the study with more opinions about the classroom setting, it also impacted the various teacher appraisals of Classroom A. In other words, each teacher had his or her own perception of the social and physical setting and their impressions were often inconsistent. In the future, it would be wise to use one teacher that instructed multiple computer lab sections, and possibly in differently arranged computer lab classrooms.

Second, the comparison of two different courses in two different computer lab classrooms may have impacted the findings. Although both courses taught the principles of research methods, the difference in overall subject matter, criminology or sociology, may have had an effect on student grades. The level of difficulty in each subject matter plays a significant role when comparing the student grades in each class. It could also be the native ability of students in one major or another.

Third, this study was conducted at the University of Florida. This campus has a limited number of computer lab classrooms as well as a limited number of seating arrangements for their computer lab classrooms. Thus, significant findings are limited to the responses of this campus only—or just one case study.

Suggestions for Further Research

Further exploration of both the social and physical settings in the computer lab classroom and their effect on teaching style and student learning needs to be conducted before definitive conclusions can be drawn concerning this subject. Nonetheless, there are several areas that warrant further examination.

Further studies should compare classroom guidelines, such as those provided by Clabaugh et al. (2002), to the items listed in each category of the CCEI. For example, some students commented about the lack of writing surface, and although the CCEI lists that adequate workspace should be provided for books, it does not list a numerical amount of space. Nonetheless, Clabaugh et al. (2002), Niemeyer (2003), and Smarter College Classrooms (2001) have all stated that students should have at least 150 square inches of workspace even at a computer workstation. Other guidelines concerning the Workspace, Computer, Visual, and Spatial environments should also be examined and added to the CCEI if necessary. For example, the acoustics of each computer lab classroom should be measured or at least noted. Often, when all of the computers are on and running they can create a noisy setting along with heating, ventilation, and air conditioning (HVAC) systems. Various comments made by students on this campus have provided anecdotal evidence that some of the computer lab classrooms on the University of Florida's campus are very noisy and distracting.

Further studies should minimize the differences between courses and teachers. Although the two courses were teaching the same computer programs as well as the same basic methods of research, the difference in course subject can have an effect on the classroom setting. The level of work each course requires may vary. Therefore, one class may be harder than the other and may require more dedication from the students. It would be ideal to test many sections of one course in different computer lab classroom arrangements rather than different courses in different computer lab classrooms.

It is recommended that in future studies, further consideration should be acknowledged when determining the number of teachers and the subject they teach. If a number of teachers are involved in the study, then there will be a variety of perceptions concluded about the classroom setting. However, it is recommended that the teachers teach the same course only in different computer lab classrooms. Therefore, the variability of the course will be somewhat limited because the teachers are teaching the same material.

Future studies should consider lengthening the data collection phase. Lengthening the study to a full year, or two semesters, would increase the sample size. If two semesters were included, the researcher could arrange for all of the sections in one semester to be conducted in a pod arranged computer lab classroom, and the second semester sections could be taught in a straight row computer lab classroom. This would allow the researcher to use the same course continuously, yet in two different labs. By lengthening the study, the researcher could gather mid-term and end of semester grades. Hence, there would be fewer variables to consider.

The survey questions should be examined in future studies. Researchers may decide to include questions about the lecture hall classroom in order to compare its appraisal with the computer lab classroom's appraisal. The researcher may also consider a formal interview with the teacher in order to determine what effect the computer lab classroom or a lecture hall may have on their appraisal of the classroom.

Suggestions for Architects, Designers, and Facility Planners

The validity of this study persuades us to consider the users of the learning environment. The teachers and students are the people who spend the most amount of time in these learning environments, not the architects, designers, and facility planners. Therefore, the needs of the users must be taken into consideration in the programming and pre-design phases. A survey of the users' needs and preferences could be administered to the students and faculty of the learning environment. The programming phase of a design project may also include a simulation. This would allow architects, designers, or facility planners to observe behaviors of students and faculty and then determine whether or not the preferred learning and teaching styles are facilitated within the simulated learning environment. Nonetheless, architects, designers, and facility planners must acknowledge the importance of including the users in the programming phase if they intend on creating a positive learning environment.

Conclusion

Findings in this exploratory study support the assumption that there are connections between the physical and social settings and their effect on student learning, teaching style, and the overall appraisal of the computer lab classroom. Architects, designers, and facility planners should first identify users' preferred activities and aspirations for the social setting. Once the social setting is addressed, the physical setting can be designed to support and enhance the intended social activities. Therefore, this researcher argues that technology is only one environment shaper of school design (Spurgeon, 1998). This study has shown that there are significant transactions between both a physical setting that supports technology and the social setting or the classroom. The social setting and the physical setting characteristics are intertwined and can be mutually supporting of human intention. For example, comfortable chairs, good views, and adequate workspaces may encourage students to pay attention and participate in learning activities.

This study is intended to provide architects, designers, facility planners, and researchers with a beginning examination of the effects that different computer lab seating arrangements can have on the physical and social settings of the classroom. More effort is needed in the pre-design phase to provide the users with their needs in particular learning environments. One way to determine the users' needs would be to setup simulations to see which designs work, or survey the users who spend the most time in the settings. Often, University design projects are given low budgets and therefore, do not have the money or time for the pre-design phase. However, this study persuades us to believe that the physical environment supports and has an effect on the social setting, which in the end effects student learning, teaching style, and student and teacher appraisal of the classroom.

APPENDIX A
COMPUTER CLASSROOM ENVIRONMENT INVENTORY (CCEI)

Location: *Class size:* *No. of computers:*

For each statement below, the observer will tick each condition noted to be true with actual measures recorded on the attached worksheets (see reverse).Where multiple criteria exist, all must be true for the statement to be scored true. The maximum score for each domain total below is five.

Tick if true:

Workspace environment

- Adequate workspace exists for the placement of notebooks and other resources
- Screen depth (front of screen to table edge) located within the range of 500-750 mm
- Chair has adjustable height and back support and is set on moveable (rolling) castors
- Keyboard height (floor to home row) is adjustable within a min. range of 700-850 mm
- Screen height (screen centre above floor) is adjustable within a range of 900-1150 mm

Total score:

Computer environment

- Inclination of the viewing monitor is adjustable (within 88° - 105° from the horizontal)
- Keyboard height (home row to desk level) is adjustable within a range of 100-260 mm
- Operating system utilizes a graphical interface with icons rather than teletype inputs
- System uses a colour display monitor with adjustable brightness and contrast contols
- Computer software uses a reverse display (dark text on a light or neutral background)

Total score:

Visual environment

- Glare controlled through the use of screens, indirect lighting or equipment positioning
- Good light quality with natural or indirect lighting sources (full spectrum preferred)
- Excessive contrast of work surfaces are contolled through the use of neutral finishes
- Illumination levels (measured on the horizontal plane) fall in the range of 500-750 lux
- Luminance of surrounding surfaces is maintained within 10-100% of illumination

Total score:

Spatial environment

- Adequate space exists for easy movement among workstations, resources and exits
- The number of students in the classroom does not normally exceed thirty students
- Resource areas are of sufficient size to display or store neccessary learning materials
- Overall finishing of room walls, flooring etc. is in light coloured or neutral tones
- The aisle width between desks or benches falls within the desire range of 152-183 cms

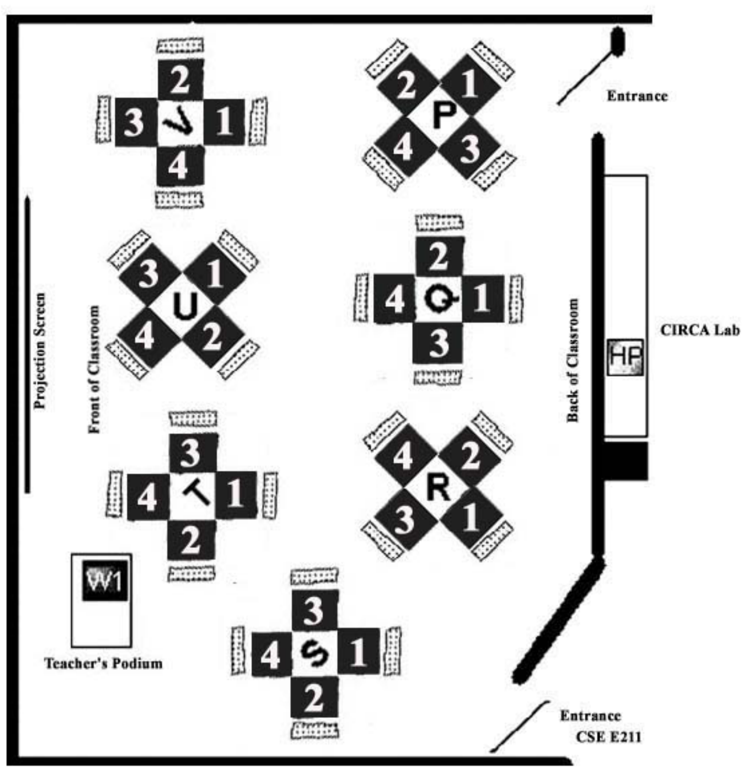
Total score:

APPENDIX B
ISOVIST ANALYSIS

The isovist analysis will determine the teachers' restricted views of students and their workstations, as well as, the students' restricted views of the teacher, projection screen, and other students. The first three floorplans below give an isovist analysis from the teacher's point of view. The next three floorplans give an isovist analysis from the student's point of view. The workstations are coded according to the difficulty of view.

CSE E211

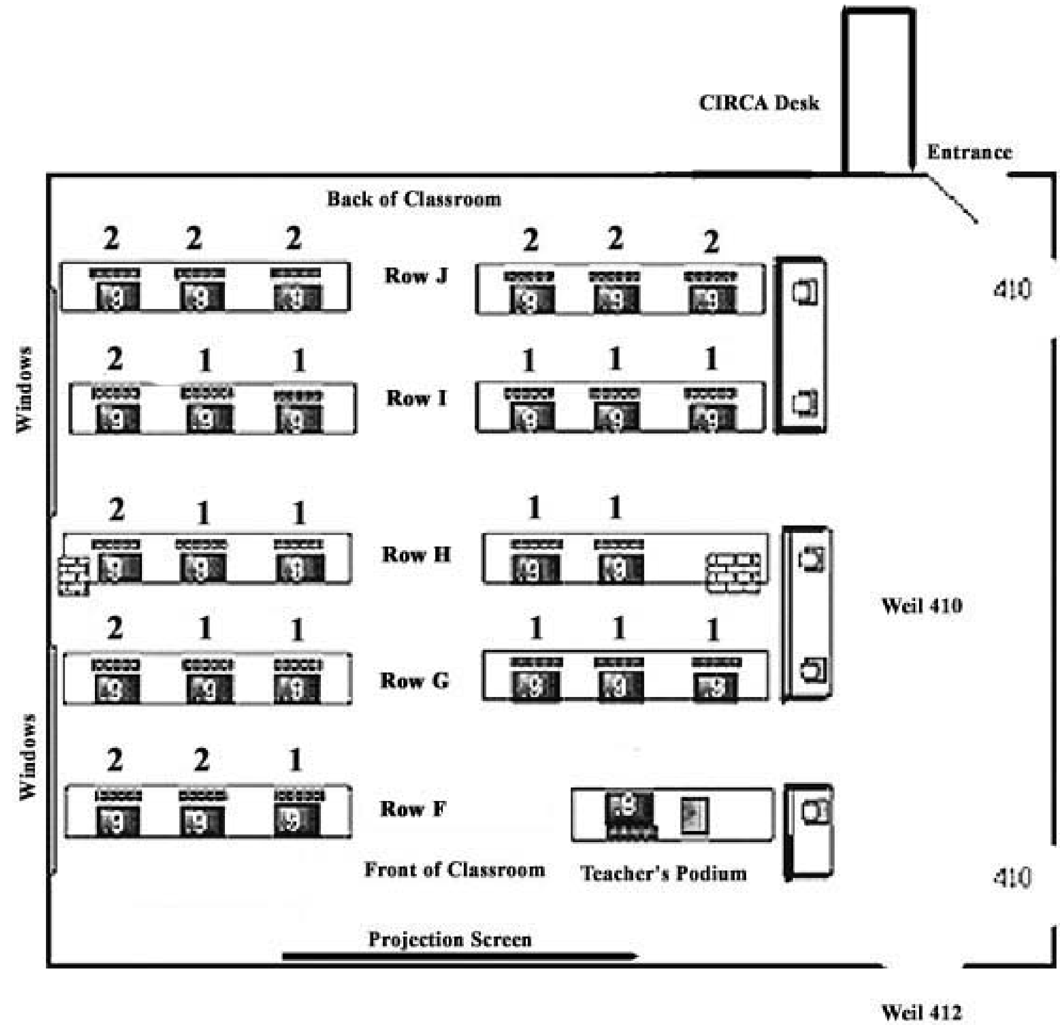
Students' View



1	Best View
2	Good View
3	Poor View
4	Difficult View

WEIL HALL 410

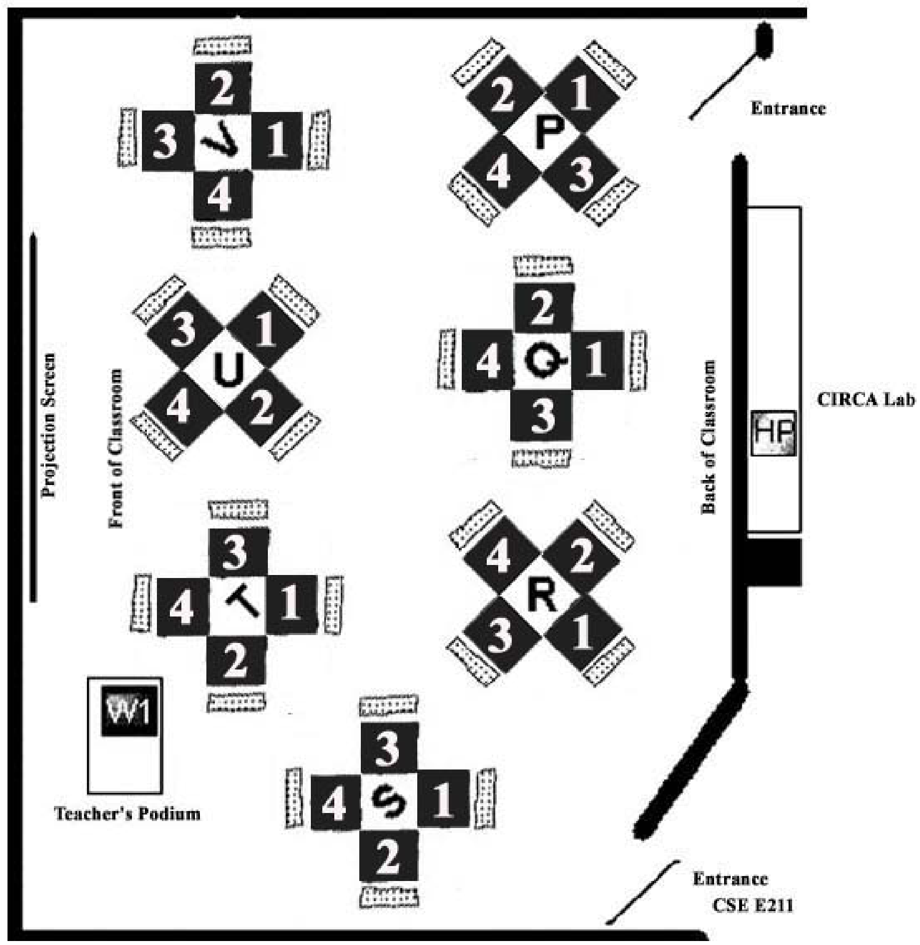
Students' View



1	Best View
2	Good View
3	Poor View
4	Difficult View

CSE E211

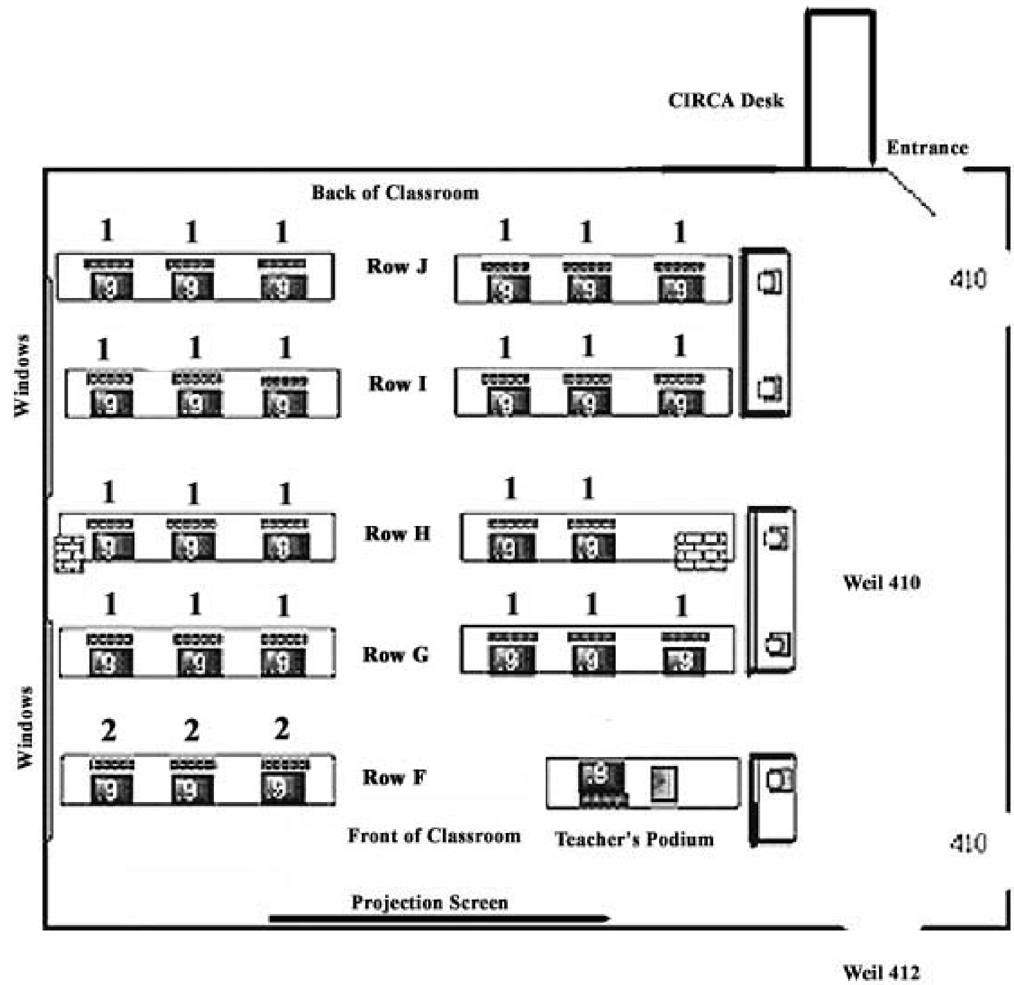
Teacher's View



1	Best View
2	Good View
3	Poor View
4	Difficult View

WEIL HALL 410

Teacher's View



1	Best View
2	Good View
3	Poor View
4	Difficult View

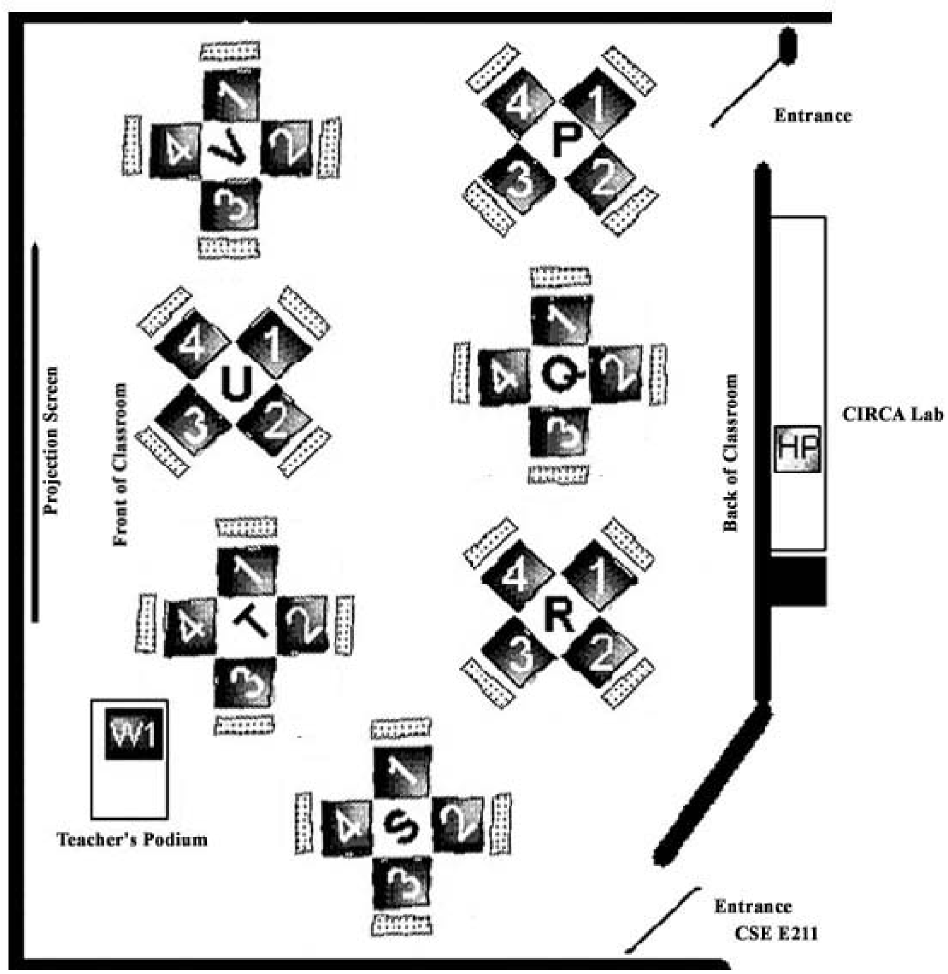
APPENDIX C
BEHAVIORAL MAPPING

The behavioral mapping instrument will include a map or floorplan of each room being observed and charts to record verbal interactions. The charts display the seating position of the student and allow for tallies to be made of the amount of verbal interactions the student made. One chart is for student-to-student interactions and the other chart is for student-to-teacher interactions. The map of the room will permits notes to be made about whether the students interacted with someone next to them or across from them. The map will also display movement patterns of the teacher if there are any at all.

CSE E211

Behavioral Mapping

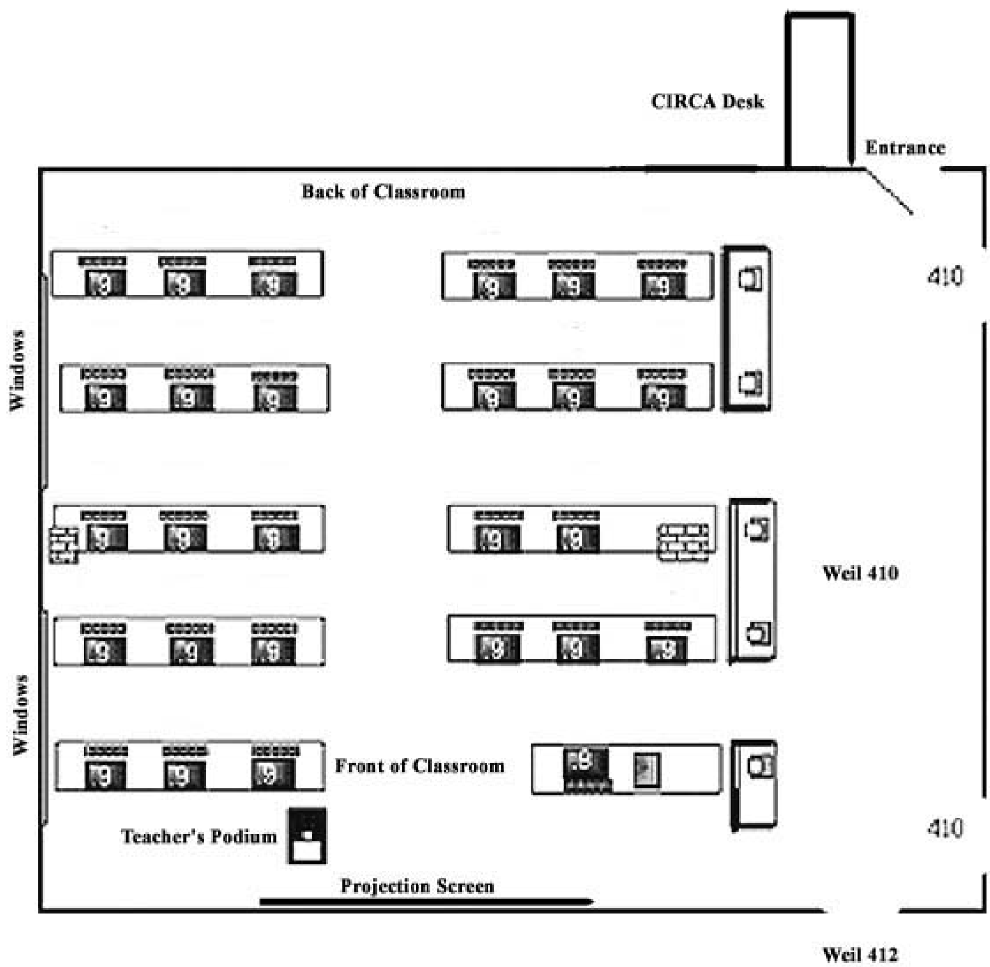
/ - vacant seat
X – off task
I – student-to-student interaction
- - student-to-teacher interaction



Weil Hall 410

Behavioral Mapping

/ - vacant seat
X – off task
I – student-to-student interaction
- - student-to-teacher interaction



APPENDIX D
CLASSROOM APPRAISAL SURVEY: STUDENT

(Student – CSE E211)

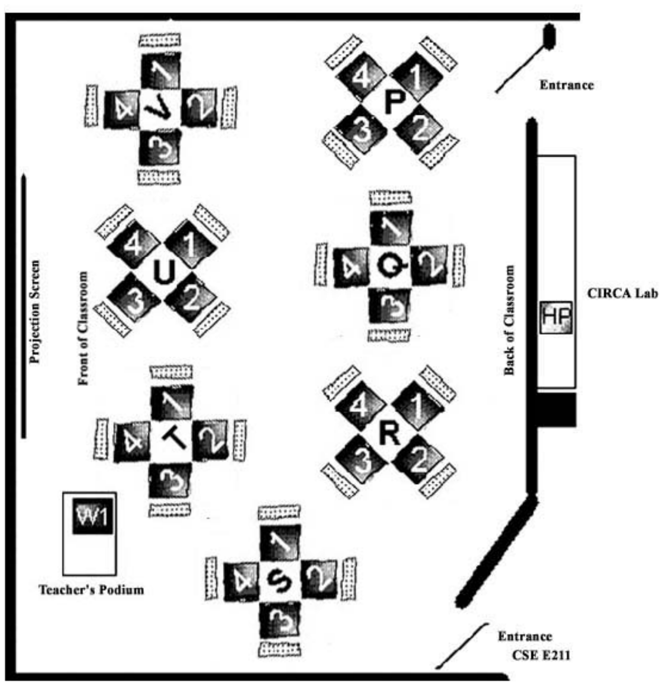
This survey contains statements and questions about the physical characteristics of this class and the activities that take place in this class. There are no right or wrong answers. Some statements and questions may be similar. Please answer all of the questions.

1. Gender (circle one) male female
2. Race (circle one) African American Caucasian Hispanic Asian Other_____________
3. Major (circle one) Sociology Criminology Other________________
4. Age __________
5. Current College GPA _________

6. Where do you usually sit in this classroom? (please circle the row and seat)

Pod P Q R S T U V

Seat 1 2 3 4



Classroom Appraisal Survey

(Student – Weil 410)

This survey contains statements and questions about the physical characteristics of this class and the activities that take place in this class. There are no right or wrong answers. Some statements and questions may be similar. Please answer all of the questions.

1. Gender (circle one) male female

2. Race (circle one) African American Caucasian Hispanic Asian
Other______________

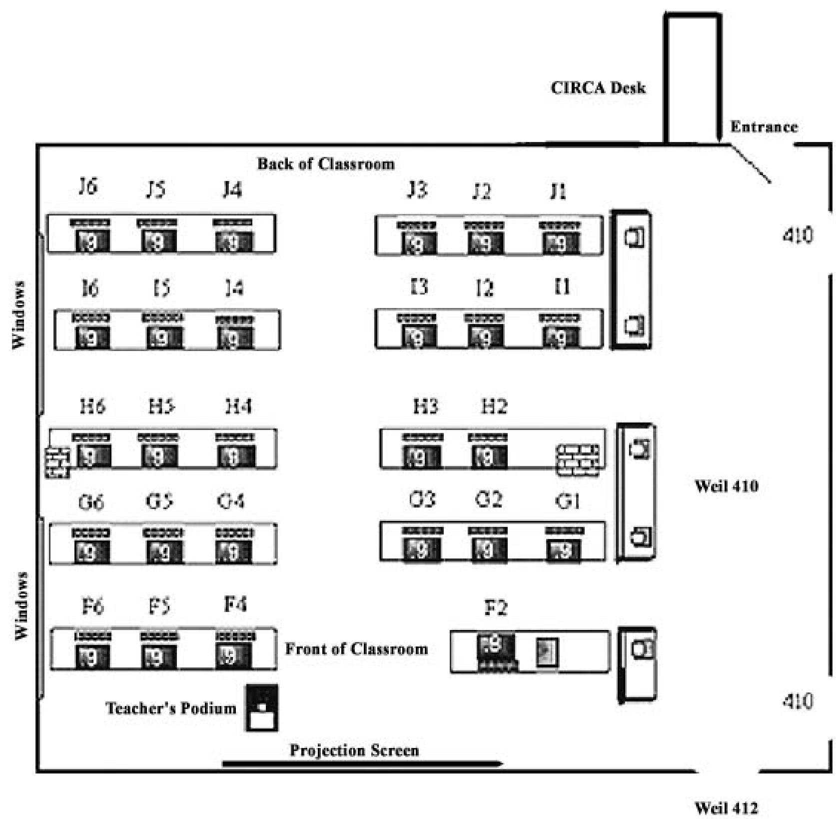
3. Major (circle one) Sociology Criminology Other______________________

4. Age ___________

5. Current College GPA _________

6. Where do you usually sit in this classroom? (please circle the row and seat)

Row	F	G	H	I	J	
Seat	1	2	3	4	5	6



7. How often do you sit here?
   a. 100%
   b. 75%
   c. 50%
   d. 25%
   e. occasionally
   f. different seat each time

Please answer the following statements concerning the social environment in this classroom.	Never	Seldom	Often	Always
8. How often do you feel that the teacher uses the following styles of teaching:				
a. one on one interaction with students	1	2	3	4
b. presentation (lecture, tutorials, drill and practice)	1	2	3	4
c. teamwork (collaboration, group work)	1	2	3	4
d. discussion (seminar)	1	2	3	4
9. Students help each other in this class.	1	2	3	4
10. Students work in groups in this class.	1	2	3	4
11. Students give their opinions during class discussions.	1	2	3	4
12. Students ask the teachers questions.	1	2	3	4
13. The teacher decides how much movement and talk is allowed.	1	2	3	4
14. Students work at their own pace.	1	2	3	4
15. Students get distracted during class.	1	2	3	4

Please answer the following statements concerning the physical environment in this classroom.	Never	Seldom	Often	Always
16. The seating arrangement facilitates teacher's assistance during class.	1	2	3	4
17. The seating arrangement facilitates class related interaction among the students during class.	1	2	3	4
18. The seating arrangement allows for ease of movement	1	2	3	4
19. I have trouble viewing the projection screen at the front of the room during demonstrations.	1	2	3	4
20. The computer tables provide adequate workspace for me to write.	1	2	3	4
21. I can see every student in the class and the teacher from my seat.	1	2	3	4
22. There is adequate aisle width between the desks.	1	2	3	4
23. There is glare on the computer screens.	1	2	3	4
24. Does the computer lab classroom arrangement meet your needs?	1	2	3	4

25. Please circle your current mid-term grade.
   a. A/A-
   b. B+/B
   c. B-
   d. C+/C
   e. C-
   f. D or below

26. Do you like this classroom arrangement?
   a. absolutely
   b. to some extent
   c. not at all

27. Why?

APPENDIX E
CLASSROOM APPRAISAL SURVEY: TEACHER

CSE E211 / Weil 410

This survey contains statements and questions about the physical characteristics of this class and the activities that take place in this class. There are no right or wrong answers. Some statements and questions may be similar. Please answer all of the questions.

1. Which course do you teach?
   a. Methods of Social Research
   b. Research Methods in Criminology

Please answer the following statements concerning the social environment in <u>this</u> classroom.	Never	Seldom	Often	Always
2. How often do you feel that you use the following styles of teaching:				
a. one on one interaction with students	1	2	3	4
b. presentation (lecture, tutorials, drill and practice)	1	2	3	4
c. teamwork (collaboration, group work)	1	2	3	4
d. discussion (seminar)	1	2	3	4
3. Students help each other in this class.	1	2	3	4
4. Students work in groups in this class.	1	2	3	4
5. Students give their opinions during class discussions.	1	2	3	4
6. Students ask the teachers questions.	1	2	3	4
7. The teacher decides how much movement and talk the students are allowed.	1	2	3	4
8. Students work at their own pace.	1	2	3	4
9. Students get distracted during class.	1	2	3	4

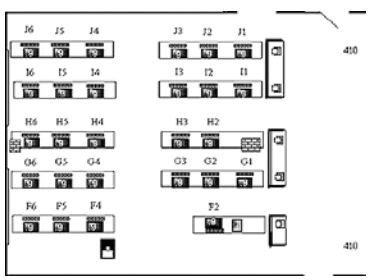
Please answer the following statements concerning the physical environment in <u>this</u> classroom.	Never	Seldom	Often	Always
10. The seating arrangement facilitates the teacher's assistance during class.	1	2	3	4
11. The seating arrangement facilitates class related interaction among.	1	2	3	4
the students during class.	1	2	3	4
12. The seating arrangement allows for ease of movement.	1	2	3	4
13. I have trouble viewing the projection screen at the front of the room during demonstrations.	1	2	3	4
14. The computer tables provide adequate workspace for me to write.	1	2	3	4
15. I can see every student in the class and the teacher from my seat.	1	2	3	4
16. There is adequate aisle width between the desks.	1	2	3	4
17. There is glare on the computer screens.	1	2	3	4
18. Does the computer lab classroom arrangement meet your needs?	1	2	3	4

19. Do your students learn:
    a. passively (receiving information and taking notes)
    b. learn by doing (actively engaged in the learning process through experimenting)
    c. other

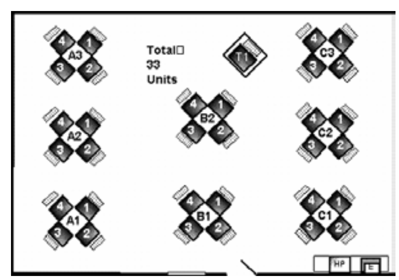
20. Have you taught a course in a traditional straight row computer lab classroom before? (refer to images below)
    a. yes
    b. no

21. Have you ever taught a course in a computer lab with the pod arrangement? (refer to image below)
    a. yes
    b. no

Straight row arrangement



Pod arrangement



22. Do you prefer one computer lab seating arrangement over another for teaching this part of the course?
    a. yes, the straight row arrangement
    b. yes, the pod arrangement
    c. no preference

23. Why?

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BIOGRAPHICAL SKETCH

Jessica Lee Callahan was born in Memphis, Tennessee. Since she was a child, she has always been interested in the design of interior spaces. Jessica moved to Chattanooga, Tennessee, after graduating high school. She obtained a Bachelor of Science degree with a focus in interior design in December of 1999.

After working in the residential field for two years, Jessica decided to further her knowledge of the broad field of interior design. She enrolled in the Master of Interior Design program at the University of Florida and was enlightened by the knowledge she gained from the professors and the program.

Upon completion of this master's thesis, Jessica plans to apply her knowledge and experience within the commercial industry. She hopes this will allow her to be well experienced in both aspects of the residential and commercial design fields so that one day she can educate others.