EFFECTS OF FULL-SPECTRUM LIGHTING ON USE OF CLASSROOM LIBRARY CENTER BY PRESCHOOL CHILDREN

By

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Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1995

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
July, 2000

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OF CLASSROOM LIBRARY CENTER
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PREFACE

The physical environment is a key element in a child's educational experience. This study focused on one specific and often overlooked component of the physical environment - lighting.

I would like to express my thanks to all who have assisted and supported me in this project and throughout my graduate study at Oklahoma State University. First and foremost, I wish to express my sincere gratitude to my major adviser, Dr. Mona Lane, for her continual guidance, advice and patience throughout this study. Appreciation is also extended to the other committee members, Dr. Kathryn Castle and Dr. Deborah Norris; their direction and support was invaluable.

Special thanks and appreciation are due to all who helped me with the implementation of this study at the Child Development Laboratory. I am grateful for the parents, and children who participated in this study; for the teachers in the preschool laboratory, Margaret Napier and Jami Radle, for their cooperation and feedback during the study; and for the undergraduate students who volunteered their time to record observations for the study, Sara Courtin, Alena Leggitt, Twila Smith, and Jeffery Williams.

I am fortunate to have had many people to help me with the technical aspects of this project. Thanks go to Sissy Osteen and Christine Johnson for their help with analyzing and interpreting the statistical data. My gratitude is also extended to Charlene Fries for her technical support and guidance with the formatting of the final paper.

Finally, I would like to say thanks to my entire family for their support throughout my graduate career. This thesis would not have been possible without my husband, Todd, who has been an invariable source of encouragement and love, and has volunteered his help in many ways throughout this project. I am also indebted to my parents, Richard and Rita, for instilling in me the value of education, and for their constant support and guidance throughout my life and academic career. I would also like to extend my thanks to my mother and father in law. Don and Cheryl Snethen for their support and help with this project. I finally finished it!

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The demand for childcare and preschool programs is increasing (Children's Defense Fund [CDF], 1998). A large number of children attend these programs for a longer amount of time each day. The children enrolled in a childcare or preschool setting spend the majority of their waking hours there. It is of utmost importance that this environment meets the developmental needs of the children in it. These needs must be met through interaction, health and safety, curriculum, and the physical space. All the components of the environment must be examined to ensure that the children in it are in a safe, stimulating, and well-prepared environment (Shore, 1997).

Statement of Problem

Lighting is an often overlooked and under- recognized part of the physical space. It is not only an important factor in the physical environment, but also one of the most basic requirements of all classrooms (Schreiber, 1996). It is commonly understood that lighting serves the basic function of enabling vision, but how often do educators stop to consider the non-visual effects of lighting on students? School lighting is an active element in the educational environment that not only provides for performance of visual tasks, but also significantly affects the aesthetic and psychological character of the learning space (Dunn, Krimsky, Murray, & Quinn, 1985).

Lighting in schools deserves close consideration, rather than equipping schools with inferior or even harmful lighting systems simply because they are more economical. People react to light both physically and emotionally. Lighting affects our moods and ability to function; too much lighting is irritating and may cause squinting and fatigue, too little lighting makes visual tasks difficult and is linked to depression (Alexander, 1995).

Research has indicated that full spectrum lights are more favorable than standard lighting such as cool-white fluorescents. Full-spectrum lighting shows the color of objects as they appear,

enhances seeing, and reduces eye fatigue, whereas most of the light emitted by fluorescent lighting is in the green and yellow spectral range, where the eyes are the most sensitive. The use of full-spectrum lighting in classrooms, as opposed to fluorescent lighting, has been associated with many psychological and physiological benefits; some of which are: a decrease in dental carries, achievement gains (Hathaway, 1995; Mayron. Ott, Armontree, & Nations, 1975), better attendance, gains in height and weight (Hathaway, 1995), decreased hyperactivity (Painter, 1976-77; Mayron, Ott, Nations, & Mayron, 1974), and more interest in school work (Ott, 1976).

More research is needed to bring attention to an often overlooked, yet omnipresent factor in all classrooms; lighting. Whether teachers simply overlook classroom lighting as a factor in the quality of the educational experience in their classrooms, or simply do not know how to improve current lighting systems is unclear. The proposed study will examine a simple modification of classroom lighting, the addition of full-spectrum lighting in the library center, and its effects on the children and their educational experience.

Purpose of Study

The main focus of this study was to examine the effects of the addition of full-spectrum lighting to the library center of a preschool classroom. Some research has examined the use of full-spectrum lighting in classrooms, but no studies have examined the use of full-spectrum lighting and preschool children. The frequency of visits to this center and length of time spent there were examined. Previous studies have explored the effects of lighting on hyperactive behavior in children and physiological effects of lighting (Hathaway, 1995; Painter, 1976-77; Hughes, 1981; Mayron, et al., 1974; O'Leary, Rosenbaum, & Hughes, 1978; Mass, Jayson & Kleiber, 1974). This study examined lighting as an educational tool, used to attract children to certain centers and facilitate a longer amount of time spent in that center.

Research Question

The following major research question was developed for this study:

Will the addition of full-spectrum lighting to the preschool library center increase the amount of time children spend engaged in that center?

Prediction: The addition of full-spectrum lighting will increase the amount of time children spend in the library center.

Null Hypothesis

The null hypothesis for this study was:

Supplementing regular fluorescent classroom lighting with full-spectrum lighting will not increase the amount of time preschool children spend in the classroom library center.

The use of the library center by a group of preschool children will not change when full spectrum lighting: (a) is introduced in the center, (b) has been used in the center for one week, (c) has been used in the center for two weeks, and (d) has been used in the center for three weeks.

Assumptions and Limitations

It is assumed that during this study the classroom structure did not change in any way. The children in this program choose activities they want to participate in from the available classroom centers. Children are not forced or required to work in any center. This structure remained intact during the length of this study. It is also assumed that the children were not disturbed by the presence of the observers; the observers remained in an observation booth that allows people to look into the classroom through a one-way mirror. Neither the teachers nor the children were visibly aware of the observers.

Because the study used a pre-assigned classroom, limitations to this study include the use of a sample that is not randomized. The conclusions from this study are limited to include preschool age children, from primarily the middle class, who attend a university laboratory school with professionally trained teachers and low teacher to child ratio.

Some of the books in the classroom library center are normally rotated based on the current topic of study, while the other part of them remains the same. To help eliminate book selections as a factor in the use of the library center, the same books remained in the library for the duration of the study. The books selected for use in the library center during the study were chosen from a collection of quality children's literature by Morrow (1993). This collection was consulted to assure that the books chosen for the study were quality literature selections that will hold the interest of the children. Additional books were provided to the children at rest time and during outdoor

centers. The researcher kept a list of the books selected for the library, which was considered when interpreting the data (Appendix A).

Finally, this study was limited because it focused only on supplementing the current classroom lighting system with full-spectrum lighting, instead of replacing the complete lighting system with full-spectrum lighting.

Definitions of Terms

In order to promote understanding, definitions of terms used in this project have been defined in this section.

1. Fluorescent lighting - the most commonly used type of artificial lighting that emits most of its light in the green and yellow range of the spectrum.

2. Full-spectrum lighting - the type of artificial lighting that most closely resembles natural light, emits light in all colors of the spectrum, and offers excellent color rendering.

3. Interest center - an area in the preschool classroom where children can explore activities appropriate for their developmental level and interests (Rutledge, 1987).

4. Library center - an interest center in the preschool classroom which contains: books, a soft area where children can read books, puzzles, games, and literacy materials such as flannel board stories, puppets, etc.

CHAPTER 2

REVIEW OF LITERATURE

Enrollment numbers for childcare and preschool programs are soaring. In 1973, 30% of mothers with children under the age of six were in the work force, and 50% of mothers of school age children were in the work force. In 1997, those percentages were 65 and 77, respectively (CDF, 1998). Today, children are enrolled in childcare at younger ages than in the past, many from infancy (Bredekamp & Copple, 1997). Approximately 13,000,000 preschool children, including 6,000,000 infants and toddlers, spend a majority of their day being cared for out of their home, by someone other than their parents. In addition, millions of school age children require supervision in the hours both before and after school (CDF, 1998). Growth is not only expected, but desirable according to the National Education Goals Panel, whose objectives state that by the year 2000, all children will have access to high-quality and developmentally appropriate preschool (Bredekamp & Copple, 1997).

In addition to increased enrollment, childcare facilities have responded to the needs of working parents by extending the program day for all ages (Bredekamp & Copple, 1997). A 10-hour program day is not unusual.

The millions of children who attend childcare facilities, and their parents, depend upon the teachers, directors, and regulating agencies to guarantee a safe, stimulating, and well-prepared classroom environment. Researchers find that most childcare settings are of mediocre if not inadequate quality. The nation's youngest citizens are likely to be in unsafe, poor quality childcare. Over one-third of children are in childcare settings that are detrimental to their health, and majorities of the rest are in environments where little learning is taking place (Shore, 1997). Children are being "warehoused" in their most formative years. According to Bredekamp and Copple (1997), the number of childcare programs is on the rise not only because of increased demand for out of home care, but also because society has begun to realize the critical importance

of educational experiences in the early years. Additionally, only 15% of childcare programs are considered to provide "good quality" programs that support the health and cognitive development of the children.

The environment in which children spend most of their waking hours must be carefully examined. This environment must meet their developmental needs through interaction, curriculum, health and safety, and physical space. Because children primarily experience the world through sensory and motor experiences, they have a very acute awareness of the physical environment.

Significance of Classroom Lighting

Classroom climate is created through the combination of many variables. Often, poor student attitudes about school and learning and undesirable student behavior are attributed to the classroom curriculum. Green, Cook, and Bolt (1996), argue that classroom environment variables such as overall classroom design, temperature, acoustics, color, wall coverings, comfort and location of seating and lighting can contribute to these negative effects as well. They suggest that though poor classroom environments are usually easy to identify, it is usually more difficult to pinpoint why they are substandard. Educators and parents often assume that the physical and psychological safety needs of children are being met by the classroom environment when it has four walls, a roof, chairs, a light fixture, and offers the protection of life and limb.

Wurtman (1975) states that the decisions about classroom lighting are made based on economical and technological information, rather than on the biological needs of the student. Poor lighting can cause glare, headaches, and visual fatigue (Green, et al., 1996). In addition, light is a nutrient for the body that performs many functions, some of which include: production of vitamin D in the skin, activation of biochemical events involving endocrine control, timing of our biological clocks, entrainment of circadian rhythms, immunological responses, sexual growth and development, regulation of stress and fatigue, control of viral and cold infections, and dampening of functional disorders of the nervous system (Hughes, 1981).

The psychological needs of the student are being neglected as well. Different types of lighting evoke different reactions in the unconscious mind. Rovner (1982) identifies the different

associations that may be made by the unconscious mind in response to different types of light. Some lighting types evoke pleasant responses. For instance, ultraviolet light evokes the feeling of being outdoors, and feelings of home and hearth may be associated with incandescent light. Responses to other types of lighting may not be as pleasant; fluorescent lighting stimulates associations of hospitals and institutions.

Ninety percent of the information we receive is taken in through our sensory channels: seeing, hearing, and touching. These are our primary sources of learning (Schiller, 1997). There is a direct relationship between good lighting and a student's performance, between eye fatigue and eye health, and between eye health and general health. When the tasks performed are more visually challenging, lighting becomes more significant, suggesting that the classroom may be the most critical area visually in the entire school (Falk, 1972). Hanlon suggests that teachers would be more effective if they acknowledged the significance of classroom climate, and expanded that climate to include the sensory intuitive and subconscious experiences that influence human behavior (1979-1980). Ironically, lighting is often the most ignored environmental condition in schools (Bullock & Foster-Harrison, 1997).

Fluorescent Lighting

The most commonly used type of illumination is fluorescent lighting. It can be found in office buildings, hospitals, banks, stores, schools and universities, and many other highly populated and public venues. Although fluorescent lighting is generally more expensive upon initial purchase, it remains popular because it is less expensive to run, more efficient, generates less heat, and consumes less energy than other types of lighting (Painter, 1976-77; Green, et al., 1996). Fluorescent bulbs are also popular due to their longevity. Most have an approximate life of 20,000 hours (McShane, 1997).

Despite the widespread use, economy, and efficiency of florescent bulbs, the other effects and components of this type of lighting should be examined as well. The majority of light emitted from fluorescent bulbs is in the green and yellow spectral range. This range of energy is also where the eyes are the most sensitive (Hathaway, 1995).

Olds (1988) reports that fluorescent bulbs flash 120 times each second. Though the naked eye does not detect the flashing, it is assumed that the brain attends to it at some level. When the bulbs and ballasts are close to their age limit, sounds such as flickering, buzzing, and humming occur (McShane, 1997; Green, et al., 1996).

Additionally, the physical appearance of the lamps is to be considered (Green, et al., 1996). Fluorescent lights produce an institutional tone for the environment. In many locations, such as schools and hospitals, where it is desirable for people to feel relaxed and at ease, this effect is less than desirable. This and other factors have led hospitals and medical facilities in Germany to ban fluorescent lights in those facilities altogether (Walker, 1998, November 14).

Research examining fluorescent lighting in the classroom has related it to several undesirable outcomes. Ott (1976) believes that the radiation that is emitted from fluorescent lighting is linked to hyperactivity, or at least it is a stress to the body, which results in hyperactivity. In a classroom of nine children who were diagnosed with autism and emotional disturbances, Painter found that turning off the fluorescent lighting reduced the marked hyperactivity of her students. Table and floor lamps produced the only lighting used in the classroom. Incidences of hyperactive behavior dropped 32.2% (1976-77). Coleman, Frankel, Ritvo, and Freeman (1976), report that the repetitive behaviors of six autistic children decreased when classroom illumination was switched from fluorescent to incandescent lighting.

Green, et al. (1996) point out that if the only factors to be considered when furnishing schools with lighting are cost and efficiency, then fluorescent lights are the best fit. If this is so, then why are more homes not furnished with that type of lighting?

Full-Spectrum Lighting

Full-spectrum lighting is the type of artificial light that most closely resembles natural light. When seen under natural light all colors of the spectrum are present in equal amounts, and are visible to the same degree. The Color Rendition Index (CRI) measures the way that colors look under different types of light. Sunlight has a CRI of 100, and serves as the reference point for that index. Other types of lighting are compared to sunlight using the CRI (Hathaway, 1995).

Full-spectrum lighting has a relatively high CRI that, according to Hathaway, may be integral to the vision process (1995). One specific brand of full-spectrum bulbs, Westinghouse ReaLites, has a CRI of 98 out of a possible 100. Like natural light, full-spectrum lighting incorporates wavelengths at all points on the spectrum, and light waves range from infrared to ultraviolet (Schreiber, 1996).

Hughes reports that full-spectrum lighting offers excellent color rendering, or the ability to see colors as they really appear. Full-spectrum lighting also enhances the ability to see, thus reducing student fatigue (1981).

The subliminal flicker, a chief complaint about standard fluorescent lighting, is not present in full-spectrum lights. Compared to fluorescent lighting, full-spectrum lighting uses half the amount of energy, costs less to install, and does not deprive the eyes of infrared and ultraviolet light (Bailey, 1997).

When different forms of lighting are used in the workplace, workers report that they feel best when under full-spectrum lighting (McShane, 1997). Full-spectrum lighting is also reported to increase the comfort and health of individuals working under it (Hughes, 1981).

As early as 1969, research was being done which examined the effects of lighting that had a spectrum similar to natural light. Kolorite lamps were found to provide better color qualities and visual clarity than other types of lighting at the same level of illumination (Hathaway, 1995).

The Austrian Institute of Sports Medicine examined the effects of natural light and/or full-spectrum lighting during a three-year period. They found that healthy students who received controlled exposure to sunlight or full-spectrum lighting showed improvements such as: increased physical working capacity, lower heart rates, and increased uptake of oxygen (Hughes, 1981). Bailey (1997) reported that the use of full-spectrum lighting could help to eliminate between 70-80% of the health problems that can be associated with lighting conditions.

Fluorescent Lighting vs. Full-Spectrum Lighting

Several studies have examined the effects of full-spectrum light when compared to fluorescent light (Hathaway, 1995; Hollwich, 1998, November 14; Maas, et al., 1974; Mayron, et al., 1974; Schreiber, 1996).

Hathaway completed a two-year study of classroom lighting with fourth grade students in 1986 and 1987. The students were enrolled at five different schools, each with different types of lighting. The lighting conditions included: sodium vapor lamps, full-spectrum lighting, full-spectrum lighting with UV supplement, and cool white fluorescent. Hathaway found that the students enrolled in the schools which used full-spectrum lighting with UV supplement developed fewer dental carries and had greater gains in height and weight than the students at the other sights. In addition, the students at the sights that used full-spectrum lights and full-spectrum lights with UV supplements had greater achievement gains and better attendance that the children at the school sights that used fluorescent lighting and sodium vapor lamps (1995).

In 1980, Hollwich compared the effects of full-spectrum and cool white fluorescent lighting using changes in the endocrine system. The individuals who were sitting under the cool white fluorescent lights had stress like levels of the stress hormones ACTH and CORTISOL. Both of these metabolic hormones play major roles in the functioning of the entire body, and are related to the stress response. These hormonal changes were not present in the individuals who were sitting under full-spectrum lighting. The findings of this study suggest that children who spend their entire day under cool white fluorescent lights may display agitated behavior, fatigue, and reduced mental capacities (1998, November 14).

Maas, et al. (1974) completed a study at Cornell University comparing the effects of full-spectrum and fluorescent lighting on forty-one undergraduate students. A university classroom was converted into a study room where the students studied for four hours a day for a period of four consecutive days. The students studied for two days under fluorescent lighting and for two days under full-spectrum lighting. The subjects were naïve to the nature of the research and the variables being investigated.

During the first and last fifteen minutes of every four-hour session, the students were given tests for fatigue. The test examined two different criteria: subjective fatigue, or feelings of weariness, and objective fatigue obtained by objective measures while performing different tasks. This study found that students were livelier after studying for four hours under full-spectrum lights. The students could also see more clearly after four hours of study under the full spectrum lighting.

In 1974, Mayron, et al. completed a study that attempted to establish and document the value of full-spectrum lighting as it affects school age children. The study was completed in Sarasota, Florida, in four first grade classrooms. Two classrooms were control classrooms that continued to use fluorescent lighting, and two classrooms were experimental classrooms that employed full-spectrum lighting. The classrooms were photographed for 30-minute intervals using time-lapse cameras four to five times throughout the spring semester.

The researchers found a significant difference in the behavior of the two groups. The use of full-spectrum lighting versus cool white fluorescent lights decreased the hyperactive behavior of the students. The experimental (FSL) group appeared to be calmer and more interested in their work. One particular boy who was always in motion and was inattentive progressed to a quieter child who was able to sit still and concentrate in his work. His teacher reported that he was capable of working independently, and had even learned to read during the study (Ott, 1976). There were also strong indications that the experimental condition (FSL) played a role in the attainment of academic achievement to a greater degree than that seen in the control classrooms

Dentists examined the students at the beginning and end of the study. The children who were in the control classroom under cool white fluorescent lights had a significantly higher incidence of dental carries when compared to the children in the experimental classroom which used full-spectrum lighting (Mayron, et al., 1975).

There were no reported differences between the rooms regarding absenteeism (Mayron, et al., 1974).

In an informal study, Schreiber (1996) added full-spectrum lighting to her classroom. She found that the lighting had many positive effects on the children, including: being more relaxed when entering the room, less clingy, more curious about the classroom activities, regrouping better after outings, and being more calm at the end of the day. She noted that the lighting seemed to have an effect on the adults in the classroom as well. The teachers and parents were more at ease when playing with the children, lingered longer in the morning and afternoon, and commented that the room seemed more cozy and felt like home. In addition, the caregivers in the classroom experienced less fatigue and headaches at the end of the day. It is important to note

that some of the reported effects of full-spectrum lighting in this informal study may be due to passage of time and familiarity with the classroom and the routine.

Summary

In summary, research indicates that there are many benefits to using full-spectrum lighting as opposed to fluorescent lighting in the classroom environment. Some of the physiological benefits reported are: fewer dental carries (Hathaway, 1995; Mayron, et al., 1974), greater gains in height and weight (Hathaway, 1995), absence of stress hormone production in the body (Hollwich, 1998, November 14), clearer sight (Maas, et al., 1974), and decreased hyperactivity (Mayron, et al.; Schreiber, 1996). Reported psychological benefits include: greater gains in academic achievement (Hathaway, 1995; Mayron, et al.), better attendance (Hathaway, 1995), calm children who were more interested in their work (Mayron, et al.; Schreiber, 1996), and children who are less clingy and regroup better after outings (Schreiber, 1996).

CHAPTER 3

METHODS AND PROCEDURES

The main goal of this project was to examine the effects of adding full-spectrum lighting to the library center in a preschool classroom. Of particular interest was the amount of time the children spent engaged in that center. The behavior of the preschool children in the classroom was observed over a period of four weeks in this descriptive study.

Subjects

A total number of 13 subjects were selected from a university laboratory preschool program that is accredited by the National Association for the Education of Young Children. Parental permission was obtained for each subject to participate in the study (Appendix B). The sample consisted of 7 males and 6 females, ages four and five, selected from one classroom. As of February 2000, the ages of the children were: 9 children (5 males and 4 females) were age four (age range: 49 to 59 months), and 4 children (2 males and 2 females) were age five (age range: 64 to 66 months). All of the subjects were close in age and were predominately middle-class children (Table 1).

This project was an observational study completed from the observation booth adjacent to the classroom. The classroom schedule and curriculum were not altered in any way. The children were not aware that they were being observed, and the day was a typical day in the program for them. The children were however, made aware of the addition of the lamps to the library center in an introductory group time.

Data Collection

The procedure was the one-group pretest-post-test design. The main reason this procedure was selected is that it allows the researcher to compare performances by the same group of subjects both before and after exposure to full-spectrum lighting (Isaac & Michael, 1995).

Introduction of Full-Spectrum Lighting

Permission was obtained by the institutional review board (IRB # HE-00-123) before the study began. An introductory letter was sent to parents before the lighting was introduced, and a parental permission/release form was attached to this letter (Appendix B). The parents signed the release form, granting permission for their child to participate in this study.

Full-spectrum bulbs are not harmful to the children in any way; in fact, the literature suggests that they have many psychological and physiological benefits (Schreiber, 1996; Hughes, 1981; Hathaway, 1987; Hathaway, 1994; Painter, 1976-77).

Four student volunteers observed the use of the learning centers for baseline data from the observation booth that had a one-way mirror. Then two table lamps containing full-spectrum bulbs were placed in the classroom on opposite sides of the library center. The children were made aware of the lamps at a special group time. One week elapsed before the next observations began. This was necessary to allow the novelty of the lamps to subside.

Observations

During the study, the preschool classroom had twelve self-selected interest centers available to the children. These centers included: (1) easel area, (2) writing center, (3) dramatic play area, (4) math center, (5) science center, (6) manipulative table, (7) media table, (8) block area, (9) creative expression center, (10) library center, (11) computer center, and (12) listening center. The activities in these interest centers are planned with the age, developmental level, and interests of the children in mind. Children may choose which center they work in and how long they stay, as long as the rules for that center are observed. The centers allow for hands-on exploration and manipulation of learning materials related to the center topic.

The 50 books in the classroom library remained the same during the four-week study (Appendix A). The books were selected from a collection of children's literature (Morrow, 1993) to ensure they were quality literature selections that would hold the interest of the child. The researcher kept a list of the books in the library center during the study; this list will be considered when interpreting the data.

The configuration of the centers and classroom rules remained the same as before the study took place. The student volunteers observed the classroom as it usually functions, with the exception of the addition of full-spectrum lighting.

The major emphasis of this study was to note any significant changes in the amount of time children spent in the library center after the addition of the lamps containing full-spectrum bulbs. An instrument was constructed for recording the observational data. A variation of the Interest Center Frequency Chart developed by Kathleen Rutledge (1987), for use in her unpublished Master's thesis, was created (Appendix C). Subject numbers for the children who had permission to participate in the study were listed across the horizontal axis. On the vertical axis the three interest centers for one observation station were listed. In order to record data for all twelve centers, four different observation stations with four different Interest Center Frequency Charts were created. Each observation station had it's own unique Interest Center Frequency Chart. The charts were duplicated for the observers and placed in color-coded folders. These folders were made available to the observers before each observation was made. All data were stored in the researchers locked filing cabinet between observations.

Volunteer observers who were competent, conscientious, and consistent were selected to collect the data. A total of four undergraduate student volunteers recorded data for four 30-minute sessions. A back-up observer was selected as well. Each observation took place at the same time (9:30-10:00 a.m.), and the same day of the week (Wednesday), from an observation booth with one-way mirrors.

The four volunteers and one back up volunteer were instructed on the use of the Interest Center Frequency Chart, and participated in a trial observation with the researcher before the observations began. The observers were trained using the same Interest Center Frequency Chart, and trial observations continued until their observations agreed with those of the researcher 98% of the time. The observers were also reminded of the confidentiality issues associated with observing young children. The children were identified by using cards with their picture and subject number on them. To facilitate observations, the cards were formatted to follow the same order as the subject numbers on the horizontal axis of the Interest Center Frequency Chart. The photos were used to ease the data collection only, and will be destroyed after the final report has

been approved. Each volunteer observed the same station for each observation. The observer obtained the color-coded folder for her assigned observation station and a three-minute egg timer in order to record time sampling of the children's participation in each interest center in her designated observation station. The four Interest Center Frequency Charts were combined on the Center Scoresheet (Appendix D) to provide the details of participation in each of the 12 centers.

At the beginning of each observation, the student volunteer noted which children were present in each of the centers he or she was observing, and a tally mark was made in the appropriate box on the Interest Center Frequency Chart for each child. After this was done, the observer started the three-minute egg timer. When the three minutes elapsed, the observer again recorded which children were in the interest centers he or she was observing. The data will indicate how many three-minute periods each child spent in an interest center. The observations continued for 10 three-minute periods for a total observation time of 30 minutes. Each child had a maximum total of ten tally marks for each observation.

During the first week of the study, one 30-minute observation session was completed to establish baseline data. This was completed before the lamps were introduced. The baseline observations helped identify which interest centers the children were using and how much time children spent in each interest center before the addition of the full-spectrum lighting.

After the baseline data were collected, the full-spectrum lighting was introduced. One week elapsed before any further observations were made. This helped allow for the novelty of the lamps to subside. Additional observations took place during the second, third, and fourth weeks of the study.

Analysis of Data

The primary goal of this project was to examine the children's use of the library center before and after the introduction of full-spectrum lighting. The data were transferred from the Interest Center Frequency Charts to the subject's score sheets and center score sheet (Appendix D). Subject number was used to identify the children on the score sheets; their names were not used. Paired Samples t-tests were performed to compare the baseline observation to the three subsequent observations (Table 2). Also use of each interest center during the baseline, second,

third, and fourth weeks was compared (Figure 1). This helped to illustrate which interest centers were affected by the addition of full-spectrum lighting to the library center, which were not, and which centers returned to baseline observation levels during the study, and which did not. A chart was created that depicts which children were absent for one or more observations (Table 3). Percentage of time individual subjects participated in the library center was also examined (Figures 2 - 13).

CHAPTER 4

RESULTS OF THE STUDY

The main goal of this project was to analyze the effects of adding full-spectrum lighting to the library center in a preschool classroom. Of particular interest was how the lighting affected the children's use of this center, and of the other interest centers in the classroom.

Measurements

The quantitative measurement used in this study was the number of three-minute intervals the children spent in the interest centers in the preschool classroom. In addition, when selecting statistical treatment for the data, interval level assumptions were accepted.

Subjects

The subjects were a sample (one group of 13) of preschool children. The sample was not a random population sample; the children were selected from the same classroom of 15 students who attended preschool for the morning session. The study was open to any of the children in the classroom who attended class in the morning and returned the parental consent form. Only three children in the class did not participate in the study. One student who returned the form attended only in the afternoon, so she was not eligible; another did not return the form; and the third student, subject 01, was absent during the baseline observation, so he was not included in the data analysis. Because the sample was not biased through the selection of certain individuals, it may very well be a fairly representative selection of preschool children who live in an academic community (Table 1).

Type of Research

This study was primarily descriptive. However, some inferential statistical techniques were applied to the data in order to shed some light on the research question. Any inference derived

could serve to guide further research, but should not be used to predict the behavior of children, either individually or as a group.

The null hypothesis for this study was that supplementing regular fluorescent classroom lighting with full spectrum lighting would not increase the amount of time preschool children spend in the classroom library center. The use of the library center by a group of preschool children will not change when full spectrum lighting: (a) is introduced in the center, (b) has been used in the center for one week, (c) has been used in the center for two weeks, and (d) has been used in the center for three weeks. Paired Samples t-tests were performed to compare the baseline observation to the three subsequent observations. There were no significant differences found; however, there was a tendency found between the baseline observation and observation 4 (p=.082) (Table 2). The calculated means were found when comparing the baseline observation (M=2.3000) and observation 4 (M=0.6000). This tendency illustrates a relationship inverse to the predicted relationship: i.e., the children spent more time in the library center during the baseline observation than during observation 4.

In reflecting on the data, the attendance of the subjects must be considered. Several of the students were absent for one or more observations during the study. The absences were as follows: one male subject (01) was absent during the baseline observation; three male subjects (01, 02, & 03) were absent during the second observation; two male subjects (01 & 07) were absent for observation three; and one male subject (07), and one female subject (13) were absent for the fourth and final observation (Table 3). The missing data were reflected in the analysis.

The use of each interest center during the baseline, second, third, and fourth weeks was also examined (Table 3). This illustrated which interest centers were affected by the addition of full-spectrum lighting to the library center, which were not, and which centers returned to baseline observation levels during the study, and which did not. The data indicated that the library center was the most used center by the children during the baseline observation, observation 2 and observation 3. When comparing the baseline data to the data from observation 2 and 3, an increase in the use of the library center was noted (Figure 1). The library use increased in all observations with the exception of observation 4.

During observation 4 the children used the writing center the most. These findings differ

from the findings of others. Rutledge (1987) found that children spent more time in blocks, dramatic play, gross motor, and art; however, in the current study, the library center and writing center received the most use followed by the block center, then the dramatic play area. The writing center tends to be a popular center in this classroom and has been for several years. Perhaps this is a result of the materials available to the children on a permanent basis; i.e., a variety of writing tools and paper, scissors, rulers, stencils, glue, and rubber stamps to name a few. It is important to note that Rutledge found the library center to be one of the least used centers in the classroom, which is the opposite of what this study found.

In this current study, the easel was used only once and the writing center was used twice. The tools at the easel are changed daily, and the listening center is changed weekly depending on the topic of study. The classroom teachers mentioned that this particular group of children tended to participate in "quieter" activities during the afternoon, such as the listening and easel center. Since the observations for this study took place during the morning, this could shed some light on why these centers were not used frequently by the children in the study.

The percentage of time individual subjects participated in the various interest centers were examined as well (Figures 2-13). All subjects included in the data analysis used the library center at some time during the study. This differs from Rutledge's (1987) study, where the library center was one of the least used centers. There were six subjects in the current study who were engaged in the library center more than any other interest center in the classroom; two males (02 & 07) (Figures 2 and 7), and four females (10-13) (Figures 10-13). This number of subjects reflects half of the subject sample; half of the children in this sample used the library center more than any other interest center in the classroom.

It is essential to note the important role the selection of the books used in the library center (Appendix A). Because the books remained in the library center for the duration of the four-week study, it was important to select quality children's literature that would hold the interests of the children. The books selected for use in the library center during the study were chosen from a collection of quality children's literature by Morrow (1993). The selected books were "favorite" children's literature, most of which have been around for many years and have proven to be popular with children.

CHAPTER 5

CONCLUSIONS AND DISCUSSION

The major hypothesis stated that the usage of the library center by a group of preschool children would not change when full-spectrum lighting was introduced, and had been available for 1, 2, or 3 weeks. Although no significant differences were found, there was a tendency found with an inverse relationship between the baseline observation and observation 4, indicating that the usage of the library center during the baseline observation was greater than during observation 4.

The researcher cannot conclude that the introduction of full-spectrum lighting made a major change in the pattern of usage of the library center; however, all subjects included in the data analysis used the library center quite often. The library was, in fact used more overall than any other center in the classroom, and this is not necessarily reflected in the statistical data.

Implications for the Classroom

In addition to the statistical results of the study, other effects of the lighting should be considered. The teachers, parents and children in the classroom made comments to the researcher on several occasions regarding the addition of the lamps to the center. The classroom teachers communicated that they enjoyed the ambiance created by the lamps. They believed the lamps made the library center attractive and home-like to the children and the staff, and the library center looked comfortable, cheery, and soothing. It appeared to be an area where children and adults could get comfortable and enjoy books. In fact, the teaching staff and children enjoyed the lamps so much that the researcher left them in the classroom after the study was completed. The lead teacher commented that she would like to purchase some lamps to remain in the library center permanently. Approximately one month later the lamps were removed and a parent remarked to the researcher that she did not know what the study had shown statistically, but she missed the lamps in the classroom library and thought they had a positive effect on the children.

Several of the children also commented to the researcher about the lamps. They expressed that they liked the lamps, and after the lamps were removed, the children asked where they had gone.

The findings of this study are of particular interest to classroom teachers. Lighting tends to be overlooked as something in the physical environment that the teacher cannot change. Indeed lighting can be changed by something as simple and inexpensive as adding lamps to the library area or to other interest centers in the classroom. Exploring lighting and other physical components of the classroom is essential to having a successful, comfortable learning environment. As Rosenfeld (1977) stated, "The best curriculum and the highest hopes have little chance of being realized unless the stage for learning is appropriately set" (p. 167).

Implications for Future Research

Additional research is needed to further explore the effect of full-spectrum lighting on children in the classroom. Studies using full-spectrum lighting as the sole source of lighting in the classroom would be of particular interest. Studies using lamps could also be completed using incandescent bulbs in the lamps, and then switching to full- spectrum bulbs, thus eliminating the possibility that the children were attracted to the library because of the lamps. Future research studies should employ a larger sample size, and possibly examine the use of full-spectrum lighting with varying ages of children. A larger sample size would accommodate statistical data analysis that considers gender as a factor. Future studies should increase the length of the study, i.e., collect baseline data at the beginning of the school year and then throughout the school year. Observations made at different times during the program day might provide a more accurate picture of the children's use of the interest centers. Collection of qualitative data in addition to quantitative data may help to shed light on the popularity of the library center and the lamps with full-spectrum bulbs. It would be interesting to complete a study similar to this one using a group of children who demonstrated low use of the library center. It would be of further interest to examine whether where the adults were during the observations was related to the children's use of the interest centers.

In conclusion, the addition of full-spectrum lighting to one preschool classroom over a period of time did not affect the usage of the library center. However, the library center was used and

enjoyed by teachers, parents, and children of both genders. Although there was no significant difference in the use of the library center after the addition of the full-spectrum lighting, this center was a popular area that received more total use than any of the other interest centers in the classroom.

At the beginning of the 21st century, when a great deal of emphasis is placed on reading and writing, the library and writing centers are crucial areas of the classroom; however, in a developmentally appropriate program, all interest centers in the classroom are essential. Quality lighting should be used in the entire classroom and throughout other visually important areas of the school. The examination of full-spectrum lighting in the classroom should be continued to further examine this type of lighting and its effects on the educational environment.

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TABLES

Table 1

Description of Subjects

Characteristic	n	%
Gender		
Male	07	53.8
Female	06	46.1
Age		
48 – 54 Months	03	23.1
55 – 60 Months	07	53.8
61 – 66 Months	03	23.1
Race		
Caucasian	12	92.3
Other	01	07.7

Table 2

Paired Samples t – tests

Pair	Mean	N	SD	p
Pair 1				.191
Baseline	2.6000	10	2.8363	
Observation 2	4.4000	10	1.8974	
Pair 2				1.000
Baseline	2.8182	11	2.7863	
Observation 3	2.8182	11	2.9603	
Pair 3				.082
Baseline	2.3000	10	2.3118	
Observation 4	.6000	10	.9661	

Table 3

Subject Absence Information

Subject	Gender	Baseline	Obsv. 2	Obsv. 3	Obsv. 4
01	Male	Absent	Absent	Absent	Present
02	Male	Present	Absent	Present	Present
03	Male	Present	Absent	Present	Present
07	Male	Present	Present	Absent	Absent
13	Female	Present	Present	Present	Absent

Note. Subjects not listed were present for all observations.

FIGURES

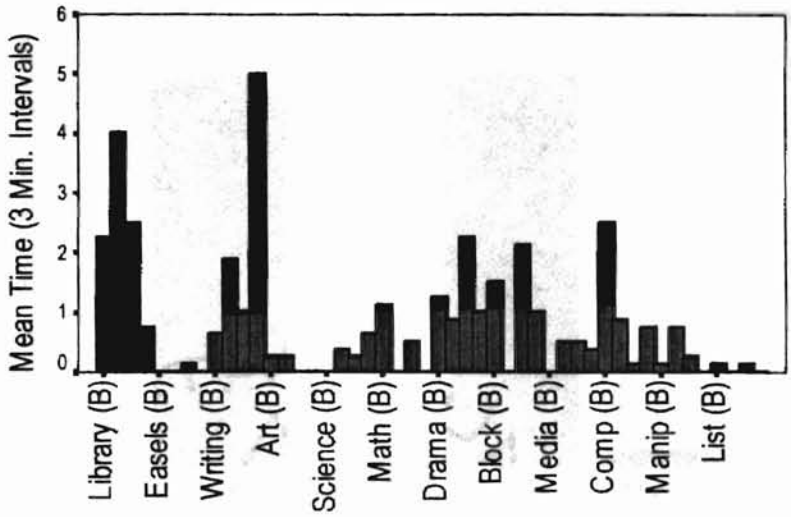

Figure 1. Center Use by Observation

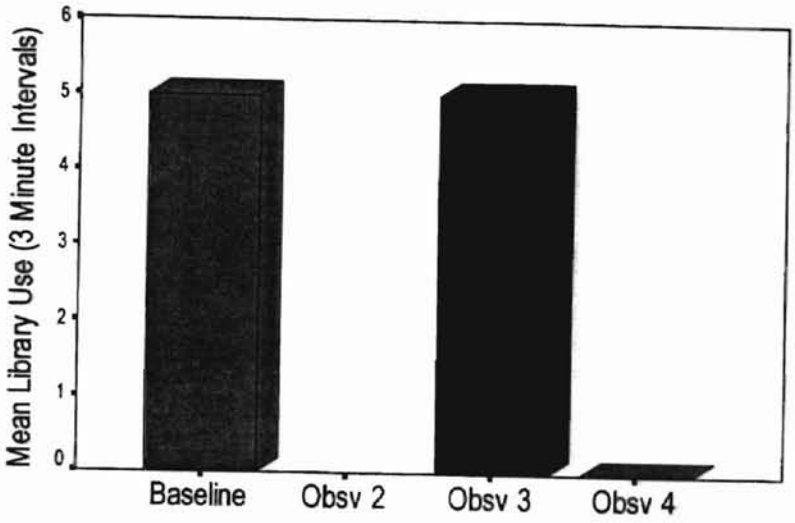

Figure 2. Use of Library Center by Subject 02 (Male)

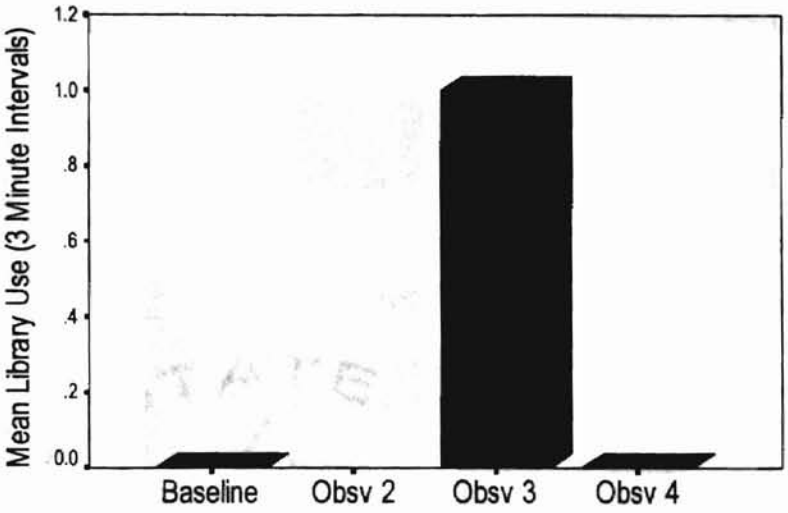

Figure 3. Use of Library Center by Subject 03 (Male)

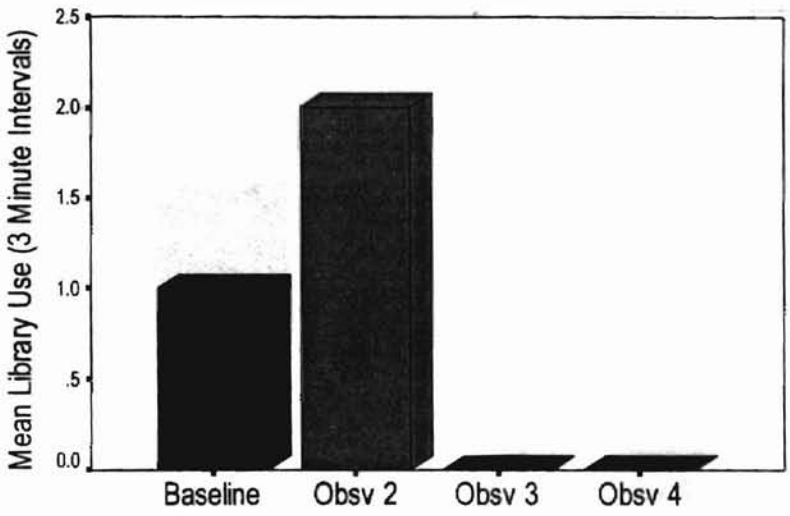

Figure 4. Use of Library Center by Subject 04 (Male)

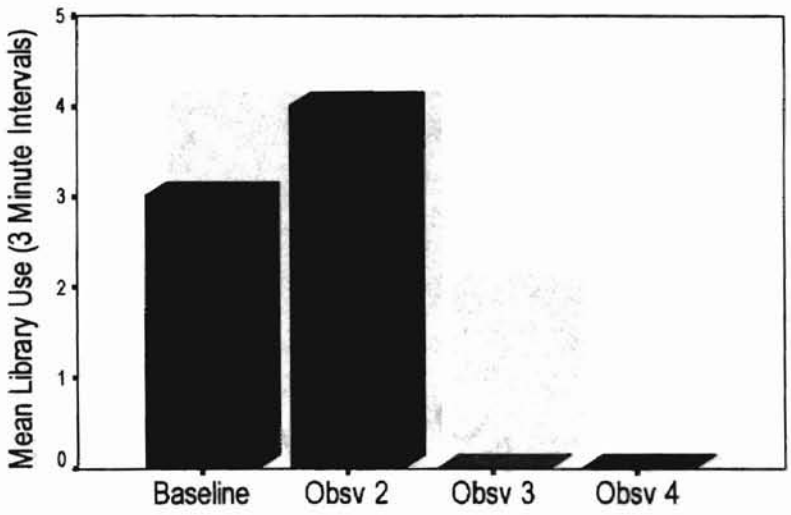

Figure 5. Use of Library Center by Subject 05 (Male)

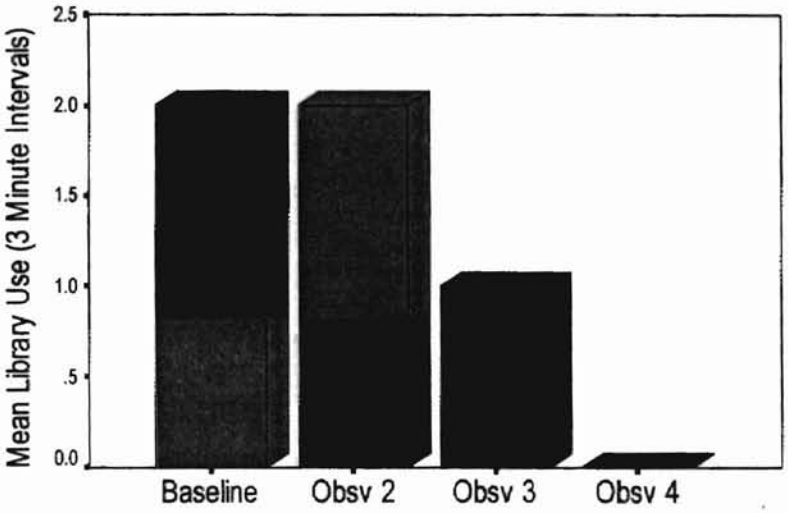

Figure 6. Use of Library Center by Subject 06 (Male)

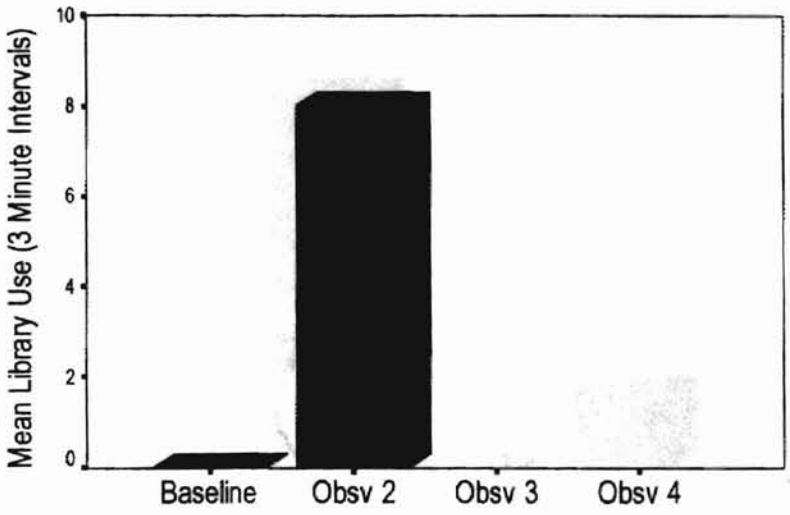

Figure 7. Use of Library Center by Subject 07 (Male)

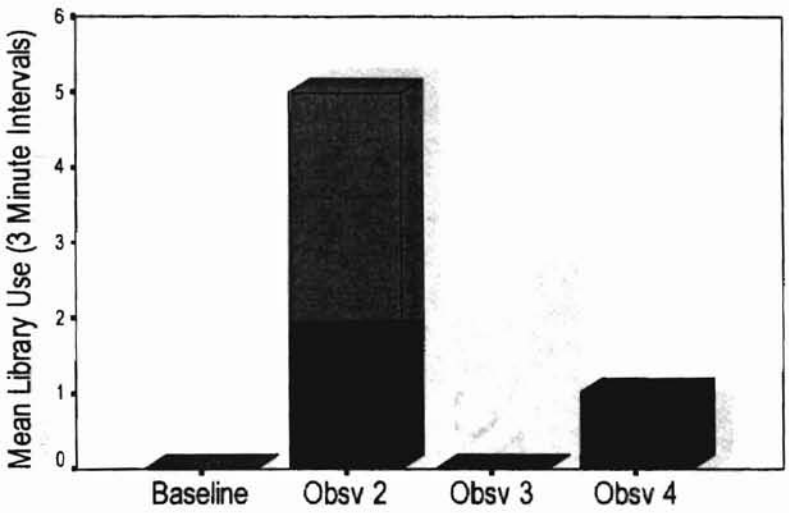

Figure 8. Use of Library Center by Subject 08 (Female)

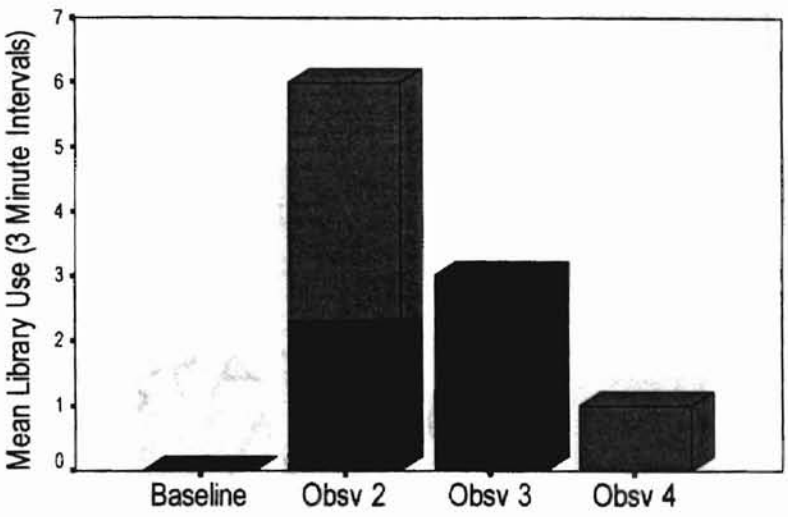

Figure 9. Use of Library Center by Subject 09 (Female)

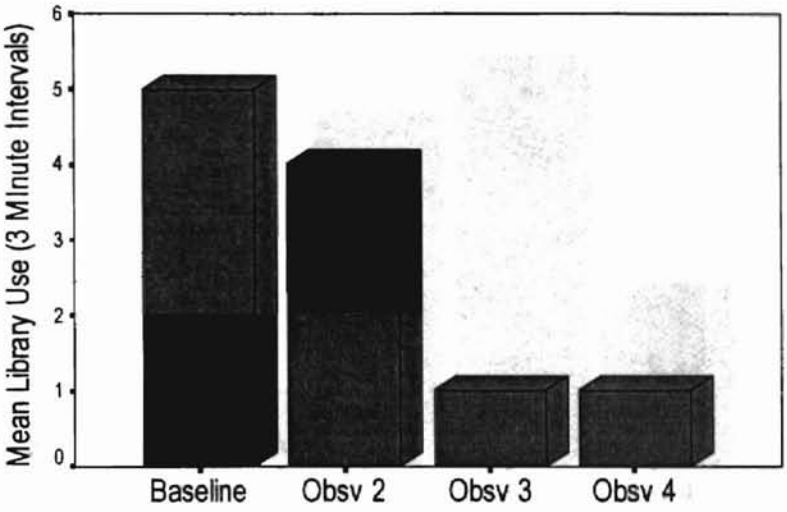

Figure 10. Use of Library Center by Subject 10 (Female)

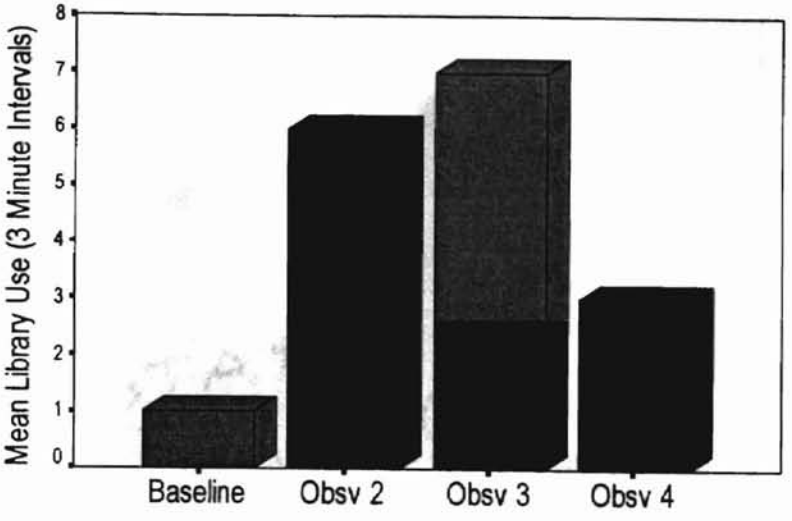

Figure 11. Use of Library Center by Subject 11 (Female)

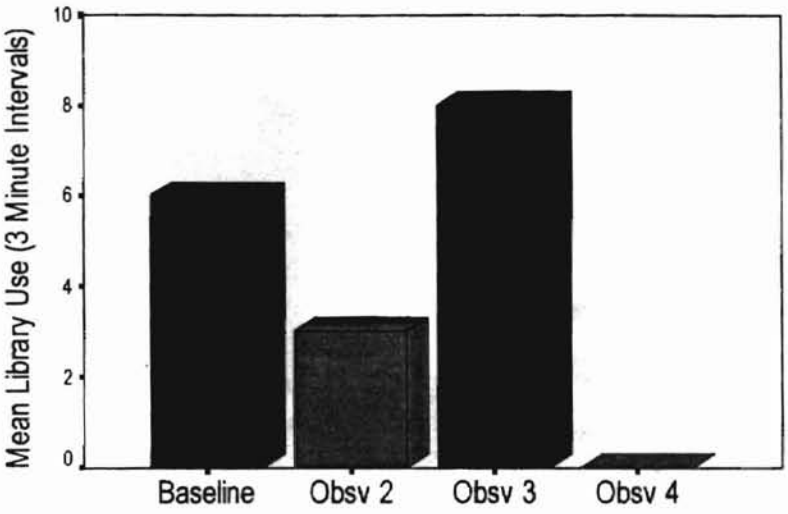

Figure 12. Use of Library Center by Subject 12 (Female)

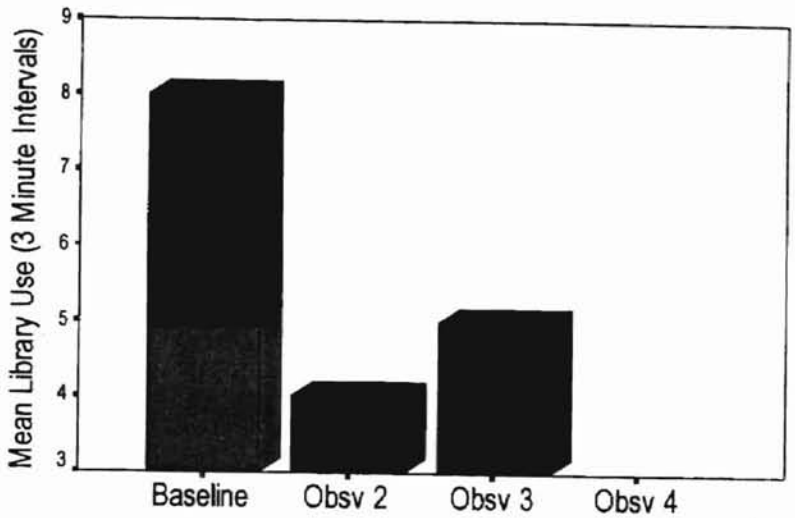

Figure 13. Use of Library Center by Subject 13 (Female)

APPENDIX A

CHILDREN'S LITERATURE USED IN STUDY

CHILDREN'S LITERATURE USED DURING RESEARCH STUDY

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Brown, M. W. (1972). The runaway bunny. New York: Harper & Row.

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Carle, E. (1969). The very hungry caterpillar. New York: Philomel Books.

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Stevenson, R. L. (1977). A child's garden of verses. New York: Platt & Murk.

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Galdone, P. (1972). The three bears. New York: Scholastic.

Gramathy, H. (1978). Little toot. New York: Putnam's.

Hoban, R. (1968). A birthday for Frances. New York: Scholastic.

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Hutchins, Pat. (1971). Changes, changes. New York: MacMillan.

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McGovern, A. (1971). Stone soup. New York: Scholastic.

Mitzumura, Kazue. (1971). If I built a village. New York: Thomas Y. Crowell.

Rey, H.A. (1973). Curious George flies a kite. Boston: Houghton Mifflin.

Rey, H.A. (1973). Curious George learns the alphabet. Boston: Houghton Mifflin.

Rockwell, Anne & Harlow. (1972). Machines. New York: MacMillan.

Sendak, Maurice. (1962). Chicken soup with rice. New York: Harper & Row, Publishers.

Slobodkina, Esphyr. (1947). Caps for Sale. MA: Addison Wesley.

Stieg, William. (1969). Sylvester and the magic pebble. New York: Simon & Schuster.

Suess, Dr. (1963). Dr. Suess's ABC. New York: Random House.

Suess, Dr. (1957). The cat and the hat. New York: Random House.

Udry, Janice May. (1956). A tree is nice. New York: Harper & Row, Publishers.

Viorst, Judith. (1976). Alexander and the terrible, horrible, no good, very bad day. New York: Atheneum.

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APPENDIX B

PARENTAL CORRESPONDENCE

FRCD LETTERHEAD

January 26, 2000

Dear Parents:

In addition to being the Interim Director at the Oklahoma State University Child Development Laboratory, I am also a graduate student at Oklahoma State University in the Department of Family Relations and Child Development. As part of my Master's thesis, I would like to conduct research in Lab 114B, in the Child Development Laboratory.

The purpose of my research is to examine the effects of full-spectrum lighting (the type of lighting that most closely resembles natural light) on children's use of the classroom library. I will gladly answer any questions you may have about full-spectrum lighting.

Four observers will observe the children's selection of and participation in the interest centers during morning self-select center time from the one-way mirrored observation booth. They will observe for four times in 30-minute segments during February and March. The classroom schedule and curriculum will not be altered in any way. The children will experience a typical classroom day. The data recording sheets, which will be kept in the researcher's locked filing cabinet, will not identify the children by name. No one will have access to the file cabinet but the researcher. After the research is analyzed, and the report is written, the data will be destroyed. No child will be identified by name in the written report.

In order for your child to participate, we need for you to fill out the enclosed consent form and place it in the manila envelope hanging by the parent sign-in book by Wednesday, February 2, 2000. You will receive a copy of this consent form for your records.

Respectfully,

Mona A. Lane, Assistant Professor
Department of Family Relations and Child Development

April Baumgartner Snethen
Interim Director, Graduate Student

CONSENT TO PARTICIPATE IN RESEARCH PROJECT

I, _____, agree for my child, _____, to participate in the master's thesis research project of April Snethen titled, The Effects of Full-Spectrum Lighting on the Use of the Classroom Library by Preschool Children. This project has been approved by the Department of Family Relations and Child Development and the OSU Institutional Review Board.

I understand this research will be carried out by April Snethen, principal investigator, under the supervision of Dr. Mona Lane. The purpose of this study is to examine the effects of full-spectrum lighting on use of the preschool library center.

I have been made aware of the research procedure, which will involve observation of the children during self-select center time. Four thirty-minute observations will be made by student observers from the observation booth during February and March. The observers will not have direct contact with the children, and the classroom schedule will not be altered in any way.

I recognize that my child's participation in this study is voluntary. I also understand that I have not waived any of my legal rights or released this institution from liability for negligence. I may revoke my consent and withdraw my child from this study at any time. Data will be stored in a locked filing cabinet, and records and results of this study will protect my family's confidentiality by not identifying my child or me by name. After the final report is written, the data will be destroyed.

I have read this consent form and understand its contents, and I freely consent for my child to participate in this study under the conditions described. I understand that I will receive a copy of this signed consent form.

If I have any questions about my child's rights as a research subject or this research project, I may consult with April Baumgartner Snethen or Dr. Mona Lane, FRCD, by calling (405) 744-5061, or Sharon Bacher, IRB Executive Secretary, Oklahoma State University, 203 Whitehurst, (405) 744-5700.

_____ _____

Signature of Parent Date

_____ _____

Signature of Principal Investigator Date

FRCD LETTERHEAD

March 15, 2000

Dear Parents:

I am writing to let you know that I have completed my research study at the Oklahoma State University Child Development Laboratory, and to thank you and your child for your cooperation. The children...(include reaction to the lamps). It was a pleasure to observe the children in their classroom environment. The research task was made simpler because of the capable assistance of the classroom teachers and the office staff.

Your role in this research was as important as any other aspect of the research. Without your help and support, this project would not have been possible. Thank you for the large response and prompt return of your child's permission slip.

I have enclosed an additional copy of the signed consent form for your records. Again, I thank you and your child for your support.

Sincerely,

April Baumgartner Snethen

APPENDIX C

INTEREST CENTER FREQUENCY CHARTS

INTEREST CENTER FREQUENCY CHART

Observation Station #1 _____ Time _____ to _____ Date _____

Instructions: Observe your assigned area. If a child is in one of your observation areas, place a tally mark under that child's subject number indicating in which area he or she is playing. Start the 3-minute egg timer. When the egg timer has emptied place a tally mark under the children's subject numbers who are in your assigned area. Repeat this process for 30 minutes (9:30-10:00). Return the observation folder and egg timer to the researcher when your observation is complete. Thank you for your help!

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Easels															
Writing Center															
Listening Center															

INTEREST CENTER FREQUENCY CHART

Observation Station #2 _____ Time _____ to _____ Date _____

Instructions: Observe your assigned area. If a child is in one of your observation areas, place a tally mark under that child's subject number indicating in which area he or she is playing. Start the 3-minute egg timer. When the egg timer has emptied place a tally mark under the children's subject numbers who are in your assigned area. Repeat this process for 30 minutes (9:30-10:00). Return the observation folder and egg timer to the researcher when your observation is complete. Thank you for your help!

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Science Center															
Math Center															
Block Area															

INTEREST CENTER FREQUENCY CHART

Observation Station #3 _____ Time _____ to _____ Date _____

Instructions: Observe your assigned area. If a child is in one of your observation areas, place a tally mark under that child's subject number indicating in which area he or she is playing. Start the 3-minute egg timer. When the egg timer has emptied place a tally mark under the children's subject numbers who are in your assigned area. Repeat this process for thirty minutes (9:30-10:00). Return the observation folder and egg timer to the researcher when your observation is complete. Thank you for your help!

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Library Center															
Art Center															
Computer Center															

INTEREST CENTER FREQUENCY CHART

Observation Station #4 _____ Time _____ to _____ Date _____

Instructions: Observe your assigned area. If a child is in one of your observation areas, place a tally mark under that child's subject number indicating in which area he or she is playing. Start the 3-minute egg timer. When the egg timer has emptied, place a tally mark under the children's subject numbers who are in your assigned area. Repeat this process for 30 minutes (9:30-10:00). Return the observation folder and egg timer to the researcher when your observation is complete. Thank you for your help!

Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Manip. Center															
Media Table															
Dramatic Play Area															

APPENDIX D

SUBJECT AND CENTER SCORE SHEETS

SUBJECT SCORESHEET

Subject Number _____ Sex _____

Date of Birth _____ Age _____

Enrollment Date _____ Enrollment Length _____

	Baseline Observation	Observation #2	Observation #3	Observation #4	Totals
Easel Area					
Writing Center					
Art Center					
Science Center					
Math Center					
Dramatic Play Center					
Block Center					
Media Table					
Computer Center					
Manipulative Table					
Library Area					
Listening Center					

CENTER SCORESHEET

	Baseline Observation	Observation #2	Observation #3	Observation #4	Totals
Easel Area					
Writing Center					
Art Center					
Science Center					
Math Center					
Dramatic Play Center					
Block Center					
Media Table					
Computer Center					
Manipulative Table					
Library Area					
Listening Center					

APPENDIX E

INSTITUTIONAL REVIEW BOARD APPROVAL

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

Date: November 29, 1999 IRB No.: HE-00-123

Proposal Title: "EFFECTS OF FULL-SPECTRUM LIGHTING ON USE OF CLASSROOM LIBRARY CENTER BY PRESCHOOL CHILDREN"

Principal Investigator(s): Mona Lane
April Baumgartner Snethen

Reviewed and Processed as: Expedited (Special Population)

Approval Status Recommended by Reviewer(s): Approved

Signature:

Carol Olson, Director of University Research Compliance Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modification to the research project approved by the IRB must be submitted for approval with the adviser's signature. The IRB office MUST be notified in writing when a projejct is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

VITA

April Baumgartner Snethen

Candidate for Degree of

Master of Science

Thesis: EFFECTS OF FULL-SPECTRUM LIGHTING ON USE OF CLASS-ROOM LIBRARY CENTER BY PRESCHOOL CHILDREN

Major Field: Family Relations and Child Development

Biographical:

Personal Data: Born in San Antonio, Texas, March 21, 1973, the daughter of Dr. Richard E. Baumgartner and Rita J. Baumgartner (Ramsey). Married to Todd M. Snethen on December 13, 1997.

Education: Graduated from Ada High School, Ada, Oklahoma, in May, 1991; received the Bachelor of Science degree in Family Relations and Child Development with emphasis in Early Childhood Education, from Oklahoma State University, Stillwater, Oklahoma, in July, 1995. Completed requirements for the Master of Science degree with a major in Family Relations and Child Development at Oklahoma State University in July 2000.

Professional Experience: Private and public school undergraduate student teaching experiences, 1991 to 1995; Lead Teacher, Oklahoma State University Child Development Laboratory, 1995 to 2000; Interim Director, Oklahoma State University Child Development Laboratory, 2000 to present; Student, Oklahoma State University, Department of Family Relations and Child Development 1991 to present.

Professional Organizations: National Association for the Education of Young Children, Southern Early Childhood Association, Early Childhood Association of Oklahoma.