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Color, Form, and Light: Recommendations for Design of ECE Classrooms Based on Group Structure and Activity Type

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Abstract

The aim of this study is to present recommendations for the design of ECE classrooms based on time children spent on activities and the structure of the groups in the classrooms. The study focused on data collected for the *National Survey of Early Care and Education* (*NSECE*,) a large national study in the United States. The analyses revealed that the majority children typically spent up to one hour each day on each activity, including physical activity; book reading, looking, and sharing; and singing/rhyming activities. Children spent one hour or more engaged in free-play activities at the majority of the centers. Design recommendations based on the empirical literature are detailed with a focus on images of activity areas in existing early childhood education and care centers. Recommendations are also made for loft design ideas to enhance children's experiences with different activities in the environment. Variation of these design elements encourages exploration and movement within the space. Color, form, and light combine to enhance the activity areas for children with sensory experiences and inspiration.

Keywords

Design Elements, Children's Environments, Loft Design

1. Introduction

Children's early childhood education and care (ECEC) settings are complex. Interior design elements in the spaces influence children's perceptions, sensory experiences, and exploratory movement. Additionally, the time spent on different activities in the settings contributes to the children's experience with the activity within the space. Successful engagement with activities requires teachers

and caregivers to have resources for children at their disposal which include space for materials and manipulatives; time for organization and planning; and a designed interior environment conducive to inspiration and engagement. The form, color, and light of ECEC centers are the focus of the recommendations presented in this paper. The empirical literature provides a foundation for optimal design elements. Visual examples of existing centers provide detailed examples of design elements within different settings.

A unique approach in this paper is the basis of an analysis of time spent on activities from a national study on children's environments as the foundation for the design recommendations. It is important to consider how children spend their time in these spaces. The *National Survey of Early Care and Education* (2019) is a national study completed in the United States which focuses on childcare and development settings. The purpose of this study is to analyze data from a nationally representative sample which highlights types of activities in the early childhood education classroom along with the time spent on the activities. Data on activities has been collected with specific time frames for each activity. The goal is to illuminate the practice of activities in the childcare and development centers across a representative sample. Subsequently, recommendations are made for the design of specific areas for activities within the classroom with emphasis on color, form, and light.

2. Background

The literature on children's development and education within built environments ranges along a continuum from theoretical concepts (Gibson, 1979/2014; Piaget, 2013) to practical applications (Malaguzzi, 1994; Montessori, 1917). Additional guidance is given from a sustainable/biophilia perspective (Dennis et al, 2014; Ghaziani, et al., 2021). The Children's Environments Research Group at City University of New York focuses particularly on this area. Recommendations for classroom design from a child-centered perspective (Greenman, 2017; Olds, 2001) incorporate specific design elements from a child's point of view. Researchers in education (Clevenger et al., 2022; David & Weinstein, 1987; Kuh & Rivard, 2014; Matthews & Lippman, 2020) and environmental psychology (Barrett et al., 2013; Maxwell, 2007; Moore & Sugiyama, 2007; Spencer & Blades, 2006) provide specific guidance for the design of the early childhood education classroom. Additionally, the US government offers a useful Child Care Center Design Guide (GSA, 2003) which is designed to comply with the National Association for the Education of Young Children (NAEYC) standards. The design recommendations for children's activity spaces are detailed from across the continuum for theoretical to applied concepts.

The perspective for the design recommendations presented in this paper is based on the actual time children spend engaged with different activities as analyzed by the national study. Gibson (1979/2014) provides two concepts that are important in the design of children's environments: 1) Level of Environmental

Stimulation and 2) Affordance. Ata et al. (2012) identified the importance of balance between under-stimulation and over-stimulation within the environment. The architect and/or interior designer of the interior classrooms considers these concepts in the layout of the activities in the classroom. Optimal environments include balance of principles and elements of design, enhancement of sensory information, and use of color, form, and light.

Lighting affects every visual element in the designed environment. Additionally, it contributes to sensory perception with actual and perceived temperature changes. Therefore, both electric lighting and daylighting are critical design influences on interior space. Lekan-Kehinde and Asojo (2021) reviewed the literature on lighting of children's learning environments. They found that consideration of children's heights was often overlooked by planners of the designs. They also identified the need to consider different lighting scenarios for different activities (Lekan-Kehinde & Asojo, 2021). Ata et al. (2012) highlighted the importance of how lighting affects children's mental attitude. Angelaki et al. (2022) studied the literature on spaces for kindergartners' perception of space relating to lighting design. They synthesized the literature focuses on 3 design concepts: 1) *Highlight each part of the room that has an activity area*; 2) *Concentrate light for activity clusters*; *and* 3) *Combination of light sources and light distributions* (Angelaki et al., 2022: p. 20). Of particular value in this review is the focus on light and shadows which is a central component to the design of Reggio Emilia-inspired child development centers. The findings from another study focused on children's behavior regarding turning off lighting in the environment revealed that visual prompts positively influenced children to turn off the lights (Mattsson & Laike, 2022). Use of full-spectrum lighting is presented as an optimal color for lighting in children's environments.

The transition to LED lighting has been in the process for several years in the United States. Internationally, approximately 50% of lighting sales is for LED lighting. Companies are now creating and manufacturing LED lighting and fixtures for different uses with different dimming technology. The opportunity to reduce energy costs and waste is driving these changes. There are important considerations with LED lighting, including the brightness of the lamps, the color rendering of the lamps, and the dimming abilities of the fixtures. The Unified Glare Rating (UGR) is a metric used to evaluate the glare from lamps. It is especially useful as LED lamps replace fluorescent and incandescent lamps. This will be an open direction for researchers in the future as spaces incorporate LED lighting throughout the spaces. Bellia et al. (2015) focused on the different methods used to measure lighting. The paper illustrates the ways to measure both visual and non-visual effects of light. Nair and Fielding (2009) developed a set of design patterns for schools. Many of the recommendations are applicable to ECEC spaces. For example, they uses of colors in specific area. Additionally, they describe the importance of lighting that is not uniform. This is a very important point that ECEC designers often do not incorporate, most likely because of cost

and convenience. These are important considerations when designers, architects, and engineers are specifying lighting in educational spaces.

The color rendering and the color temperature of the lamps influence the perceived colors in the spaces. Consideration of the influence of both the electric lighting and the daylighting is important when selecting colors for the floors, walls, ceilings, and support structures and elements. Color recommendations do not center on specific hues. The ideal design focuses on the relationship between the color, value, and saturation of the selected elements. The complexity of ECEC spaces can be challenging when designers and architects are selecting colors for the spaces. A review by Gaines and Curry (2011) separates findings for different hues along with perceptions of warm and cool colors. A recommendation from this study is the priority to select colors based on the functional aspects of the setting rather than the aesthetic aspects of the setting. Therefore, focusing on the time spent on specific activities for young children in the ECEC spaces is an approach open for investigation. Nair and Fielding (2009) combine a design pattern as Color and Light. They describe the importance of using light values on the walls and ceilings to reflect lighting throughout the centers. They also present the challenge of all neutral environments. It is important to provide stimulation through use of color for visual stimulation.

Use of form in the designed environments would also focus on the functional priorities for each activity. Shelving for materials, play structures for climbing opportunities, and cases for organization of materials are all different form within the designed space. The work of Gibson (1979/2014) highlights the importance of affordances in the environment. For example, a step affords a climbing opportunity for young children. The step also affords a tripping opportunity for all. The layout of affordances is the key to an optimal design. Nair and Fielding (2009) propose a design pattern entitled Cave Space. This is important for children to be able to separate themselves from peers for privacy and reduced stimulation. Inclusion of a loft or play structure fulfills this recommendation. Another example of a change in form is a stage area. This offers children variation in floor heights and perspective. The concepts presented here are further investigated in terms of actual time spent in different activity areas as well as designs of space from field research.

3. Survey

The *National Survey of Early Care and Education* (2019) focuses on a broad range of surveys for early childhood care and education. For this investigation, analyses were conducted to consider the group structure and time spent in specific activities for 3 and 4 year old children in the child care and development settings. The group structure includes: 1) Whole Group Activities, 2) Small Group Activities, and 3) One-on-One Activities. The time spent on different activities analysis includes: 1) Free-play Activities, 2) Vigorous Physical Activities, In- or Out-of-doors, 3) Singing/rhyming Activities, and 4) Book Reading and Looking Activities.

4. Findings

Children spent one hour or less in whole group activities at over 77% of the centers. This is an important finding because centers are often designed with whole group activities as a significant goal of the design program. Flexibility in the space to make room for group activities with separation may be more conducive to how teachers actually structure the activities. The time spent on Whole Group Activity for all centers is presented in Table 1. The open layout in Figure 1 illustrates an example of a space using different flooring materials to define the whole group activity area. Additionally, overall ceiling lighting with bright natural light from the windows. However, glare is a concern with this space. Control of natural light would improve the light depending on the time of day and time of year.

Children spent up to one hour in small group activities at over 80% of centers. in small group activities. 14.6% of centers noted that children spent 2 or more hours in small group activities. These activities can vary in number. Often children are in groups of 3 - 5 during small group activities. The time spent on Small Group Activity for all centers is presented in Table 2.

Children spent up to one hour One-on-One activities at 93.6% of centers. The majority of centers spent 30 minutes or less. This is logical when considering the challenges of the ratios of children to staff members. The time spent on One-on-One Activity for all centers is presented in Table 3.

Table 1. Whole group activity.

	3 and 4 year olds	
	%	N
No time	1.1	40
30 minutes or less	44.2	1580
About one hour	31.9	1138
About two hours	14.1	504
Three hours or more	8.7	309
Total	100.0	3571

Figure 1. Space for whole group activity.

Table 2. Small group activity.

	3 and 4 year olds	
	%	N
No time	3.8	134
30 minutes or less	52.9	1880
About one hour	28.8	1023
About two hours	10.8	383
Three hours or more	3.8	134
Total	100.1	3554

Table 3. One-on-One activity.

	3 and 4 year olds	
	%	N
No time	9.4	331
30 minutes or less	68.5	2416
About one hour	15.7	554
About two hours	4.2	149
Three hours or more	2.2	76
Total	100.0	3526

Activities Selected by the Child

There was more variation among the groups for activities selected by child rather than teacher-directed activities. 3 - 4 year olds at 37.9% of centers spent about 1 hour self-selecting activities, followed by 25.8% spending 30 minutes or less. At 34.1% of centers children spent 2 or more hours engaged in activities they selected on their own. This activity is both individual and group depending on their choice. Wood (2014) discussed the importance of free play activities with a focus on individual and group agency. "Children are not simply influenced by their environments but act in ways that change them" (Wood, 2014: p. 14). This statement illustrates the importance of time spent for selecting activities and group structures.

Design Recommendations:

Easy access to materials and levels of display is the primary goal for self-selected activities for children. In free play, encouraging creativity and exploration is important. Variation in color between the walls and flooring and furniture is optimal. Consider an accent wall with a brighter color to anchor the play materials. Lighting in the area should come from 2 sources plus natural lighting, direct or indirect. These can be ceiling mounted, wall mounted, or moveable so as not to disrupt traffic or cause danger to children. LED lighting is an opportunity to vary the lighting in the space with wall mounted, ADA approved sconces. The overhead lighting should have diffusers to block the sharp glare of

LED lighting. The concern for lighting is glare and the color of the light. Access to shelves and a small table are shown in Figure 2. The variation in form adds to the interest in the space with the arch separating the area for storage spaces for children. Lighting in the space shows use of overhead lighting with reflected light from the mirror. The light wall color with a pale blue reflects lighting in the space. Figure 3 shows an alternative design with neutral colors. Wood materials are used in both images to provide a warm and comfortable feeling in the space. Lighting in Figure 3 is overhead and separated between the table area and open play areas. Form in this space is rectilinear in contrast to the curvilinear forms in Figure 2. An option to separate activities with a flexible alternative in design is shown in Figure 4. In this image the translucent film with fish designs is an effective design to separate the activity areas. The bright color is a pleasant design with a shimmering finish. Placed against the table, it also acts as a visual anchor for children playing at the table. This is an inexpensive way to add color, texture, and form into the space. Flooring in the area for free-choice works best when teachers have options for arranging materials. For example, include rug mats to reduce noise in the space. Colors should show contrast for stimulation. Figure 5 depicts a classic layout for a dramatic play area with a table and shelves for activity materials. Many centers design activities with this layout. It works well with variety of form, two types of lighting, and contrast of flooring materials. The use of wood for the play appliances and shelving adds warmth and familiarity with residential design to the space.

Figure 2. Space for activities selected by children.

Figure 3. Space for activities selected by children.

Figure 4. Space for activities selected by children.

Figure 5. Space for activities selected by children.

Vigorous Physical Activity, In or Out of Doors

The results show 3 - 4 year old spent about 1 hour on physical activity at 46.3% of the centers. Overall, there was a more even distribution across the time spent on physical activity when compared to selected activities in Table 4. Time spent in physical activities at the centers is shown in Table 5.

Design Recommendations

Space for physical activity for young children is important in both the interior and exterior of the center (Segura-Martínez et al., 2021). There are different options for designing spaces for vigorous physical activity. Definition of space for physical activity with flooring material is critical for active young children. Figure 6 shows different flooring with carpeting. Children can move around easily in this open space with small balls, hoops, climbing structures, and manipulatives. The lighting in Figure 6 shows a variety of overhead evenly distributed electric lighting which is complemented by daylighting. The darker carpet separates the vinyl flooring with texture and color. Another interior option is to vary

the flooring with a stage area as seen in Figure 7. The mirrors encourage reflection and movement for children. The variation of the step affords different height experimentation. The carpeting works well for sound control and spatial definition of the staging area. Figure 8 illustrates an effective example with different options for outdoor physical play. The concrete bike path contrasts well with the grass area for spatial definition of activities. Wayfinding is clear in this photo for children's activities. Figure 9 shows clear use of curvilinear form on the outdoor play areas. The spatial definition uses color, form, and texture for children's different activity areas.

Table 4. Activities selected by child.

	3 and 4 year olds	
	%	N
No time	2.2	78
30 minutes or less	25.8	917
About one hour	37.9	1348
About two hours	20.8	739
Three hours or more	13.3	471
Total	100.0	3553

Table 5. Time spent on vigorous physical activity (indoors or outdoors).

	3 and 4 year olds	
	%	N
No time	1.3	46
30 minutes or less	30.5	1087
About one hour	46.3	1650
About two hours	17.5	623
Three hours or more	4.4	155
Total	100.0	3561

Figure 6. Space for indoor physical activity.

Figure 7. Space for Indoor physical activity.

Figure 8. Space for outdoor physical activity.

Figure 9. Space for outdoor physical activity.

Singing/Rhyming Activities

Seventy two percent of classrooms spent 30 minutes or less on singing/rhyming activities. This was followed by 21.3% of centers where 3 - 4 year olds spent about one hour engaged in singing/rhyming activities. Time spent in Singing/rhyming activities is shown in Table 6.

Design Recommendations

Spaces for singing and rhyming are often activities for the entire group. Therefore, a larger space works well for the floor plan layout. The acoustics work well with a textured flooring of carpet. Variation in lighting in the space offers

variety of illumination for inspiration. Lighting on dimmer switches/fixtures in the singing/rhyming area offers opportunities to create different moods within the space. Deep colors in the area also create a different mood from other areas in the setting. Figure 10 shows an open space with an area for children to sit or stand for singing and rhyming activities. The back wall is an effective anchor for acoustics and spatial variety. Figure 11 shows a wall plane as an anchor with an area rug for group singing and rhyming. This is a good option for centers to add when the predominant flooring materials is a hard surface or water resistant material. Colors in the area rug add interest to the activity area for inspiration. The space shown in Figure 12 is similar to Figure 11, however, the group area for singing/rhyming is a multifunctional space. Teachers are able to alternate the building material activities with group singing/rhyming activities. The flooring has an oval shape for clear definition of the activity area. Lighting in this image is clear overhead electric lighting.

Book Reading and Sharing

The time spent on activities focused on book reading and looking or sharing was up to one hour each day for 92% of centers. At 6.9% of centers, 3 - 4 year olds spent 2 - 3 or more hours each day engaged in book reading or sharing activities. Table 7 shows the time spent for each segment for book reading or sharing.

Table 6. Singing/rhyming activities (planned in advance).

	3 and 4 year olds	
	%	N
No time	3.4	121
30 minutes or less	68.6	2439
About one hour	21.3	756
About two hours	4.8	170
Three hours or more	1.9	68
Total	100.0	3554

Figure 10. Space for singing/rhyming activities.

Figure 11. Space for singing/rhyming activities.

Figure 12. Space for singing/rhyming activities.

Table 7. Book reading or sharing activity.

	3 and 4 year olds	
	%	N
No time	1.1	38
30 minutes or less	66.1	2354
About one hour	25.9	923
About two hours	5.4	194
Three hours or more	1.5	54
Total	100.0	3563

Design Recommendations

Consideration of focus and minimal stimulation are important for creating book looking and reading spaces in children's centers. Lighting is the most important design element for this activity. Books range from small font to large font. Children's visual perception varies by individual. Optimal design in the space includes indirect daylighting without glare or with window treatments for control of glare. Overhead electric lighting with a balance of warm and cool color rendering works well for book looking and reading. To create a quieter area, add an area rug for texture. Colors in this area should blend with the activity spaces in proximity to the book area. Colors with bright hues or pattern can be distracting in the book area. Curvilinear form has been researched in terms of approach/avoidance behavior. Dazkir and Read (2012) found that college students identified an interior space with curvilinear form as a more welcoming

space when compared with interior spaces with rectilinear form.

Figure 13 illustrates a carpeted area with bookshelves. This is a space with red, blue, and green. The colors complement each other. Additionally, the texture of the carpet reduces the acoustic noise from the rest of the center with a smooth surface flooring. In Figure 14, a table with chairs is provided for children who want to look at books. The book area is designed with natural lighting which is controlled with vertical blinds. Figure 15 shows a pleasant corner book area with carpet and controlled natural lighting. In Figure 16, the reading area is designed with child-scaled upholstered furniture, creating a social area for book looking and reading. This would encourage book sharing and conversation among children. Natural lighting is also prevalent in this layout. These options show different layouts with textures, color, form, and lighting.

Figure 13. Space for book reading and sharing activities.

Figure 14. Space for book reading and sharing activities.

Figure 15. Space for book reading and sharing activities.

Figure 16. Space for book reading and sharing activities.

The design recommendations and time spent in children's different activities show specific examples of best practices in early childhood education centers. Teachers, care providers, and directors at centers have flexible options for incorporating exceptional design elements within the setting.

5. Loft Design

An additional design option is a loft structure or a three-dimensional structure. Lofts offer children important opportunities to separate from peers for a quieter space. Whether it is climbing to the top part or entering the lower section for a smaller scale enclosure, children have many opportunities to think, create, and imagine with a loft option. In terms of design elements, the structure, breaks up the visual space with vertical elements. The scale and location of the loft are important in defining areas. Some centers add the book reading and sharing activity to the loser enclosure of the loft. Some centers use the lower section loft as a

dramatic play area for role playing. The designs include colorful, neutral, rectilinear, curvilinear, open and closed elements. The surrounding lighting influences lighting to both the lower and upper levels of the loft. Additionally, shadows are created on both levels from electric and natural lighting.

Figure 17 shows a loft design located in the center of the space with natural and overhead lighting. The lower section offers children a deep area for movement. The ladder is vertical which is not the ideal design for access to the upper level. The safest design of the steps for balance is at an angle with handrails, as is true for all ladders. Figure 18 shows a painted design of castles in the snow on the second level. One disadvantage to this design is the view from the upper level with the wide picket boards. Figure 19 shows a dramatic play level on the lower section of the loft. The loft is located in the corner of the space with the stairs next to the wall which is a safe design for young children when climbing to the second level. Additionally, the loft is painted blue which contrasts well with the light walls. This loft is similar to Figure 18 with a painted element on the vertical boards. It is easier for children to look down and caregivers to see in to the second level with this loft design because of the separation between the vertical boards.

Figure 17. Loft design with different colors.

Figure 18. Loft design with a landscape painting.

Figure 20 shows a loft designed of natural wood. The form shows a rectilinear design with seating on the upper level. The lighting for this loft is overhead without natural lighting. The loft in Figure 21 shows variation of form with a gable and arch form in the center of the design on the second level. Additionally, the dark blue color adds a clear contrast to the neutral color on the walls. One negative feature of this design is the close ceiling height for proper lighting and volume in the space. Figure 22 illustrates a loft design with contrasting colors and a sloped stair design. Additional electric lighting would enhance the second level

Figure 19. Loft design with dramatic play area.

Figure 20. Loft design with natural wood.

Figure 21. Loft design with variation of form.

of this design. Figure 23 shows a natural wood design with sloped and carpeted stairs for access. Seating is provided on both the upper and lower levels of the loft. This design has overhead electric lighting with well-designed and safe access. The ceiling height in the center for Figure 24 is high, therefore, allowing for a higher upper level for the loft design than seen in the other loft design examples. This loft is designed with rectilinear form, natural wood, and a sloped ladder. Electric and natural lighting are seen for both levels. The open level below is an affordance for movement. However, this loft does not provide children with a separate area for privacy. Figure 25 shows a loft design with a book reading and looking area on the upper level. The lower section is separated with fabric to offer children a separate area for play. The multicolored guardrails or balustrade creates a focal point in the space for exploration. The area is dark with limited electric lighting. Figure 26 shows a large cardboard box painted with a bright orange hue with a cutout for a door. This option is an inexpensive approach to add large form variation in the space with an option for children's privacy.

Figure 22. Loft design with contrasting colors.

Figure 23. Loft design with natural wood and sloped stairs.

Figure 24. Loft design with large scale lower level.

Figure 25. Loft design with bright hues and a carpeted staircase.

Figure 26. Cardboard structure for play.

6. Discussion

The design of children's early childhood centers is complex. This study utilized an applied approach to the evaluation of design elements by analyzing activity time and group variables. Additionally, examples are provided of existing activi-

ty areas in centers with different designs. Strengths and recommendations for improving the designs are detailed in the Findings section. 30 minutes through 1 hour were the typical time spent for the different activities at the centers studied for this investigation. Group structure was also analyzed. Children spent the most time in small groups or in on-on-one time with caregivers. In terms of choice, children spent the most time on self-selected activities which would provide both individual exploration and small group interactions. This analysis reveals the critical importance of flexibility of design affordances for caregivers, teachers, and directors.

Caregivers need to be able to adjust the environment for the many activities with which children engage in different group structures over the course of the day. For this reason, early childhood education and care facilities are the most challenging spaces to design for optimal experience for children, caregivers, parents, and guardians. Recommendations presented here are suggestions for care providers to incorporate into the design of their centers. The designs of the activity areas depend on a multitude of design principles and elements. Color, form, and lighting interact with each other to offer children opportunities for engagement and inspiration. Loft design adds scale to large facilities with variation of height levels, form, and color. The designs presented provide solutions to design challenges based on the empirical literature on the design of children's environments. In this study the connection to actual time spent on activities provided a foundation to investigate the designs of different early childhood education and care facilities.

Disclosure

This study uses the online data sets from the *National Survey of Early Care and Education* (*NSECE*,) as a foundation for the design recommendations.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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