Colour Communication in Children's Play Environments

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Abstract

Children learn by playing in different environments, including museums, schools, daycares, and playgrounds. To maximize the effectiveness of children's learning, it is important to improve these environments. This study explores the correlation between colour and children's play behaviour, and how this correlation can be utilized by designers to promote learning. Specifically, it focuses on using colour as a design element in children's artificial play environments to encourage children (aged 4 to 7) to learn through play. This study also shows how achieving this goal can be assisted by an interdisciplinary understanding of colour. It advocates improving our understanding of scientific research on the effects of colours and colour harmony in order to create better balance and ambience in these children's environments. This study will benefit anyone who works with children's play environments, including architects, interior designers, exhibit designers and preschool administrators, among others.

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Chapter 1: Introduction

This study is about investigating the role of colour and its proper application in artificial play environments for young children created by designers, including architects, industrial designers, interior designers and colour consultants. Specifically, this study reviews what scientific research concerning colour exists, and seeks to discover if and how designers actually employ this research into their own designs for interior children's spaces such as a children's museum or an indoor playground.

Winston Churchill once said that "people build buildings then buildings build people" (quoted by Grangaard, 1993). Environment plays a critical role in educating, nurturing and improving children's current and future development. Every feature of the physical environment can contribute to their education and growth. The location of a site or the design and layout of a building and playground can either contribute to their learning or hinder their full development (Cohen, McGinty and Moore, 1982).

As one of the most powerful and important interior components, colour is a crucial consideration in man-made environments that can influence a child's psychological reactions and physiological well-being. This is particularly true for young children (aged 4 to 7) who cannot yet communicate effectively through reading and for whom colour is a major resource for them to perceive information from the outside. It is therefore no longer valid to assume that the primary role of colour is simply to provide a pleasant visual environment (Mahnke, 1987).

Based on the review of existing studies and the findings obtained from a semi-structured interview and survey with design practitioners, this study proposes some important principles of colour that can be applied by designers working on children's environments. This is intended to assist them in using colour in a way that could enable children to learn while they play in such environments.

Research Objectives and Questions

As mentioned, colour is a key component in designing children's educational environments. Based on a literature review and preliminary observations of child environments such as children's museums and kindergartens, it seems that some designers do make use of existing colour research in their designs. However, they do not do this all the time, and they sometimes choose inappropriate colours for the environments they design. This can be for a variety of reasons, including budgetary demands, mixed-uses of the environments, or simply a lack of knowledge.

Thus, the objectives of this research are to see what colour knowledge designers currently have, and to provide guiding principles that designers can use to make more appropriate colour selections when designing children's environments. The following question served as the basis for the collection and analysis of data.

- *Do designers of children's play environments utilize research about the effects and impacts of colour?*

- *If yes, how so? How can this use be improved?*
- *If no, why not? How can they be made more aware of this research?*

Significance of the study

Children learn and reach their full potential in environments where they are challenged and provided opportunities to learn (Hohmann and Weikart, 1995). Research shows that the environment can have a significant impact in improving achievement levels (Bowers 1987), improving productivity and accuracy (Bross and Jackson, 1981), generating more positive attitudes (Young, 1982), and influencing behaviour (Wohlfarth, 1981) (as cited in Grangaard, 1993).

Both indoor and outdoor environments can provide distinct learning opportunities for children. However, this study focused only on indoor environments because the age group (4-7) of this study tends to spend more of their time indoors and perform the important activities of their day (i.e. playing, eating, and learning) in indoor environments. More specifically, this study focused on children's museums, play rooms and indoor playgrounds because these are environments specifically designed to enable children to learn something new about life and the world around them through play.

As mentioned earlier, colour is one of the most powerful visual tools for children of this age group to perceive information from the outside. Studies show that most children reach the height of colour recognition by the age of about four-and-a-half, but around ten percent of this age group still recognize

form more than colour. These “form dominant” children “are said to be intellectually brighter than those showing colour or mixed dominance. The median age of transition from colour to form dominance is about five, and form dominance usually is established by the age of nine” (Sharpe, 1974, p. 8). For this reason, colour is a very important aspect of design for young children.

Organization of the study

- Chapter 1 includes the introduction and background, providing the research objectives and questions, the significance of the study, and the organization of the study.
- Chapter 2 provides a literature review as it pertains to the study of colour in the human environment.
- Chapter 3 outlines in detail the methodology, data collected, and the analysis of the data.
- Chapter 4 provides the analysis of data and discussion.
- Chapter 5 presents a summary of the study and its conclusions, limitations, and recommendations for designers for future use and implementation.

Chapter 2: Literature review

Design for human beings is an interdisciplinary practice that brings together the humanities, natural sciences and various disciplines of design (Mahnke, Meerwein, and Rodeck, 2007). The purpose of this study is to demonstrate the importance of colour in children’s educational/play

environments. This literature review concentrated on a number of key areas including child development, children's learning through play, colour and children, and empirical studies on colour (such as colour and surrounding environments and elements, particularly light).

There are many publications on the "aesthetic" aspects of colour, including discussions on different colour systems and theories, colour's effect on physiology and psychology, the use of colour in marketing, and so on. However, few focus on the design of architectural spaces for young children and there is a need for more knowledge in this area.

1. Children

1.1. Child development

This study demonstrates the importance that children's senses play in establishing a relationship with the environment, and in developing their sense of attachment to the world of which they are a part. A recognition of the differing ways in which young boys and girls see their places within the educational setting can enhance learning (Cohen and Trostle, 1990).

This requires a better understanding of some principles of child development and how children learn through play. Like all humans, children are "physical-psychological- intellectual beings, closely connected with the material and immaterial components of their world" (Mahnke, Meerwein, and Rodeck, 2007, p. 10). By "world", Mahnke, Meerwein, and Rodeck, (2007) are referring to the entirety of the human condition. Children interact with the environment around them using their senses as communication facilitators (Mahnke,

Meerwein, and Rodeck, 2007). Their sense of sight is used to communicate with the world of light and colour and other visible environmental factors.

Children also work more effectively when operating within environments that are more pleasing to them. Research indicates that colour plays a critical role in a child's cognitive and motor development (Cockerill and Miller, 1983).

Of the various child development theories that were reviewed, Piaget's theory on constructivism is one of the most relevant for this study. It elaborates on the nature of human knowledge from birth to adolescence, and proposes that there are three types of knowledge that determine how certain subjects should be taught: physical, social, and logico-mathematical knowledge.

Physical knowledge is "knowledge of objects in external reality", which is related to the physical and visual appearance of objects such as colour, and form (Constance Kamii and Janice Ewing, 1996, p.3). For example, the colour and weight of a block are examples of physical properties of an object in external reality and which can be observed empirically. Examples of social knowledge include the days of the week, languages, and social customs such as saying "hello" in certain circumstances. The source of physical knowledge lies in the objects themselves, while the source of social knowledge lies partly in man-made conventions (Constance Kamii and Janice Ewing, 1996, p.3). Logico-mathematical knowledge involves individual relationships. An example was provided in Constance Kamii and Janice Ewing (1996, p. 3):

"When we are presented with a red block and a blue block and think that they are similar, for instance, the similarity is an example of

logico-mathematical knowledge. Almost everybody thinks that the similarity between the blocks is observable, but this is not true. The blocks themselves are observable, but the similarity between them is not. The similarity exists neither in the red block nor in the blue one. If a person did not put the objects into this relationship, the similarity would not exist for him or her. The source of logico-mathematical knowledge, therefore, is in each child's mind. Other relationships the individual can create between the same blocks are different (...). Mathematical knowledge such as $2 + 2 = 4$ and $3 \times 4 = 12$ is constructed by each child by making new relationships out of previously created relationships”.

Piaget's constructivism suggests that children learn by constructing knowledge and meaning out of their experiences through interaction with people and things (Ackermann, 2001). This is rooted in “inspiring interest, initiative, experimentation, discovery, play, and imagination” as essential factors in the development of a child's ability to learn (Piaget, 1973).

Piaget's theory identifies four developmental stages:

1. Sensorimotor (birth to age 2)	<ul style="list-style-type: none"> • Intelligence is demonstrated through motor activity without the use of symbols. • Knowledge of the world is limited (but developing). • Some symbolic abilities are developed at the end of this stage.
2. Preoperational (age 2 to 7)	<ul style="list-style-type: none"> • Intelligence is demonstrated through the use of symbols, language use matures, and memory and imagination are developed.

	<ul style="list-style-type: none"> • Thinking is done in a non-logical, non-reversible manner. • Egocentric thinking predominates.
3. Concrete operational (age 7 to 12)	<ul style="list-style-type: none"> • Intelligence is demonstrated through logical and systematic manipulation of symbols related to concrete objects. • Operational thinking develops. Egocentric thought diminishes.
4. Formal operational (age 12 and up)	<ul style="list-style-type: none"> • Intelligence is demonstrated through the logical use of symbols related to abstract concepts.

Table 1: Piaget cognitive development stages

The age group for this study (4 to 7) falls within the preoperational stage, a time of rapid physical and cognitive growth. The term “preoperational” refers to the fact that even with this growth, children are still lacking logic skills and are bound by perception. The preoperational stage is divided into two phases: the *preoperational phase* (2-4 years) and the *intuitive phase* (4-7 years).

This study focuses on the preoperational phase, and the intuitive phase in particular because this is the phase where a child utilizes linguistic guidance, where mental representations and actions become susceptible to change, and where some primary concepts about important topics are formed. Children at this stage also attend preschool. According to Mahnke, Meerwein, and Rodeck (2007), preschoolers constitute mixed groups with differences according to their:

- communicative abilities and social behaviour,
- psychomotor skills and perceptive abilities,
- self-awareness, self-expression/self-assertion,
- independence,

- creative behaviour, and
- experience of things.

1.2 Play

While some people believe that play is not important for children, others believe it is one of the most important parts of a child's life. Piaget believed that in the first two developmental stages (sensorimotor and preoperational), children learn from imitation and play (Piaget, 1962). Piaget argued that play is one of the main aspects of any activity (like imagination in respect to thought) (Piaget, 1962). He proposed that there are four types of play: practice play, symbolic play, games with rules, and constructions. Practice play is the "...exercise [of] structures for no other purpose than the pleasure of functioning" (Piaget, 1962, p. 110). It starts from the first month of life. Symbolic play starts from the second year of life and involves playing with absent objects. Games with rules tend to belong to the third developmental stage (ages 7 to 11), and rarely occur before the preoperational stage (ages 4 to 7) (Piaget, 1962). Constructions are a unique form of play for older age groups that are beyond the scope of this study.

Children's play consists of both active elements (like rolling and jumping) and inactive elements (like resting and being lazy) (Senda, 1992). It can consist of such activities as drawing, modelling, acting, singing, dancing or constructing something to explore ideas (Smidt, 2005). It can occur in "contrasting elements of wide-open space and narrow, constricted spaces, high and low places, as well as soft and hard places" (Senda, 1992, p. 21). It is universal, and a way for all

children to learn about themselves and the world around them. Playing together is a good way for children to build mutually beneficial relationships with one another. As outlined below, this contributes to their “cognitive growth, improved social skills, physical development and emotional well- being” (Davis, Graves and Larkin, 2002, p. 42):

<i>Cognitive benefits</i>	<ul style="list-style-type: none"> • <i>Increased flexibility in thinking (imagination; symbolic representation)</i> • <i>Making new connections of meaning</i> • <i>Gaining concrete experience with visual/spatial and mathematical relationships</i> • <i>Solving problems</i>
<i>Social benefits</i>	<ul style="list-style-type: none"> • <i>Expressing ideas and negotiating with peers (language development)</i> • <i>Learning what is acceptable language and behavior in the culture</i> • <i>Learning to share, compromise, and respond to others</i> • <i>Making friends</i>
<i>Physical benefits</i>	<ul style="list-style-type: none"> • <i>Practising and consolidating small and gross motor skills</i> • <i>Oxygenating and stimulating blood flow to the brain</i> • <i>Gaining concrete experience with relationships of weight, size, distance, etc.</i> • <i>Increasing control over tools and materials</i>
<i>Emotional benefits</i>	<ul style="list-style-type: none"> • <i>Interacting with others and learning to express feelings appropriately</i> • <i>Working through emotionally charged experiences</i> • <i>Experimenting with new roles for the self</i> • <i>Learning to show empathy</i> • <i>Building self esteem</i>

Table 2: Benefits of play

Play lets the child express his/her imagination. Without imagination, “a child is unable to grasp the abstract symbolic representation and conceptual

understanding that is so necessary to cognitive development" (Davis, Graves, and Larkin, 2002, p. 44). Children who do not play are less likely to develop the critical social and emotional skills needed in life. According to Smith and Pellegrini (2008), there is a critical need for children to play as it provides them with learning opportunities.

As mentioned above, play has different emotional, social, physical and cognitive benefits. Colour can add to these benefits, for example, by increasing imagination, or creating motivation for certain actions; colour can also help with focus for better learning (Holtzschue, 2006).

1.3 Learning through play

Much of the literature reviewed suggests that children learn best when they are able to play, i.e. when they are able to pursue their own interests. Through voluntary play, children can take risks, which is a required element of learning. At the same time, adults should be alert to how children are playing and offer objects, advice or physical help to enable the child to advance (Smidt, 2005). Children learn best when they are allowed to actively explore their environment through social interaction (Smidt, 2005) in an appropriate environment. Therefore the environment should provide a safe and secure, yet challenging space for children.

Children notice and take an interest in everything they encounter. In this way, they are active learners, with the word "active" referring to what is happening as well as to the learning that takes place when the child is also

physically active. This is why thinkers like Piaget and Vygotsky, who are described as “constructivists”, believe that children can be in control of their own learning. They believe that the child’s brain “constructs” its own model of the world and then adapts this according to the child’s experiences (Smidt, 2005). In fact our entire system of neural models is self-generating (Laughlin and d'Aquili 1974, Varela 1979, Maturana and Varela 1980; see also Piaget 1971, 1985 as cited in Laughlin, 1990). This is what is known as our “cognized environment” (Laughlin, 1990). While this cognized environment is determined by how people experience their existence and the world, the specific neurological changes that produce this environment are an actual part of this world (our “operational environment”) (Laughlin, 1990). As indicated by Laughlin 1990, this operational environment can be considered “transcendental relative to our cognized environment” because there is always more that can be learned about the operational environment than we can ever hope to know. As a result, we can accurately describe ourselves as “transcendental beings” striving towards, but never able to achieve complete self-knowledge (Laughlin, 1990).

The child’s brain forms its learning patterns as early as birth, and probably even earlier during pregnancy. As each child adapts to a particular environment, the brain itself adapts to that manner of living. These learning patterns will serve for the lifetime of the child unless something intervenes and changes them (Chan and Petrie, 1998). In addition, the brain learns best “through multisensory processing” and in a flexible environment when

intrinsically motivated. But the human brain doesn't have a preferred style of learning. The style changes according to the type of environment and different situations (Taylor, 2007). Many writers believe that a child's genes may limit the extent of their learning, but other writers dispute this. In fact a child's environment is now understood to have a much stronger influence on brain development than what had been previously understood (Chan and Petrie, 1998). As Bjorklund 2006 (p. 214) explained:

"Theories of development provide a framework for interpreting the interacting roles of experience and genetics both in ontogeny and phylogeny and the transmission of nongenetic characteristics across generations (epigenetic inheritance). In mammals in particular, differences in maternal behavior may contribute substantially to epigenetic inheritance. Changes in early rearing experiences may have been especially important for humans' ancestors, leading to the acquisition of symbolic functioning. Such representational changes were most influential in social cognition and led to new selective pressures furthering the evolution of symbolic abilities".

Most scientists now estimate that heredity has at best a 50% influence on a child's brain development (Chan and Petrie, 1998). This means that the environment is of critical importance to a child's learning. To enable our children to learn and grow, "we must not forget that the environments we design have a

major influence in building smarter brains” (Chan and Petrie, 1998, p. 2.11).

2. Colour

“Colour is a specific visual sensation produced by visible radiation, or ‘colour stimulus’. Colour stimulus occurs when light from a natural or artificial source is interrupted by an object or a dust particle” (Mahnke, Meerwein, and Rodeck, 2007, p. 18).

Colour is “an important medium of visual communication in the human environment relationship” (Mahnke, Meerwein, and Rodeck, 2007, p. 17).

Colours are products of how we experience the environment. We encounter and are surrounded by colour whenever we open our eyes. It accompanies us in a variety of visual ways and is always influenced by light in both natural and artificial environments (Mahnke, Meerwein, and Rodeck, 2007). Colour is important not only for aesthetic reasons. It is part of our lives and experiences. Colour affects our emotions and influences us consciously and unconsciously (Mahnke, Meerwein, and Rodeck, 2007).

2.1. Colour and children

Colours connect children, their architectural environments, and their actions together. They can signify different purposes for different environments (Mahnke, Meerwein, and Rodeck, 2007). Colour can be an important element in evaluating child development and tends to be the dominant factor in designing for

preschool children (Sharpe, 1974). Some researchers believe that “colour is always a secondary identifier”, that “colour has no identity without form” (Holtzschue, 2006). However, other researchers disagree. According to Sharpe (1974), people can react differently to colour and form in different stages of life, especially children versus adults. Children tend to make the critical shift from colour dominance to form-dominance between the ages of three and seven. This shift takes place gradually. Most children attain the peak of their colour dominance by the age of four-and-a-half, although about 10 percent exhibit pure form dominance at this age. These form-dominant children are thought to be “brighter” than those exhibiting colour or mixed dominance (Sharpe, 1974). Form dominance is usually firmly entrenched by the age of nine. Also, when children aged seven or older are shown representations of familiar objects, “neither colour nor form is normally the basis of conceptual similarity” (Sharpe, 1974, p. 9). However, “colour and form together can be entirely successful in establishing a colour-product link” (Holtzschue, 2006, p144).

Another aspect of colour is colour preference, which changes with each person's age (Beke, Kutas, and Kwak, 2008). For example, much of the literature suggests that most children prefer bright and warm colours. Below are examples of some of the assumptions used in the literature in this field:

- *“Young children are attracted by warm, bright colours” (Cobble, Gertel, and Daggett, 2008, p. 1).*
- *“Young children seem to gravitate towards bright colours — primarily warm colours, such as red and yellow ... Warm and bright colour schemes*

seem to complement the active, energizing nature of children. However, while colour brightness and intensity are useful in attracting attention, they may not be conducive to learning" (Thompson, 2003).

- *"Children of kindergarten and elementary school age are mostly extroverted by nature. A warm, bright colour scheme complements this tendency, thereby reducing tension, nervousness and anxiety. Good colours are light salmon, soft warm yellow, pale yellow-orange, coral and peach" (Mahnke, 1978, p. 83).*
- *"There are also indications that the childhood preference for high chroma decreases with age. Observations suggest that four to five years olds are still mostly in the warm colour preference category" (Sharpe, 1974, p. 18).*
- *"Children respond more to warm colours, whereas adults respond more to cool colours" (Birren, 1969, p. 83).*
- *"Generally speaking, young children prefer brilliant, bright colours, including the primaries, but as they grow older their tastes become more subtle" (Halse, 1968, p. 47).*

Although many studies suggest that children prefer bright colours and especially primary colours, "others found that by the age of kindergarten, children have already developed a sophisticated taste for colour" (Fehrman, as quoted in Agunga, Cole, Donenberg, and Rutledge, 2002). There are also studies indicating that "children love colour and respond to it well but that does not mean the only approach is to use primaries" (Marberry and Zagon,

1995, p. 32). Other studies such as Thompson (2003) suggest that “for preschools and elementary facilities, mild, soothing colours — such as warm, soft shades of whites and light creams — work well as the anchor colour. Stronger, brighter colours are recommended as accents and focal points”. Each colour can have different psychological effects on different children (Birren, 1969).

Paying attention to children's age groups and their response to colour can help with designing a better environment for their learning. There is a link between colour and children's brain development and it is not sufficient to use colour only superficially for its mere decorative or signage qualities in educational environments (Engelbercht, 2003). According to Mahnke (1996, p. 180), “appropriate colours are important in protecting eyesight, creating surroundings that are conducive to study and in promoting physical and mental health”. Thus, when creating a children's space, it may be important for designers to consider the functional aspects of colour rather than just the aesthetic aspects.

Colour can be used to communicate ideas and emotions, manipulate perceptions of space, create illustrations of size, nearness and distance, create focus, and to motivate and influence actions. It can be used purely for its functional attributes, such as to reflect or absorb light (Holtzschue, 2006). Colours are an essential part of the environment and visual perception. They can be used as communicators and as information. By seeing, perceiving and experiencing colours (the three parameters of the relationship between colour

and people), colours can connect things with each other and connect things with people (Pieter Uyttenhoven cited from Mahnke et al, 2007).

2.2. Seeing colour

The ability to see colour is a sensory experience dependent upon the following conditions (Mahnke, Meerwein, and Rodeck, 2007, p. 18):

- The existence of light,
- The ability of the eye to record and relay colour stimuli, and
- The ability to perceive and process relayed colour stimuli as a visual sensory.

As will be discussed later, the existence of light is necessary for all types of colour design. However, the ability of the eye to record and relay colour and then perceive and process it as a visual sensory stimulus is different in children and adults, as described below.

2.2.1. Mechanism of seeing colours.

The eye is an organ for detecting light. As light enters the eye through the pupil, it shines on the retina located at the back of the eye (Holtzschue, 2006). The retina is a complex, layered organ with several layers of neurons interrelated by synapses. Only the photoreceptor cells are directly sensitive to light. These are primarily of two kinds: the rods and cones. Rods function mainly in dim light and provide black-and-white vision, while cones help maintain daytime vision and the perception of colour. A third cell is the photosensitive ganglion cell, which is important for reflexive responses to bright daylight. The retina transmits the sensory signal to the brain.

Figure 1: The structure of the eye, Source: <http://www.patient.co.uk/pilsinl/185.gif>

Researchers continue to investigate the role of the brain in colour perception. The perception of colour and form, which takes place in the brain (and not in the eye), are completely linked (Grangaard, 1993). "It is not easy to understand that the colour is in our mind, not in a transmutable property of the object" (Cytowic, 1989 p. 292, as quoted in Grangaard, 1993).

There are two ways in which colour can be experienced: "either as light directly from a light source or as light reflected from an object" (Holtzschue, 2006). Helmholtz's theory of colour vision (as reported by Mahnke, 1978, p. 39) states that "one type of cone is sensitive to red, one to blue, one to green and some types are sensitive to a combination of the three". However another study claims that "the nerve ends on the human retina (rods and cones) are tuned to receive any of the 3 primary colours (red, yellow or blue), which constitute all colours" (Albers, 1963). Also Holtzschue (2006, p. 54) claims that "when the three primary colours are

present in the visual field, the eye is in a state of rest, or equilibrium". This may be the reason that some sources suggest that primary colours are preferable for children: so that their eyes don't have to mix or analyse colours.

The connections in a child's brain are not completed until the age of five or six and it may take another year for them to mature. At this age, children can't undertake mature reading (Konzak, 2006) and the easiest way to communicate with them is by visual means, where colour can be a powerful tool (Jute, 1993). Vision develops rapidly in children up to the age of six months, and continues to develop throughout the first decade (Mills, 1999). Like all humans, children receive the same light projections on their retinas, but no one is sure if each child perceives the same thing (Albers, 1963).

2.3. Perception of colour

Perception is the key connection between humans and their environment. It involves the awareness and comprehension of a sensory event. Perception identifies and determines what is sensed. "It acts as a filter, separating useful and important information from competing stimuli in the environment" (Holtzschue, 2006, p. 34).

Vision is the most important sense that connects us to the world, with the vast majority of our sensory experiences being visual. We are attracted to light and therefore colour. The average human eye can discern about 150 different colours of light. This means that "a person with normal colour vision

can distinguish millions of different colours" (Holtzschue, 2006, p. 31).

Colour is "one of the characteristics that enable us to determine, judge, and evaluate an object" (Mahnke, Meerwein, and Rodeck, 2007, p. 19).

Further, because all human perceptions have a specific reaction, the "perception of colour addresses the areas of emotions, thought and will and also triggers memory" (Mahnke, Meerwein, and Rodeck, 2007, p. 26). To perceive colours is to experience and become more aware of them, processes that have many associated meanings. Human experiences and responses to colour can be as diverse as people themselves. For this reason, "it is not possible to generalize colour experience, colour effect, or the human response to colour" (Mahnke, Meerwein, and Rodeck, 2007, p. 19).

As explained earlier, while colour is detected by the eye, the perception of colour occurs in the mind, and this perception can be conscious or unconscious. Colours also need to be understood in context (Holtzschue, 2006). Colour can no doubt be inspiring and desirable, but it can also be challenging to incorporate effectively in a children's environment (Read and Upington, 2009).

3. Design essentials of colour

3.1. Colour fundamentals

The three fundamentals of colour as defined by the Munsell colour notation system are as follows:

- Hue: a pure colour with no black or white added. This is what makes a colour unique (Kemper, 2006). "It is the name of colour: red, yellow,

or violet “(Holtzschue, 2006, p. 44).

- Saturation or chroma: the amount of hue in a colour (Kemper, 2006).
- Lightness or its synonym value: “the relative lightness or darkness of a sample” (Holtzschue, 2006).

Figure 2: Colour organization
Source: Holtzschue, 2006

Colour can be organized according to hue, variation in value and chroma (saturation). In the figure above, “tone” represents greyness (Holtzschue, 2006).

3.2. The colour systems

Colour was a relatively obscure field of study until about the eighteenth century, when it became part of the mainstream of philosophical and scientific thought largely as a result of experiments by Isaac Newton. Most of those who studied and wrote about colour during this period were not artists. The observations of Isaac Newton (1642-1727) and Johann von Wolfgang Goethe (1749-1832) form the foundation of the modern study of colour. Newton’s conclusion that colour is generated from light alone remains a basis of modern

physics. Goethe's most familiar contribution was his six-hue-colour-circle, which remains a standard for artists. Similarly, Newton's seven hue model of visible light remains the spectrum of science. Later on, other individuals made further contributions to colour study. These included Albert Munsell (1858-1918), the German chemist Wilhelm Ostwald (1853-1932), and Johannes Itten (1888-1967) whose books are still used as a resource on colour study in many universities. Other individuals include Josef Albers (1888-1976), Faber Birren (1900-1988) and Frank Mahnke who is currently president of the International Association of Colour Consultants/Designers, a position he has held since 1988.

These days there are many different books on colour study and colour systems, which designers can use according to their needs. As mentioned by Gunter Wyszecki in his 1960 book *Farbsysteme* ("Colour Systems"), the most important colour systems can be structured according to three groups (cited by Mahnke, Meerwein, and Rodeck, 2007, p. 34):

- Systems based on additive colour mixing (the Ridgeway System, Ostward System and the CIE Standard Valency System as the international standard);
- Systems based on subtractive colour mixing (the Plochere System and the Colourizer for pigment mixing; the Hicketheir Colour order, the Villalobos Colour Atlas, and the Wilson Colour System for halftone printing); and
- Systems based on perceptually equal divisions (the Munsell System, the DIN Colour Chart, the Hesselgren Atlas (NCS) and the

RAL System).

A few of the more important colour systems are explained in further detail below:

Munsell System¹:

Munsell colours have three elements: hue, value (lightness), and chroma (saturation) (Birren, 1969). It is based on a colour circle of ten 'major hues', made up of five 'principle hues' (red, yellow, green, blue, purple blue and red purple) (Halse, 1968, p. 25).

Figure 3: Munsell colour system

¹ For more information on the Munsell system, see:
<http://www.vanseodesign.com/blog/wpcontent/uploads/2010/02/munsell-color-system.png>

Ostwald System²:

This system was used for the artists and designers at the Bahaus (Holtzschue, 2006). "It is concerned with hue, and white and black content. The colour wheel is divided into 24 sections. The colours of the 'cold' half of the circle have been selected in such a way that they are complementary to those of the 'warm' half" (Mahnke, 1978, p. 34)

Figure 4: Ostwald Colour System

Paint Colour Systems:

Practically every architect and designer who works with colour uses one or more paint systems for specifying colours. Each paint manufacturer also has its own colour system reflecting its standards, as well as custom-

² For more information on the Ostwald system, see:
http://files.myopera.com/psychofizjologiaasp/blog/barwa_22.jpg

mixed colours (Mahnke, 1978) such as the Pantone system colours.

There are several additional colour systems in existence, but they are too numerous to be described individually in this study. The existence of these different kinds of colour systems is due not to differences in colour, but differences "in the divisions of various colour wheels, and colour identification" (Mahnke, 1978, p. 25). Designers who work with colour understand the importance of using a colour system. These systems situate colours next to each other and classify them according to their hue, saturation and value. Therefore it is common for designers to choose one or more specific paint systems and manufacturers to use for their designs in order to create harmony (Mahnke, Meerwein, and Rodeck, 2007). Designers know "that the only effective and accurate way of working is by visual means - not by the slavish application of set formulae but by educated, practiced visual judgment under controlled lighting conditions" (Samuels and Stephens, 1997, p. 24).

3.3. The effect of colour contrasts

Learning about colour contrast and harmony can help designers to better choose what is suitable for children's environments (and any other environment). When combining colours, it is efficient to use different colour contrasts. Below is a description of Itten's Seven Contrasts (Itten, 1973):

Contrast	Definition	Examples
Hue	Best illustrated by the contrast between colours in their most intense luminosity.	The contrasting of the three primary colours: yellow, blue and red.

Light-dark	<p>Between light and dark colours in the colour wheel.</p> <p>This polarity is of fundamental significance in human life and nature.</p>	Yellow and purple.
Cold-warm	<p>Warm colours appear to have no depth and may seem to advance while cool colours seem to have more pronounced depth and appear to recede. When cold and warm colours are contrasted with each other these qualities are more exaggerated.</p>	Warm red-orange and cold blue-green.
Complementary contrast	<p>Between a pair of complementary colours which are the colours directly opposite one another on the colour wheel. Any such pair will contain all the primary colours and mixed together will produce a neutral grey-black. Physiological reality that the eye tends to supply the complementary of any observed colour plays a significant role in any harmonious arrangement of complementary colours.</p>	Red and green.

Simultaneous contrast	Depends on what is known as the simultaneous effect. While observing a colour, the eye automatically supplies the complementary colour in a tendency to “balance” the effect. Each of two adjacent colours which are not precisely complementary will seem to want to shift the other colour in the direction of its own complement creating a dynamic effect.	A grey paper square superimposed on a red background, thereby taking on a greenish cast.
Contrast of saturation	Contrast between pure intense colours and dull diluted ones.	A typical example would contrast areas of the same hue, which differ in saturation from intense to dull.

Table 3: Itten's seven contrasts

The more designers are aware of and understand these contrasts, the more it will help them to create a better harmony in their designs. This is crucial because one colour is rarely experienced on its own in isolation from other colours (Albers, 1963).

3.4. Harmony

Colours can also exist in various types of harmony with each other. A few of the more important and better known examples are outlined in more detail

below.

<p>Analogous harmony: colours beside each other on the colour wheel (Marberry and Zagon, 1995). This involves two primary colours but never the third. For example a composition of red and orange is enhanced, not changed by adding red- orange (Holtzschue, 2006).</p>
<p>Complementary harmony: colours opposite each other on the colour wheel such as red and green, or blue and orange (Marberry and Zagon, 1995).</p>
<p>Split complement harmony: "two opposite colours, along with an additional one or two more that are analogous to one, the other or both" (Marberry and Zagon, 1995).</p>
<p>Analogous-complementary harmony: two colours next to each other on the colour wheel combined with the complementary of one of the two (Mahnke, 1996).</p>

<p>Double complementary harmony: two closely related hues and their complements (Mahnke, 1996).</p>
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Table 4: Colour Harmony

For each of these types of harmony, there are countless possible ways in which they can impact the use of colour. However, it is difficult to summarize this into a simple set of rules for designers to use. What has been referred to as colour harmony is really “balance” (Munsell, 1969, p. 14 from Holtzschue, 2006). Variety and unity of colours are both required to sustain interest, and must be balanced against each other. Balance is achieved by the “securing of unity in the midst of variety” (Mahnke, 1996). Variety attracts and arouses interest, while unity can help to create a favourable impression and to satisfy moods and desires. “Variety overdone is confusing and unpleasant, and unity overdone is monotonous; the mark of good colour arrangement is in knowing where to stop between these extremes” (Mahnke, 1996).

Surrounding colours can greatly influence the human body and mind, but are usually experienced with a lack of awareness (Holtzschue, 2006). Using different kinds of harmony depends upon the designer; for example, they can use nature as inspiration. Nature helps a person to feel complete and connected to the world, and many undergo spiritual experiences in natural environments (Änggård, 2010, p. 6). Colours can act as both signals and stimuli in nature, especially for younger children who spend most of their time in

an indoor environment (Mahnke, Meerwein, and Rodeck, 2007).

Both under- and over-stimulation can lead to unfavourable environmental conditions (Mahnke, 1978). Adults are usually responsible for this age group (4-7) and have to create a positive balance between the children and their environments.

Colours can stimulate, soothe, relax, fatigue, depress, irritate or create a range of other feelings. As outlined further below, the subconscious mind can associate a given colour with many feelings. "Colour may cause emotional reactions and create feelings of coolness, warmth, size, dimension, weight and distance" (Day, 1980).

Yellow attracts attention, like a source of light. In combination with black it has been used to send a warning. It has a primarily emotional appeal (Mahnke, Meerwein, and Rodeck, 2007). Yellow is within the area of the spectrum most sensitive to the eye (Varley, 1980). It can also be associated with joyfulness, happiness, and fun (Sharpe, 1974).

Red has among the greatest number of stimuli, and can act as an alarm signal (Mahnke, Meerwein, and Rodeck, 2007). Psychologically, red is connected with blood. It associated with excitement and stimulation. It is characterized by its dominance over all other colours because red objects always seem closer than all others (Mahnke, 1987). Red has the longest wavelength, is the fastest moving colour in terms of catching the eye, and has the greatest emotional impact (Varley, 1980, p. 186).

Blue has a primarily rational character, increases and enhances

concentration, and allows the user to reflect and make decisions (Mahnke, Meerwein, and Rodeck, 2007). Blue is the colour of the sky. It is considered by some to be more spiritual than physical. It brings contemplation and meditation (Grangaard, 1993).

Green facilitates relaxation, imparting a feeling of security. It can stimulate the mind emotionally and rationally (Mahnke, Meerwein, and Rodeck, 2007). Green represents the colour of nature. "It borrows from the happiness of yellow on one side of the spectrum and from blue's tranquillity in the shorter wavelength. It is the colour of life, rebirth, vegetation on one hand and yet it is the colour of mold and decay, poison, envy and jealousy" (Grangaard, 1993).

Designers need to try and envision the outcomes of the combinations of colours that they use. For example, yellow can be the colour of joy and red the colour of excitement, but when mixed together the designer must decide which response he or she prefers more: something happier or something more exciting. Children appear to appreciate colour harmony as young as age four, however it is between the ages of eight and twelve that children can artistically analyse colour harmony, although even by that age their appreciation of colour has still not reached the same level as adults (Sharpe, 1974). Again, learning to work with colour harmony, balance and ambience can help designers to create better spaces for young children.

4. Colour and light

These days people spend more of their time indoors. This means that most of their light exposure comes from artificial lighting. Further, it does not

appear that these circumstances are about to change in the foreseeable future (Sundstrom, 1986). Therefore, designers must learn to use artificial lights and natural light both together and with other elements.

Light is an element that lets the visual system work. We can't see anything without light. Light makes it possible for us to distinguish "detail and colour, perceive form and movement and so feed our higher cognitive functions" (Boyce, 2010, p. 34). We perceive colour and light through our sense of sight (which is the richest sense for humans). It helps us with receiving an affluence of information through light, which is the fundamental stimulus for vision:

"The ability of the eyes to function on an optimum level is in direct relationship to light. Therefore the light and the environment where it is to be installed have to adapt themselves to the physiological laws of vision" (Mahnke, 1978, p. 73).

Light isn't just an aid to vision and care must be taken as to the type of artificial lights that will be used (Kuller 1981 cited from Mahnke, 1996). There are two well-known types of electric light sources that can be used in interior lighting (Boyce, 1994, p. 30):

(1) **Incandescent light sources:** These "produce light by heating a filament, the spectrum of the light being determined by the temperature of the filament."

(2) **Discharge light sources:** These "produce light by passing an electric current through an ionized gas; the spectrum of the light being

determined by the gas used, the gas pressure, the other elements in the discharge and the presence or absence of a phosphorous coating.”

Current research on the interaction of light and vision indicates that the blue-rich visible spectrum and full-spectrum lighting improves “peoples’ visual acuity for low contrast stimuli, modif[ies] their impressions of an interior and enhance[s] their performance at tasks requiring accurate colour judgments.” (Boyce, 1994)

Light is an inseparable part of colour perception. We see everything through light and colour. Collectively with the perception of form, they become part of the “overall picture” (Mahnke, Meerwein, and Rodeck, 2007). In fact colour, as a visual experience, is “a sensation of light that cannot be verified by other senses—not by touch, taste, smell, or hearing...A coloured object can be touched, but it is the object itself that is tangible, not its colours. Only light generates colour. Without light, no colour exists” (Holtzschue, 2006, p. 12).

Light and colour are integral complements to one another. “Objects attain their colour from the kind of light they reflect and light has its colour from its disposition to produce colour sensation” (Hilbert, 1987, p.6). Good quality lighting complemented with appropriate colours can improve visual processing and lead to a reduction in stress (Birren, 1969). Birren (1978) reported that warm colours and brilliant lighting increase muscular tension, respiration rates, pulse, blood pressure, and brain activity. By comparison, insufficient lighting may cause visual fatigue.

Being surrounded by the environmental conditions and lighting that one

prefers can put that individual in a good mood (something psychologists refer to as the positive effect). This can lead us to behave more co-operatively and creatively.

Three of the most important factors involved in creating good-quality lighting are the following (Mahnke, Meerwein, and Rodeck, 2007 and Veitch, 2000):

- (1) Visual power: light levels (high, medium or low) and controlling glare
- (2) Visual comfort and the colour rendering properties (which goes back to the colour attributes of light)
- (3) Visual ambiance: shadows, colour temperature, and light direction

Perhaps the important consideration to determining the light dosage is the light that the eye receives directly from both the light source and from reflections off surrounding environments and objects (Veitch, 2002). Further, the biological effects of light depend on the intensity, spectrum, and timing of the light exposure (Veitch, 2002). Good-quality lighting can meet the health, emotional and learning needs of users (who in our case are children) (Veitch, 2002).

As described earlier, light is an important medium of every environment that works with and cannot be separated from colour. Designers must take care in choosing the kind of light and colours that they use together, and must consider the type of mood that they are trying to create. Appendix four provides a summary of "Seven Myths about Lighting and Colour in Educational Architecture" which Fielding (2006) thinks are necessary to

consider.

5. Communication: children-colour-environment

5.1. The practice of colour design

There is a large quantity of research supporting the idea that people are directly and inseparably connected to their surroundings, and that their character can change according to different environments (Mahnke, Meerwein, and Rodeck, 2007). As mentioned before, colour is not the only element in an environment. It works with other elements. Designers must work carefully with colour because it is a very challenging element that can change the mood of the environment being created.

A well-designed environment smoothes the progress of learning and also shrinks behavioural problems. Proper colour design is significant in protecting eyesight, and in supporting physical and psychological health. By designing an appropriate environment, designers can help to prevent behavioural problems, premature fatigue, and lack of interest (Mahnke, 1996). To achieve these goals, designers have to understand the interdisciplinary aspects of colour and try to work in interdisciplinary groups to get better results for their users.

5.2. Aspects of interior architectural colour design

There are many interconnected aspects to using colour successfully, such as serving the needs of individuals, the architectural space, its purpose, and its elements. Some of the most important considerations include

(Mahnke, Meerwein, and Rodeck, 2007):

- (a) Physiological and psychological requirements
- (b) Relationship of colour to building and spatial function

5.2.1. Physiological and psychological requirements.

People communicate interactively with their environment, as individuals and as social beings (Mahnke, Meerwein, and Rodeck, 2007). There are many crucial links between a child's emotional and cognitive development, and how complex his or her surroundings are. In particular, children of this age group (4 to 7) need an environment that gives them a sense of security, stimulates their brain, and supports their imagination and sense of responsibility (Mahnke, 1978). Such an environment should also avoid causing fatigue, difficulties concentrating or visual disturbances (Mahnke, Meerwein, and Rodeck, 2007).

Colours may have powerful influences on children's emotions, possibly more than any other element of design (Mahnke, 1996). They have even been shown to impact physical responses, such as muscle strength. For example blue has been shown to help increase muscle strength, while pink and red have been shown to negatively affect it (Green et al., 1979 cited from Smith, Bell, and Fusco, 1986 cited from Grangaard, 1993).

Colour has also been shown to alter alpha brain wave activity, which is used in medicine to measure human alertness. Colour can also trigger the brain to release hormones that affect our moods, mental clarity and energy levels (Engelbrecht, 2003, p. 2). Colour is an energy that can affect us positively or negatively, consciously and unconsciously. The effects of colours

should be understood both psychologically and symbolically (Itten, 1973).

As seen by these examples, colour affects the strongest of human needs and emotions, including stress, hunger and sex. A designer can “direct the type and degree of colour stimulation and by extension, influence behaviour” (Holtzschue, 2006, p. 37). In turn, a stimulating environment can “motivate children to gather diverse emotional and intellectual experiences” (Mahnke, 1978, p. 84).

5.2.2. *Relationship of colour to building and spatial function.*

In interior design, there are a number of different colour combinations and contrasts that can be effective. Colour proportions, as determined by the size of surfaces and the relative amounts of colour in a defined space, are also important. The same colour combinations, when used in varying proportions, can produce different spatial impressions and effects. For a balanced colour design, it is important to “give equal attention to the proportions of area and colour as well as form and colour” (Mahnke, Meerwein, and Rodeck, 2007, p. 72).

One of the major goals of successful design is to create an appropriate framework for particular functions and purposes. Colours can symbolize functions, and in this manner give each building a purpose-oriented atmosphere “that corresponds to the users and activities that should take place in a given space” (Mahnke, Meerwein, and Rodeck, 2007). The environment's character is identified by the colour of the walls, ceiling and floor in the interior environment (Mahnke, 1996).

6. Existing studies

Throughout the history of pedagogy, there have been different studies about child educational environments and learning. These included studies by Johann Heinrich Pestalozzi, Hermann Lietz, Maria Montessori, Loris Malaguzzi in Reggio Emilia³ and Rudolf Steiner. Some of the most important studies for children and colour in their environment are summarized below:

(a) Frieling colour tests:

Heinrich Frieling worked at the Institute of Colour Psychology. He tested ten thousand children in all corners of the world. His findings helped indicate which colours are best suited for various age groups in the school environment. They covered the ages of 5-19. In general, Frieling found that the colours black, white, grey and dark brown were rejected by children between the ages of five to eight, and the colours red, orange, yellow and violet were preferred. Frieling was one of the first researchers to identify the difficulty in using actual preference colours as wall colours, as they were not always suitable as wall paints and had to be combined with other factors like visual ergonomics to be properly considered (Mahnke, 1996 and Pilaroscia, 2010).

(b) Wohlfarth studies:

Dr. Harry Wohlfarth conducted several studies on colour, including one "Effects of Colour and Light on the Development of Elementary School

³ The name of a series of preschool and primary education facilities in northern Italy.

Pupils". This study researched the impact of colour environments on mental and scholastic performance, and on the physiological reactions of students from four elementary schools in Wetaskiwin, Alberta between September 1982 to June 1983. In the study, the first elementary school was the control; a second school had a psychodynamically designed colour and light interior; the third school had only its light changed and the fourth had only its colour changed. Some results of the study were as follows:

- *"The 'least stressed' students were in the school that received the light and colour changes";*
- *"Psychodynamically chosen colours were shown to significantly reduce the average reported incidents of destructive behavior, aggressiveness, and habitual disruptiveness in the colour only school";*
- *"Light and colour showed the largest percentage improvement of the four schools in regard to academic performance and IQ. Test scores—the control school showed the lowest" (Mahnke, 1996 and Pilaroscia, 2010).*

(c) Grangaard studies:

In her doctoral thesis for an IACC diploma in 1993, Dr Ellen Grangaard performed research, which was the continuation of the Wohlfarth study. She removed most of the visual noise and then changed the colour of the classrooms from white to a darker shade, blue, for emphasis. She also changed the lights to full-spectrum UV lighting. The results of her study showed that "off-task behaviour declined and academic standing improved"

(Grangaard, 1993).

There are many other related studies that have taken place, but none specific to the use of colour in children's play environments such as children's museums, playgrounds and playrooms. Such a study would be an important resource for designers to use as a reference.

7. Colour education

Professional training is one of the most important means of communicating the latest findings and developing the initial interest in colour research (Bergström, 2003, p. 257). Learning about colour and its impact at the college/university level can help designers to become familiar with the basic elements of colour design such as understanding different colour harmonies, and the physiological and psychological aspect of the colours that they choose, which in turn helps them to better understand their users.

8. Summary

This literature review is a summary of the major issues relevant to this research. If designers want to design a better environment for children, they need to understand children's needs based on their age. Although some research has been conducted on both colour and children's design, most of them have focused on colour in classrooms and educational settings. There is no significant study focusing on young children, their play environments and colour design. This study takes such a focus and seeks to evaluate how

designers use colour for the learning environments of young children, and what sources they rely on.

Based on research and real practice it is obvious that an interdisciplinary approach is the best answer for dealing with and recognizing environmental problems. These problems include potential psychological and physiological risks induced by environmental factors. A large amount of man-environment research has been conducted but “the findings have not reached the design community with sufficient force to make a substantial impact” (Mahnke, 1996). One of the reasons for this is the lack of interdisciplinary communication and investigation. By working with other individuals from different backgrounds, designers can design better places for young children and learn something new and exciting for their future projects.

The other important way to learn about children is by observing them. Observation can help us to discover more about what children can do and what they know “at any point in time” (Smidt, 2005). Proper colour design requires insight, understanding the meaning and effect of colour, and competence in using colour in architecture and interior design. Good colour design is an important factor in communicating between human beings and architectural spaces (Mahnke, Meerwein, and Rodeck, 2007). The development of a successful colour scheme will be the result of the informed and sensitive application of the experience and intuition of the good colourist (Samuels and Stephens, 1997).

Most interior designers and architects think of their profession as being more closely related to art than to science, but the time has come in which both must walk side by side. The members of the design community, whether they are architects, interior designers, decorators, colour consultants or lighting engineers must learn to work together in interdisciplinary teams to design better spaces for children.

Chapter 3: Methodology

Introduction to Chapter 3

The research question for this study is as follows:

Do designers utilize research about the impacts of colour in their design when designing children's play environments?

- *If yes, how so? How can this use be improved?*
- *If no, why not? How can they be made aware of this research?*

This study is intended to address the research question by both bringing the views of practical designers into the discussion, and providing a comprehensive review of the literature as a whole. The empirical research strategy of the study required a combination of methods. The data was collected and analysed using a triangulation of methods, including interviews, surveys, and expert interviews. These were used to explore different issues from the participants' points of view about how they understand, use and apply colour in children's environments.

The study began with interviewing eleven professional designers. In-depth interviews were prepared to help them discover and identify the factors they consider when using colour, including light and all its other elements. It also explored the extent of their knowledge of colour research, which they may have obtained during their training. The next step was to conduct surveys of 50 designers, intended to gauge their opinions about the use of colour and the potential for improving its use in existing environments. At the end, another interview was conducted with the Professor Frank Mahnke⁴.

2. Data collection

This study relied extensively on qualitative data collection. According to Patton (2001), interviewing people enables the researcher to find out those things that can't be observed directly but enables the researcher to explore different issues from the individual's point of view. Thus, for this study, interviews and surveys were used to explore how designers understand colour, and how they use and apply it in children's environments.

Interviews

The first method utilized was a semi-structured interview, in which open and closed questions were asked. Such an interview allowed better investigation of the social realities behind the trends identified by the research (Merriam, 1998). It also provided an opportunity to obtain deeper insight into the subject of

⁴ Professor Mahnke is a renowned colour expert, the author of three books on the subject of colour, humans and the environment, and a president of the IACC (International Association of Colour Consultants/Designers)

the research (Ritchie and Lewis, 2003).

The semi-structured interview provided an opportunity to expand the effectiveness of the interviews by not limiting one to a specified interview framework. Instead, a range of different interview techniques could be explored. This enabled the exploration of other important aspects and themes and enhanced the available data.

Figure 5 Interview Participants

Different professional designers from a variety of backgrounds, as well as two non-designers were interviewed. Figure 5 illustrates the backgrounds of the interview participants.

Earlier, a test interview had been performed with two designers to ensure that the suggested method was in fact practical and the questions were clear. Afterwards, the real interviews began. Each interview was conducted

face-to-face, and lasted on average between 45 and 60 minutes. The participants were interviewed in different locations depending on their preference. Some were interviewed in their own homes or offices, some at various coffee shops, and others at the School of Industrial Design and in the graduate space at Carleton University. Soft drinks and light snacks were also provided to ease stress and create a more relaxing atmosphere.

A small gift was presented to all participants to thank them for their time and assistance. In situations where interviewees allowed video recordings to be made, this had the added advantage of allowing to focus on the discussion rather than on taking notes (although some notes were made as a back-up in case the recorders did not work). For those cases where interviewees were not comfortable with being video-recorded, an audio-recording was used instead. All the interviews were transcribed, which proved to be useful to better understanding the responses provided by the interviewees for further analysis and pattern identification. The interview questions have been reproduced in Appendix 1.

The interview questions were prepared in the same format for all of the designers, but the order of the questions had to be changed for some interviewees to better reflect the course of the discussion with them. For the two interviewees who were not designers, some of the questions were asked slightly differently. For example, designers were asked: "Do you use colours differently when designing places for children or adults?" In contrast, non-designers were asked: "Should designers use colour differently when

designing places for children or adults?" The informed consent form was also provided to all interviewees before the interviews were begun, in order to comply with the ethical requirements for the study.

Interview participants:

For this study, different professional designers from a range of backgrounds were interviewed, all of whom had at least ten years of design experience in their professional field. All were Canadian with offices in either Ontario or Quebec. They included two architects, two interior designers, two industrial designers and two environmental/exhibition designers. In addition, one educator and one instructor who worked with children were also interviewed⁵.

	Design specialty	Educational background	Professional experiences
1	Industrial-graphic-web designer	Industrial Design	Designing packaging / exhibitions for children
2	Environmental graphic designer	Industrial Design	Exhibitions for children. playgrounds
3	Manager (Canadian Children's Museum), and educator/teacher	Non-traditional learning environments for children	Managing children's museum
4	Industrial designer (exhibit), environmental designer	Industrial Design	Designing several children's museums across Canada

⁵ One additional short interview was conducted via email with Professor Frank Mahnke. However, the results of this interview will be explained separately in the research findings, because the interview was only conducted after obtaining results from the other interviews and surveys, and discussing those results with him.

5	Designer (schools and office buildings, mostly institutional and commercial).	Architecture	Designing for elementary schools
6	Lighting designer/instructor	Fine Arts	Lighting designs for children's museums in Canada
7	Architecture and small institution and non-profit institutions	Architecture	Designing several childcare centres in Canada
8	Exhibit designer (trade shows, museums, exhibits, graphic, interiors).	Industrial Design, Fine Arts, Architecture, Structures, Exhibits	Designing some environments for children and their families; designing toys for children
9	Interior design, children's health care designer.	Interior Design	Children's health-care and play environments
10	Interior designer	Interior Design, Psychology, Fine Arts	Interior colour designs
11	Instructor, consultant and practitioner in child psychotherapy and play therapy	Educational Counseling, Child Development	Working with children

Table 5: Interview participant information

Surveys

The second method that was used was a survey. It consisted of a web-based, online questionnaire that users could log onto to complete. The main

advantage of employing this method was that it enabled targeting specific designers who perform design for children by emailing them and asking them to complete the questionnaire online. The format of the questionnaire was easy to use and accessible in all common web browsers, monitors and networks. Some people have commented that online surveys are not a reliable source of information. However, in this study, a rigorous screening process was conducted to filter all but the most relevant and trustworthy designers for the issues addressed in the survey, as describe below. These included designers from different organizations such as the International Association of Colour Consultants/ Designers (IACC), The American Institute of Architects (AIA), American Society of Interior Designers (ASID), The Industrial Designers Society of America (IDSA), Interior Designers of Canada (IDC), Association of Registered Interior Designers of Ontario and the Association of Canadian Industrial Designers (ACID). Using this approach, about 200 designers were found, mostly from North America but also from some other countries such as Germany and China.

Before beginning the surveys, a pilot study was conducted to make sure that the questions were clear enough for the participants. Then, after distributing the actual survey, 68 responses were received out of approximately 200 requests. These had to be reviewed individually to ensure that the responses were genuine and trustworthy. For example, checks were conducted as to whether the participants were actual designers, whether the companies they were affiliated with actually existed, etc. After completing this check, about 50

responses remained. All were from North America, with the exception of one from China and one from Germany.

Figure 6: Survey participants

The survey participants reflected a range of design practices related to colour and design. They included architects, industrial designers, interior designers, colour consultants, exhibition designers for children and adults, and a variety of other design backgrounds. Most of the survey questions were similar to the questions asked in the interviews, and were again intended to provide an opportunity to see how responses varied according to those with different design backgrounds. The survey would take participants between 12 and 15 minutes to complete. The actual survey questions have been reproduced in Appendix 3.

The next section explains the interview and survey questions and the reason that these specific questions were chosen.

3. How the questions for the data collection were chosen

As mentioned before, the survey questions were based on the interview questions, but in a shorter form. Six types of questions were asked in both the interviews and the surveys (Patton, 2001):

- (a) **Background and demographic questions** – these related to the participants' educational and design background (overview questions—questions 1 to 4).
- (b) **Knowledge questions** – these related to the participants' factual and knowledge base, (questions 5, 9, 12, 13, 17).
- (c) **Opinion and value questions** – these provided insight about the participants' opinions, judgments and thought processes (questions 6, 10, 14, 15, 18, 19, 20).
- (d) **Experience and behaviour questions** – these were about the participants' experiences and choices in different situations (questions 7, 8, 10, 11, 12, 16).
- (e) **Feeling and sensory questions** – these provided insight about the participants' feelings and emotions in a particular fact situation, and also related to what is seen, heard, or otherwise felt by the senses (question 21)

The interview questions included both open questions, which allowed for more exploratory answers, and closed questions, which required choosing from a list of possible answers. The interviews began with an introduction about the study. This was followed by a few demographic warm-up

questions to allow the interviewer and interviewee to relax and become more familiar and comfortable with one another. Then the main questions were asked, followed by a cooling off period at the end consisting of a few simple questions (Preece, Rogers, and Sharp, 2007).

The data collected through the interviews were supplemented by sending a survey to a larger group of designers to confirm the conclusions reached following the interviews. The survey questions were essentially the same as the interview questions. However, attempts were made to make them more clear, closed and specific in order to make it easier and less time consuming for participants to answer them. Clear instructions were also provided on how to complete the questionnaire (Preece, Rogers, and Sharp, 2007). Below is a summary of the structure of questions asked in both the interviews and the surveys:

a. Designers' basic knowledge about child development and theories on learning through play.

Questions:

- As a designer for children, are you familiar with the psychology of child development? (Which theories? Or which person? Which one do you think helped you more: the things that you learned from the school or what you learned based on your need for your projects?)
- Do you know at what age child recognition of colour fully develops?

The first section tested the participants' theoretical knowledge about child development and how play can assist in a child's learning. It is important

for designers to understand their users (in this case children) before designing for them and to know at least about their basic needs.

b. The use of colour in children's and adult's environments.

Questions:

- Do you think that there is a difference between visual perception in children and adults?
- Should we use colours differently when designing places for children or adults?
 - a. If yes, how?
 - b. If no, why not?

The next set of questions were designed to determine how designers use different visual perceptions in their designs for children and to see if there are any differences in their colour designs for children or adults. It is important for designers to understand how users perceive colour and what is appropriate for each environment. The questions asked were partly based on Mahnke's 1987 book entitled *Colour and Light in Man-Made Environments* and his belief that "much of the information from the visual field (or visual stimulation) lies in the hands of designers". Another reference was Sharpe's 1974 book entitled *The Psychology of Colour and Design* where he states that "children appear to be sensitive to colour harmony as early as age four, though it is not until the ages between eight and twelve that colour harmony becomes a feature of artistic analysis and even by the age of twelve this type of appreciation has not yet reached the adult level".

The other element that these questions were meant to explore is differences in visual perception between children and adults. It is important to know how designers use different colours for this specific age group and if there are any differences with other age groups in terms of the selection of colour. It is also important to determine what kind of colours adults perceive that children like. Halse (1968) claims that “generally speaking, young children prefer brilliant, bright colours, including the primaries”, but their tastes become more refined as they grow older. This conclusion is supported in many other references including Thompson (2003), Mahnke (1978) and Cobble, Daggett and Gertel (2008). Therefore, it is very important to understand how designers in practice know this basic information and relationship between colour and children's environments.

c. Current use of colour in children's environments.

Questions:

- What are your thoughts about children's perceptions of colour? How do you apply them in your design? Can you give me an example?
- When you apply colour in an environment, what is the most important aspect to determine?
- What kind of issues influence whether you pick warm or cool colours in your designs?
- Some research suggests that younger children like bright colours more than older children. How do you apply this in your design?

The next set of questions was about the use of colour in existing designs

of children's environments. They were designed to understand how designers choose colours in different fields such as marketing or fashion, and to determine the most important factor when choosing colours in an interior environment.

These factors can be further explored in different resources such as Mahnke, Meerwein, and Rodeck (2007), Holtzschue (2006) and Halse (1978). Factors to consider include the purpose of the space, the existing colours surrounding the space under consideration, the age of the people using the space, and the use of light.

d. Importance of the use of light and colour.

Question:

- As a designer for children's related environments, do you consider how children respond to light? How you use these two together?

The next question was about colour and light. It is necessary for designers to understand some basic principles about using colour and light. Colour and light, "together with the perception of form ... become part of the overall picture" (Mahnke, Meerwein, and Rodeck , 2007). This is one basic principle that needs to be understood by every designer who works with architectural spaces.

e. The use of colour as a facilitator to help children.**Questions:**

- Do you think colour facilitates children's learning (Do you consider colour to be an educational theme facilitator? If yes how? If no, why not?
- When children play a physical game, they learn motor senses such as balance and muscle strength through play. What things about colour would enhance children's learning behavior through play?
- Have you ever designed anything to help children learn something? In that situation did you consider any colour preference?

The next group of questions was about using colours as facilitators. These questions were intended to explore whether participants had any experiences or stories regarding how they use colours to help children learn better through play. The other element of this set of questions was to see how participants use colours to help children in different ways such as increasing their imagination, improving their recognition of different functions in the environment, and motivating and influencing actions. This question was meant as a further exploration of Holtzschue (2006), which researched the use of colour in communicating ideas and emotions, manipulating perceptions, creating focus, and motivating and influencing actions.

f. Colour and form

Question:

-In some books it is stated "colour plays an important, but secondary, role in recognition" and that the initial recognition is of form. What is your opinion on this? Which one is more eye-catching?

The next question was about colour and form and which one comes first for the participant. The reason for this question was that Holtzschue (2006) in her book claims that colour plays an important but secondary role in recognition. This conclusion was doubtful as other resources indicate that each author/designer has different ideas about this.

g. Colour education at universities.

Questions:

- In some books, it is claimed that "colour study requires only six names for colours: red, orange, yellow, green, blue, and violet." Do you agree with this statement? Are there any other colours that you think are important?
- Do you have your own colour palette? Do you use a specific colour system?
- How do you think that universities can improve their colour programs? Were courses offered more theoretical or practical? Which one helped you to better learn: your study at the university or your own study after university? Which books did you study to learn more about colours?

The next set of questions explored what different designers learned about colour study from their education at universities/colleges, as well as what

they learned through practical experience. This included questions about colour theories, using different colour palettes and systems, and the different styles of using these.

h. Do designers utilize colour research in their designs?

Question:

- Do you think designers utilize research about the impact of colour on their design when designing children's environment?

The next chapter will discuss the findings and results of this study.

Chapter 4: Research findings/ Results

Analysis of data

To review the data obtained from these two methods, three basic types of qualitative analysis were used: theme identification, data categorization, and critical incident analysis (Preece, Rogers, and Sharp, 2007). Various themes were identified and these formed the primary set of findings for the analysis. These themes are discussed in this section- see page 66. Specific discoveries and insights were then analysed in more detail.

The data obtained from the interviews and surveys were analysed at the same time. In fact many of the questions asked in the interview and survey were the same or complementary so that the responses could more easily be compared. The data were organized into the following themes:

- a. Designers' basic knowledge about child development and theories on learning through play
- b. The use of colour in children's and adult environments
- c. Current use of colour in children's environments
- d. Importance of the use of light and colour
- e. The use of colour as a facilitator
- f. Colour and form
- g. Colour education at universities
- h. Whether designers utilize colour research in their designs?

Next, specific insights and findings were identified for further analysis and interpretation as to their significance (Preece, Rogers, and Sharp, 2007).

Isolating these specific insights was made possible by working back and forth between the data from the interviews and surveys and investigating them further in order to make sense of the evidence. After all, "interpretation means attaching what was found, making sense of findings, offering explanations, drawing conclusions, extrapolating lessons, making inferences, considering meanings and otherwise imposing order on an unruly but surely patterned world" (Patton, 2001). Further, Noblit and Schlechty (1982) have posited that an interpretation may take one of three forms:

- making the obvious obvious
- making the obvious dubious
- making the hidden obvious

These three forms helped in organizing insights into the research results. Below

is a brief discussion of each of the previous categories.

a. Designers' basic knowledge about child development and theories on learning through play.

These series of questions were only asked in the interviews and eleven different responses were received. Most designers who were interviewed were somewhat familiar with the psychology of child development. Some of them had taken college or university courses dealing with this subject, while others had practical real-world experience from being parents and observing and spending time with their own children. However, most learned about this subject due to the needs of specific projects involving children which required them to conduct further research on these issues. One question that was raised here was which is more trustworthy for designers: scientific research or actual hands-on experience?

One response from the eighth interviewee shed particular insight into this question. When asked whether he was familiar with the psychology of child development, he responded as follows:

"Not from a scientific perspective but from a practical perspective, with my own children and being involved with schools, daycares and helping and interviewing teachers, ... working with children, and interviewing teachers and parents for my projects. It's more hands-on experience than reading studies. I think we have general assumptions about what children like, but I see a lot of variation in how children respond to colour."

In fact this is very similar to the experiences of Piaget, who studied his own children to help him learn more about the origins of knowledge, discover how children obtain knowledge, and the different variations of knowledge at different ages. However for Piaget, this was an inspiration for his work and he had already conducted a significant number of projects. Piaget employed careful observation, conducted interviews, and performed practical tasks to investigate a child's reasoning abilities (Hansen and Zambo, 2005).

Whether scientific research or practical experience is used can also depend on what is being designed for children, for example, whether it is a children's museum, indoor playground, or child-care centre. The seventh interviewee had the following to say about a child-care centre:

"In a child-care centre we're into architecture and the relationship between the children and the adults as learning educators, and we design for the operation of the child care centre which includes the adults as well, so we're not as driven by theories of child development, because the other thing is the adults have to be able to fit in."

This indicates that some designers, even though they are aware of child development theories, will apply other more general principles in a multi- purpose environment in order to address all of the different users (not only children).

Most of the designers in this study were somewhat familiar with what

children need from their years of experience with designing for children, but were not necessarily aware of the scientific basis for these needs. For example, some designers knew that children can have (mostly) normal vision by six months of age, but most did not know that the recognition of colour in children is not fully developed for this age group (4-7). Most were also not aware that it could take up to a decade for full colour recognition to be attained (Mills, 1999). One interesting comment was made by the seventh interviewee, who said:

"I don't know in detail how a child perceives colour. Is it true that they perceive black and white first? That's interesting to me, especially if it has any behavioural implications. It would be too bad if we are designing certain colours thinking it is going to calm children and does not make any difference. That would be a problem".

It is assumed that colour recognition in children will likely depend on how much exposure to colour they had during their childhood, in addition to their age. For example Sharpe, (1974, p. 12) indicates that "children appear to be sensitive to colour harmony as early as age four, though it is not until the ages between eight and twelve that colour harmony becomes a feature of artistic analysis and even by the age of twelve this type of appreciation has not yet reached the adult level". This means that although colour has its psychological and physiological effects, it is not very significant for children of this age group (4-7) from an aesthetic point of view.

The other questions in this category pertained to learning through play. Many studies were found indicating that for young children learning happens through play. There are different types of play but the most general separation is between formal and informal play. The findings obtained through the interviews were very similar to those from the literature review. Most of the interviewees believe that play is a part of children's lives and they discover the world through play. Here is what the eleventh interviewee, who is a play therapist, had to say about play:

"I think play and learning are so intertwined. Starting from birth, play is part of the child's life...Even for children in conflict or famine zones, you see that they are playing even with sticks; any child with even a little bit of energy will start playing. Play has an important role in the development of children; children, by playing with each other, learn the social norms, for example if they play and then start fighting and are punished, then this is how they learn discipline and learn social norms. For me, I don't separate the concept of play from young or old children. They play all the time. Children explore their world through play. My feeling is only that play as a concept is undervalued. When it's formalized for them they don't like it, but for example during recess they can do what they want and they enjoy it. I agree that at preschool formal learning has to happen but what is to say that formal learning cannot happen in unison with play. Some adults don't play and they don't let their children play".

This philosophy is very similar to that of Wohlfarth and Montessori, which was explained earlier in the literature review. In fact their theory that “play is children’s work”, is one of the fastest growing in the educational systems of the world today.

b. The use of colour in children’s and adult environments.

For this group of questions, 11 responses were received from the interview and 49 responses from the survey. These questions showed that there are some differences when designing for children versus adults. One important consideration when designing an environment is who the design is for and the type of messages being conveyed.

These will depend on the subject matter and the content. Most designers believe that children are simple beings who enjoy bright and high contrast colours, while adults are more complex and prefer toned down colours. Thirty-three designers think that children are less sophisticated given that they have fewer life experiences, cultural associations and personal preferences. Also children may more immediately recognize a general object, whereas adults are more detail-oriented.

Sixteen designers believe that designing for children provides a certain level of freedom. They are not as inhibited in the use of colour and designers are able to employ a wider range of colours. For example, as the third interviewee said: “There is a nice colourful bus in the Canadian Children’s Museum and the parents see it as a bus, a nice bus, but for the kids it’s their own world, they could be driving anything.” A picture of this bus is provided

below.

Figure 7 Canadian Children's Museum

Below are a few quotes from different participants' responses to the question about designing for children versus adults:

For children, everything is a new discovery but for adults, we ignore many of the things we have learned ... for children everything about colours and shapes and textures is different, because they are learning about them (the eighth interviewee).

Kids are at a stage in life where they need to be stimulated a lot and need to be in happy places, and colour can help children be in a more comfortable environment and be happy. And that

includes all the faces of a room – it's the ceiling and walls (the fifth interviewee).

Children are a lot more imaginative and creative and free with their expressions. As we grow older we really get boring. Our tastes, everything changes. So of course we should design differently. I know as you get older, the ratio between colour and the light intensity changes because we need more light as we get older. Also, cooler colours tend to be more responsive for older people, but warmer colours would be for younger people, because it is reflective of their personality (the sixth interviewee).

Thirteen designers also believe that colour should be used to stimulate but not to over- or under-stimulate. Eight designers believed that “adults can be motivated by the same colours as children, and it is unfortunate that we have fallen into this pattern of categorizing colours as ‘adult’ and ‘child’, because children can often appreciate tones and hues as much as adults” (anonymous survey participant who was an exhibition designer and studied industrial design). However, there should be some differences in using colours for children depending on the purpose of the space and the age group. Children do perceive colours somewhat differently from adults, at least based on the fact that they don't have as many life experiences and cultural associations, and their aesthetic tastes are also less developed. These same issues are also raised in fashion and marketing, which will be discussed separately in the argument section of the next chapter.

c. Current use of colour in children's environments.

For this group of questions, 11 responses were received from the interview and 48 responses from the survey. Analysing the responses of different designers and survey participants showed that there are several important aspects for choosing colours.⁶ The results for this question are provided below.

Figure 8: Factors for choosing colour for the environment from the interviews and surveys

About 56% of designers believe that the most important consideration when choosing colours for an environment is the proposed use of the space and the length of time that the space will be occupied by various people.

This means that context is very important in colour design. The ages of the

⁶ The most important consideration in colour design is lighting. Lighting was not included in the question simply because it is inseparable from colour as colours cannot be seen without light. So I had different questions just for colour and lighting.

people using the space is also important; however, some designers (about 12.5%) don't see this as a major consideration.

Another important factor is the existing colours surrounding the space under consideration because, as the seventh interviewee said: *"You don't always have that luxury of that plain background. You always have to look at what is around you. It is important. You always have to think about what it is that you are dealing with around you"*. On the contrary some designers (about 8.5%) don't see this as an important issue. However, based on the literature review, it appears that the surrounding environments are critical in creating better balance and harmony in the environment. That is because one colour is rarely experienced on its own in isolation from other colours (Albers, 1963), which is important to create better harmony in the environment.

About 12 designers commented on how they consider harmony and balance to be one of the most important considerations, but they were constantly pressured by clients to use colours that they would not otherwise choose. An example of this was clients preferring bright and primary colours due to a belief that these were best for children.

In this study, a lot of different designers themselves also mentioned that bright and primary colours are best for children. Because this is an important issue/belief for this study, it will be discussed in more detail in the argument section of this chapter. However, there were a few designers (about 5) who preferred to use natural colours for children instead. For example, the seventh

interviewee indicated that because for the most part *"Kids have just come from drywall interiors, the idea of natural colours and materiality is very good if we can achieve it"*. He further said that *"in children's museums and play rooms there are more opportunities to use primary colours, but I don't and if I can avoid them I do because I just think its such a cliché, and stylistic"*. However, even though his ideas are different from those of most other designers, he has good reasons for his choices. He believes that the simple fact that others believe that primary colours are good for children does not in itself mean that they should be used. According to him, there are other colours that can work very well in children's environments and children need variety. From his perspective, because children are indoors most of the time, it is good to bring nature to their environments and to achieve these the designer can use different natural materials such as wood and stone, as well as different natural colours. His greater goal is to help children to become familiar with nature and bring nature into their life, which is very important.

Another interesting comment was made by the eighth interviewee:

"When you look at children's books, very often you will see text and illustrations, and when you open each page, there is a different illustration and some text. Each page has its own story, and the story develops, and there is a flow of information. When you open each page the pages may slightly change the mood by applying different colours or creating contrast between the pages, but you don't see all the pages at the same time. What is happening in

children's museums unfortunately is that you have all those pages open at the same time. And this can cause some pages of that story to be skipped. Just like there is a tendency to jump between pictures, getting the general idea but not getting deep enough to the whole story. And the museum should be a story telling experience, rather than an attack on your senses ... even if it's bright and colourful and dramatic in shapes and forms but the part of the story is missing. That is my opinion about colour and some misuse in the museums."

This is a very strong point. In effect, the message is that designers should think more about how they can change the kinds of experiences they can provide to children. For example, they can use colour to make better connections between different environments.

Designers can also use colour in children's environments to achieve different goals. Holtzschue (2006), Mahnke, Meerwein, and Rodeck (2007) and other writers have identified certain objectives that are important in a children's environment such as:

- Motivating and influencing actions
- Improving recognition of different functions in the environment
- Improving understanding of the size and proximity of physical space
- Increasing children's imagination

As a result, a question was formulated to determine which of these objectives designers see as most important. The results are summarized in the chart below, which shows that designers think colour can be used first to motivate children and influence their actions (70.2%). Improving recognition of different functions in children's environments has the same value as improving understanding of the size and proximity of physical space (42.6%). The lowest ranked objective was to increase children's imagination (37%).

Figure 9: Use of colour in children's environments- Interview and survey

Based on the analysis of the data from this question, colour has some other important uses such as:

- Making children feel safe
- Helping for wayfinding
- Affecting and controlling children's moods

- Aiding in visual ergonomics
- Improving concentration and learning
- Reducing distractions

However, care must be taken with how colours are chosen and used, because “there’s so much emotion attached to colour” (anonymous survey participant who is an interior designer). Perhaps if colours are used the same way as they are seen in nature, this will help children better connect to the natural world, feel safer, and making them more interested in exploring and learning about the natural world.

For example, red can be used not as a dominant or subdominant colour but as an accent, much like seeing a small red flower. A large amount of red is rarely seen in nature, and even if it is such as in a garden of red tulips, it is temporary. Therefore, decisions must be made with some colours like red, which can be used either in small amounts and as an accent (Itten’s contrast of extension), or otherwise used for only a short amount of time.

Another issue related to the current use of colour is the colour systems and palettes that designers use. These are chosen by designers according to their needs and what their clients want. This is because as of yet there is still no complete, comprehensive colour system or palette and companies simply cannot capture the whole range of colours that exist. This is true even for some of the most commonly used and trusted colour systems such as Pantone and Benjamin Moore. However, using different colour system and palettes is not a critical issue so long as designers try to achieve good balance and contrast in

colours.

d. Importance of the use of light and colour.

These questions demonstrated how some designers can't always control the lighting because of their clients, and how some don't have enough information to enable them to use lighting appropriately. Colour and light are inseparable elements. As the sixth interviewee said, *"lighting makes or breaks anything that any designer does... the only reason we see a colour or object is because that colour is in the source, which is either the sun or a light bulb"*.

Even though it may seem obvious how important light is, some designers such as the fourth interviewee commented as follows: *"Well colour is all about light and that's a struggle because unfortunately in most of the projects we're involved in, we can't control light. We should, but clients don't always let us"*. This may be due to many causes, such as a lack of budget, trust between designer and client, etc. Some designers try to use light as much as they can or even get help from other professionals if they have to do lighting design.

Figure 10: Interchanging colour fixture

Source: <http://www.3glighting.com/product.php?CollID=211>

Figure 10 provides one example of lighting that the fifth interviewee was using for one of her projects, which involved interchanging colour fixtures to be used for different patterns (such as Christmas). Many designers try to use light as much as they can. As the sixth interviewee said: *“Naturally, if you have a lot of light, your body is more stimulated, but if it’s dark we associate that more with rest or sleeping”*. Using light and colour, designers can make interactive pieces for children.

e. The use of colour as a facilitator in children’s learning.

For this group of questions, 11 responses were received from the interviews and 47 responses from the surveys. Based on the findings from this study, the environment can act like a teacher and colour as a part of this environment may help children learn better. However, as the tenth interviewee said, *“this will only be the case if we apply colour in the environment*

appropriately". For example, children should not be over-stimulated even in storytelling environments or in the theatre where children learn through playing different roles.

Most (nine) of the interviewees agreed that colour can facilitate children's learning. However one person (the seventh interviewee) disagreed. When asked about colour and whether it can facilitate children's learning for this age group (4-7), he replied as follows:

"No. Not really. I'm more interested in the environment, what kind of environment is created, and the behavioural implications of the environment... We do use feature walls, that might establish a path, so that might be a deeper colour and it stands out to be darker. It's not that we don't use colour...[but] there are no primary colours used at all. Door frames are not bright blue; doors are not red".

So despite not using colour specifically with the intent of facilitating children's learning, it seems that this designer was still knowledgeable with regards to creating a good environment using different colour selections. There was another interviewee (the eighth) who also said that he would not put too much emphasis on colour.

Based on the findings of this study, it seems that colour in itself does not have a direct impact or effect. For example, using red does not in itself teach anything specific to children. However, it can have indirect effects. For example, the colour red can make children excited by its stimulating effect.

Colour affects children's behaviour, emotions and their feelings. It can also be used in different ways. Using the actual colours of objects can help children learn about their environments. Alternatively, colour can be used in a way that helps children use their imagination. As a result, one might disagree with those designers claiming that colour and learning are not related, because there are numerous studies to the contrary, as described earlier. As mentioned in Section c, colour can be used in many different ways to facilitate children's learning. These include using colour to identify different functions, facilitating concentration, creating excitement, and creating motivation in children to help them better understand their environment.

f. Colour and form.

For this question, 11 responses were received from the interview and 50 responses from the survey. According to the findings of this study, 51% of designers think that colour is something that they would notice first before form. On the other hand, much of the literature suggests that colour plays a secondary role and it is form that comes first (see e.g. Holtzschue, 2006). However, based on the findings from the literature review and interview and survey results, while it is true that colours can be perceived differently in different forms, which is perceived first will depend on a number of factors.

Figure 11: Form versus colour from the interviews and surveys

For example, as the fourth interviewee said:

"I have many different examples where without the colour people would have just walked by and not seen anything. But again it depends...although shape is important, in a museum, a playroom, you're inside a space, you come into a room, see how it fits, what the colour is on the wall – those things have a huge impact, probably more than the shape."

As a result, it could be argued that as a general rule, colour comes first in an environment unless the form is very special. However this will still depend on different factors such as:

- Being inside or outside of the object
- Being close or far (if the distance is far, colour tends to be noticed first)

- The size of the object/environment
- Whether the object/environment is moving or dynamic
- Whether the form or colour is dominant, subdominant or an accent(might argue here?)

g. Colour education in universities.

In interviewing the different designers, it was discovered that most of them learned about the use of colours from their own experiences. If they had any formal colour education, it was from a related form and colour course at college or university. However, most of these courses focus on form and this appears to be true of most designers as well. This observation is discussed further in section f. The data analysis of responses to this question demonstrated that there is a need for improving colour education at universities because we're moving more towards interactive design where colour becomes a much more important interface. From this study, having discussed with different designers and one colour expert (Professor Mahnke), some of the problems identified with respect to colour education included:

- People not getting enough formal education about colour, often because instructors don't have much colour experience
- Designers not getting enough formal education about light in relation to colour
- Designers not getting enough hands on experience with using colour at schools

- Designers leaving colour selection to the end of the design process, because they don't know how to make proper colour selection; partly because they did not learn this in school.
- Designers having a very limited colour palette and using this for all applications partly because they do not have enough knowledge about selecting colours and partly because people sometimes tend to stick to what they have learned or used before or what is familiar.

It may be a good idea to improve the colour curriculum offered in universities in order to better teach design students about colour selection in real projects. Such projects can include creating a text book or website to help students learn about colour and its applications, something that will be discussed later in chapter 5. It can also be helpful to have more hands on applications of colour rather than purely theoretical knowledge.

h. Do designers utilize colour research in their designs?

The final questions of the interviews and surveys were intended to discover whether designers utilize research about the impact of colour on their designs and why designers can't apply research about colours in their designs. The results demonstrated that some designers do consider colour research in their designs, but not all the time and for different reasons which will be explored further in this section. Below are some of the responses that were received:

"I find most designers not well in tune with the world of colour. They're experts of shape instead of experts of colour" (the fourth interviewee).

"I'm aware of colour and have thought about it... my ideas are different, and when I discuss it with clients I don't always win this battle" (the seventh interviewee). (This may be because of a lack of budget or designers not knowing how to explain and convince their clients).

"Most of us get used to doing certain things, so I think we are conscious of [colour], but maybe don't take it into consideration to the fullest extent possible" (the sixth interviewee). This may be due to designers not having enough knowledge about using different colours and not having the time and budget to try new things.

"Designers are responding to whoever pays their cheque first, because they have to live, so they have to listen to whoever gives them their assignment. Will they pay attention to other things? They should but do they have the time or resources or money?" (the eighth interviewee).

"Colour selection cannot be based on a single research conclusion. Colour selection must be based on an interdisciplinary approach which includes 1) the neuropsychological aspect-processing and balancing of visual stimuli 2) the psychological

effects of colour 3) environmental influence on emotions- psychosomatic and emotions in relationship to design, and 4) visual ergonomics. Also, light can not be ignored when selecting a colour. Light and temperature has to be taken into consideration with selecting colours” (anonymized survey participant who is a colour specialist, researcher and consultant).

As a result, it would seem that designers often are unable to convince their clients about certain erroneous beliefs or myths. These include the belief that primary colours are best for children, or perhaps other beliefs that parents may have on what is best for children without the experience of having actually designed anything for children. There also appears to be a general lack of knowledge on colour on the part of designers, another reason why they are not always able to convince clients to change their preferences. However, it is understandable that a lot of designers are unable to spend much time on research and remaining updated in this area for a variety of different reasons. For example, they may not have enough time or money to do research. They may also be suspicious of certain research findings because many of these studies have been conducted in controlled environments and for specific situations.

Colour selection cannot be based on a single research conclusion, but an interdisciplinary approach, meaning that designers must analyse the results of different studies from different point of views and collaborate more with other disciplines.

In addition to the issues already addressed, there are other important issues that although not asked of all participants, were identified by most as important considerations. These are discussed below.

Use of bright colours in children's environments.

Most designers seem to think that bright colours and primary colours are ideal for children. However, a few designers mentioned that there are other colours that are good to use for children and that they preferred those colours to the primaries. For example, one designer commented as follows:

“Primary colours have been come to be known to symbolize children's play, and primary colours are more for parents than for children. [They are something] parents associate with children, but when you think about it they are used more for the parents and not for the child... people associate the concept of child's play being bright and exciting, but it's not. You're really trying to achieve focus and attention.”

Hence, this interviewee saw the use of bright and primary colours for children as a sort of cliché or stereotype. It may be that people see children as more simple than adults because culture and personal experience have not had as much of an effect on them yet. Certain colours should not be categorized as the domain of children or adults. There are, however, certain colours that may be used more often in children's environments.

Here are a few of the other responses to the question on the use of

bright colours:

"Children are full of life and vitality and bright colours represent them" (fifth interviewee).

"I don't like the idea that bright colours and primary colours should be used for young children. I think children are more sophisticated, like us" (ninth interviewee).

"Some studies say that colours have certain effects on children, that's the common knowledge, but I think this is conditioning that comes before that age, so children at ages 1 or 2 or 3 are exposed to those combinations, and then associate with it. But if some child from the jungle came would he associate orange with hunger, I don't know. I think by the age of 4 to 7 they are already responding to some conditioning. I think it is a part of culture and what people are taught. I think you can condition people to certain colours. That's my feeling" (eighth interviewee).

"For children the colours are often brighter or more contrasted, often more saturated for sure. But the problem I have is that for kids, we're focused on enhancing colour... I think we're dumbing down most of the time what we're offering kids, like the three primary colours. And I don't know where that comes from. It comes from trying to rationalize the educational system I think, like the three primary colours. But I think kids are more refined and can sense differences. If there are three shelves they don't mean the

same thing to them as they do to us” (fourth interviewee).

“Most of our preference responses to colour are learned. Children who are exposed to complex colour combinations can learn that these are attractive; children who are exposed only to combinations of bright primaries that are not used in adult environments might take longer to learn than the adult combinations are attractive. That's not developmental, that's a result of what they were previously taught” (anonymized survey participant who is a researcher at the NRC Institute for Research in Construction).

Based on this study, there appear to be two different perspectives regarding the use of bright colours in children's environments:

- Designers who use bright and primary colours for children to be stimulated in their play environments; and
- Designers who think that children's play environments such as children's museums and playrooms are already stimulating enough for children and it is not healthy to stimulate them even further.

Based on the research findings, the colours that we use in adult environments are or can be the same as in children's environments. However, there are some specific colour combinations that we use mostly in children's environments, such as the primary colours. There is not much scientific basis for this use or preference. It is likely due to conditioning, such that they have become so associated with children that when we see them in a certain

environment we unconsciously assume that such an environment must be for children. This is the same thing that Fielding (2006) mentioned in his study (see Appendix Four). Such conditioning may also have led us to believe that primary and bright colours are not appropriate to use in adult environments. However, the results of this study suggest that many designers feel that bright and primary colours are not always the best choices for children. While most designers believe that bright colours are appropriate to use in a children's environment, many are not able to explain why. This may be because they have not learned about the basic elements and effects of colour in their formal education, making them unable to create a new palette for their designs and instead repeating the same things over and over again for every child's environment.

Regarding the use of bright colours, designers in this study who use bright colours in children's environments can be separated into two different groups:

- (1) Those who really believe that bright colour are best for this age group. However, they may not be able to explain why. As mentioned in the literature review, Fielding (2006) pointed out that there is no scientific research supporting the claim that primary and bright colours are the best choices for children.
- (2) Those who use bright and primary colours because of the stereotype that primary colours are good for children and whenever they see primary colours, they may unconsciously assume that such

environments or objects are for children. Again, there is no scientific basis for this. Many designers use bright and primary colours simply to cater to parents or other adults and their beliefs. They may also rely on these colours simply because they do not have the budget to conduct more colour research for their projects.

There are very few studies on the use of primary and bright colours for young children in play environments. The only studies found that were somewhat relevant were a few pertaining to children in classroom environments. Hence, it would appear that there is limited scientific research on the use of bright colours for children, at least in the English language.

Another reason that bright colours may be associated with children is that some brain functions operate differently in children compared to adults. Children are more active and their logic functions are not yet completed. This is explained more in Piaget's theories, which are summarized in the literature review.

Another consideration, as quoted earlier, is that Helmholtz's theory of colour vision (as reported by Mahnke, 1978) states that "one type of cone is sensitive to red, one to blue, one to green and some types are sensitive to a combination of the three". Another study claims, "the nerve endings on the human retina (rods and cones) are tuned to receive any of the 3 primary colours (red, yellow or blue), which constitute all colours" (Albers, 1963). Also Holtzschue (2006) claims, "when the three primary colours are present in the visual field, the eye is in a state of rest, or equilibrium". It is assumed that some

designers are using basic primary colours because they think complex colours (and complex environments by extension) are not good for children. However, it can be argued that being in a simple, unsophisticated environment might also teach children to be unsophisticated. If our children's operational environments are simple, then so too are our children's cognized environments.

It is possible that there is a general misunderstanding among designers and lay people that primary colours are the best for children. It may be that these same people also believe that children are simple and also very energetic. This belief may be consistent with studies on child brain development, which is not yet complete for this age group. It is also consistent with those theories on vision development described earlier.

After analysing all of these data, a short interview was conducted with Professor Mahnke, who commented as follows:

Children are subject to the same psycho-physiological, neuro-psychological and visual ergonomic effects as are adults. From a psychological standpoint a difference is of course of importance for specific needs of children that are closely associated to the message a positive environmental ambiance has to give that is related to the function of children's interior environments...but remember, these are biological effects and the psychological effects of colour being seen as a visual language is different according to age group or psychological development. Young children want to feel nurtured in their environment, are prone to warmer colours.

Later on it changes somewhat as their psychological stages change. Important is not the preference of colours of different age groups, important is to know what colours they reject at a certain age group.

This is a strong point. The research for this study identified studies such as the "Frieling colour tests" (as cited in Mahnke, 1996 and Pilaroscia, 2010) which indicated that children between the ages of 5 and 8 tend to reject black, white, grey and dark brown colours. Professor Mahnke was also asked about why many designers believe that bright, warm and primary colours work best in a children's environment. His answer was interesting and consistent with one of the reasons discovered earlier in this study:

"Because in their education, whatever it is, they have not been properly instructed as to the human reaction to colour, or should I say ambiance of an environment and the message it should give".

However, in his 1978 book *Colour and Light in Man-Made Environments*, Professor Mahnke claims that:

"Preschool and elementary grades are mostly extroverted by nature. A warm, bright colour scheme complements this tendency, thereby reducing tension, nervousness, and anxiety. Good colours are light salmon, soft warm yellow, pale yellow-orange, coral and peach."

Obviously, such a colour scheme may be proper in some children's environment at some point. However, the problem with making general recommendations of this kind is that those lacking knowledge of colour, having little other hard recommendations to work from, might feel justified in arguing that all preschool environments should always use these colours. This was mentioned to Professor Mahnke and he responded as follows:

Notice that light salmon, soft warm yellow, pale-yellow orange, coral and peach are not primary strong colours but pastels. To create a warm, or friendly ambience does not require a saturated yellow for example. Colour design is separated into three functional areas: Dominant colours (with the largest amount of surface in a space that sets the mood), subdominant colours (which should introduce at all times the complementary colour temperature)....and accents [which] can be stronger in colour chromaticity - these would be the smallest areas in an architectural space.

This statement is interesting in that it suggests that to create a good ambience in children's environments, we don't need to use primary colours or bright colours. All of the colours can be used in the proper context, so long as attention is paid to which colours are rejected by which age group, and the effect of the colours being chosen.

To help designers better understand colour, perhaps the colour curricula offered at universities could be elaborated to include more information on the

different psychological and physiological aspects of colours, in addition to more basic information about colour design and harmony.

Marketing aspect of colour for children.

Another important issue in this study is the marketing aspect of colour design. Based on the literature review, interviews and surveys, children are still not locked into rigid stylistic niches like adults. For children of this age group (4 to 7), fashion and marketing is still not something that matters greatly to them. Some designers think that these children may still be too young to decide for themselves. They may therefore design some thing that appeals to adults instead of considering what children really like, because it is the adults (e.g. the parents or teachers) who in the end make the selection and spend the money on behalf of the children. Here are few examples of this from the interviewees:

Often because its with kids there's a cost issue. Parents don't want to spend a lot of money...so it becomes more about the people buying it than the kids actually playing with it (second interviewee).

I think designers are under pressure from curators and clients who have their own vision, and often designers simply follow the story line offered by curators or writers or clients, and often they don't have experience spending time with children to see what children really need... I think parents make final decisions, so in my

opinion you're marketing towards parents, towards their knowledge and experiences. I don't even think about marketing to children, because I think it is nasty! (eighth interviewee).

However, some other designers think that children have a right to be part of the decision making process for their own environment. Consider the perspectives of the following interviewees:

Children tend to be more creative, less biased, but I also find them to be clearer than adults in terms of what their preferences are (tenth interviewee).

Adults may like a product for their children but the children might hate it; so it works only when you satisfy both; so I agree adults have to be there, but both have to agree (eleventh interviewee).

Even if some designers believe that they cannot trust what children have to say, they can still learn about children by observing them, and spending time with them. Designers can be separated into two different groups in this situation:

- (1) Those who think that parents and educators are the best source for colour selection for children's environment.
- (2) Those who prefer to work with children, observe them and learn from spending time with them.

The first group tries to get the information they need from adults, including parents and educators. That is because they think children of this

age are very immature and change their mind often so they cannot trust what they have to say. There are also budget and time considerations for this group in that they may not have enough additional time or money to spend observing children. Their approach has both advantages and disadvantages. By asking questions from adults, they can get responses more quickly. Also, because adults are the main decision makers for this age group, gauging the opinions of adults facilitates the process of selling the product/environment to parents and educators. However, a disadvantage is that the opinions or responses they receive from adults may be based more on stereotypes and clichés, an example of which is the idea that primary colours are best suited for this age group.

On the other hand, the second group tries to spend time with children by playing with them, observing them, learning from them, and learning what their needs are. They think children are as trustworthy or more trustworthy than adults, and can even be more creative and/or helpful than adults. The answers they find may be more reliable than the first group. This is because even though this process is more time consuming, the responses are obtained in the children's own environment and from the end-users.

Based on the research, children should have a right to be part of the decision-making process. At the same time, marketing is one of the most important considerations in this society, and being limited from a marketing perspective can actually give designers an opportunity to be more creative. All this can help designers create balance between asking for help from adults

and observing children. It is important that designers learn how to ask the right questions to help them resolve this issue. For example, asking indirect questions instead of direct questions can sometimes yield more insight. This could mean asking more context-behavior questions and more context- colour information questions, as opposed to asking direct questions such as which colour is good for your child's playroom.

To create a balance between a child's and a parents' needs, designers need to learn about children by spending time with them to see what their needs are. At the same time, they can ask useful questions from their parents and educators to save time. This requires further investigation in order to develop a pattern of questions that can create some sort of balance between these two issues. This can prove to be very helpful to a lot of different designers.

Chapter 5: Conclusion

Introduction to the chapter

This chapter includes the conclusions of the study and why designers should pay attention to colour and its benefits in designing a play environment for children between the ages of 4 and 7. It also contains a summary of the study. At the end there will be some recommendations for designers and possible implications for future studies in this field.

Purpose of the study

The purpose of this study was to understand the role of colour in the design of children's environments, and to help designers understand this role to design spaces that enable children (aged 4-7) to learn more effectively while they play. The following question served as the basis for the collection and analysis of data:

Do designers utilize research about the impacts of colour in their design when designing children's play environments?

- *If yes, how so? How can this use be improved?*
- *If no, why not? How can they be made aware of this research?*

Evolution of the research questions

The evolutionary process was followed as the responses and data were received. The first step was to discover the existing scientific research in design. From there, it was discovered that there is a disconnect between designers and researchers and that they don't always speak a common language. This led to a questioning of why designers can't always properly understand scientific research, and a consideration of how design research could be better presented. The first issue identified concerned human centred design and how important it is to understand the different effects of colours. For this question, one answer could be to better educate designers. To achieve this, colleges and universities would be good places to start, and one option could be to create a text book or website

that students can use for this purpose. This is discussed further in the conclusions of the study.

Conclusions of the study

The findings of this study established that both the interview and survey participants for the most part had some degree of knowledge or familiarity with colour research.

One of the problems identified by the study was the application of the researcher's language into the design process. It is important to impart the existing research in a manner that designers can easily understand and absorb. This will also increase the understanding of the need for colour research, and make it easier to show designers the practical uses of colour research.

In interviewing different designers, some of them explained that one reason why they do not apply colour research is that they simply never learned it, while others indicated how they have trouble trusting the legitimacy of the results of different studies. Based on the research findings, as well as my own experience of being a student and then a teaching assistant for a "Form and Colour" course, it would appear that colour education is generally not seen as a critical issue for schools of design. Students don't appear to learn all that they need about colour design from colleges or universities, as the focus is largely about form rather than colour.

Professional designers⁷ and design students seem instead to be making a

⁷ "Designers" refers to architects, industrial designers, interior designers and all others with a professional design background

lot of decisions about colour based on their own interests. For example, many designers use the same colour palette for all of their designs, because that is what they are familiar with. Also, bright and primary colours are frequently used in the design of children's environments. This is because many designers believe these colours to be ideal for children, even though they are not always able to explain why.

Based on the literature review, data analysis, and discussions with Professor Mahnke, it seems that the prevalence of bright and primary colours in children's environments may be based on certain beliefs and stereotypes, and a general lack of knowledge about the uses of colour by designers. Clients are not convinced about appropriate colour choices. This can be changed if universities develop better colour curricula to teach students about the basic psychological and physiological aspect of colours, as well as the basic elements of colour design such as how different harmonies and contrasts can be used to create a good ambience in children's environments. In this way, it may become possible for designers to better convince their clients about colour selection preferences by producing scientific reasons for their colour choices. This can also help to make designers better aware of the use of colour and its effects. As an example, designers can learn that bright and primary colours are not always the best choices in children's environments.

Another important issue in this area is marketing. Many designers, when designing for children, ask adults (e.g. parents or educators) to help them. This is partly because they are not confident that they can elicit this information children,

thereby making adults the primary decision makers for this age group (4-7). A balance is needed between respecting the needs of parents, and the needs of children, and children's needs can be better ascertained by observing and spending time with them. However this whole issue still needs further investigation.

Therefore, colour designers should learn about scientific research about colour in the realms of neuro-psychology, physiology, visual ergonomics and psychosomatic responses. An example of this is the theory that children learn better in yellow classrooms because yellow stimulates their intellect. Of course the use of the colour yellow alone won't provide such results. This comes from a misinterpretation of Wohlfarth's study where he used yellow in classrooms. He also received the same results using blue in classrooms in later studies. In fact, the positive effects came from the change in lighting and in the elimination of inappropriate colours, creating a more supportive and beneficial environmental ambience.

This illustrates how colour selection cannot be based on a single research finding. It must instead be based on an interdisciplinary approach, which means that designers have to be exposed to the results of different studies from different fields and perspectives. At this point, it is important to realize that purposeful and sensible colour design demands giving consideration to the user of the architectural environments and to the importance of creating an environment that will serve the needs of children instead of expecting children to simply adapt to the environment.

It is recommended that designers from different backgrounds adopt a new perspective in their work with colour. They should adopt a new attitude concerning scientific research conducted in different fields and covering many disciplines: to analyse every architectural space in terms of its own particular circumstances, functions and users' needs. To address this issue, it may be helpful to create a textbook or website to teach design students and other designers the basic requirements of colour design and to help them to get the information they need from a useful source. One such proposal is illustrated in figure 12, which provides the outline for the structure of a website or a textbook that could be included in a university/college curriculum for better colour study.

In this outline, there are four categories of colour study identified. The first category is on humans and colour. This encompasses the physiological and biological effects of colours and how humans see and perceive them. This includes different human reactions to different colours, and how designers can use and incorporate these effects. Another issue covered by this category is the psychological effects of colours, and how culture and different personal experiences can enhance/ reduce colour effects. The second category relates to colour fundamentals, which most designers learn about at college/university. It encompasses colour attributions: hue, saturation and value, and how these elements can be used to create different harmony and contrasts. It is helpful for designers to learn about the different uses of colour with different materials and other environmental elements in the areas where they want to design. One of the most important issues in this category is light and its biological effects.

Figure 12: Outline of Colour Considerations

The third category encompasses different fields of design, such as designing an object, architectural environments, or graphic design. This study focused mostly on the interior and preschool environments, because of the scope of the research question.

The last category refers to resources that should prove to be generally useful for designers. Included here are some textbooks and other resources that were particularly helpful in this study.

If there is one single conclusion to be drawn from the ideas discussed in this study, it is that for those of us who wish to work effectively with colour and design, we must have an interdisciplinary understanding of colour. We must try to learn about its physiological and psychological aspects in addition to the basic information needed to create a harmony that suits the environments we design for our children.

Summary of the study

The focus of this study was to contribute to the existing knowledge on the role of colour in children's play environments. It focused on children aged 4 to 7 because they are still young and communicate mostly through visual tools of which colour is one of the most important. It was also to help designers better use colour when designing such environments in order to provide an equal opportunity for children to learn through play about the world around them. This would highlight the role that can be played by designers from the various disciplines that work for children including architects, interior designers,

exhibit designers, industrial designers, colour designers, and lighting designers.

The data was collected by interviewing 11 different professional designers and surveying about 50 different designers. After that, a qualitative analysis was conducted and the interview and survey results were analysed at the same time, thereby complementing each other. After gathering all data, nine different themes were identified and the data was then categorized accordingly for the critical analysis. The following are the nine different themes identified, along with some of the important insights.

- a. **Designers' basic knowledge about child development and theories on learning through play:** Most designers were somewhat familiar with the psychology of child development either by taking some courses at college/university or from their own experiences through different projects, or from having their own children.
- b. **The use of colour in children's and adult environments:** Most people think that children are less sophisticated and enjoy brighter colours, whereas adults prefer toned down colours. They also believe that as children grow older their colour preferences change.
- c. **Current use of colour in children's environments:** Most designers believe that the most important consideration when choosing colours for an environment are, in the following order, the context and proposed use of the space, the age group of the users, the existing colours surrounding the space, and the size of the space. It was also discovered that there are some questionable uses of colour in current environments, something which can

be attributed to a number of different factors such as pressure by clients, lack of knowledge, or stereotypes such as those about using primary and bright colours. Another discovery was that colour can be used for different purposes such as motivating and influencing actions, improve recognition of different functions, improving understanding of the size and proximity of physical space, increasing children's imagination, making children feel safe, and affecting and controlling children's moods.

- d. **Importance of the use of light and colour:** Lighting can make or break anything that designers do. It is an important part of colour design, however designers don't always have control over this because of their clients.
- e. **The use of colour as a facilitator:** Based on the findings of this study, it can be said that colour has indirect effects on children's learning. It can be used to identify different functions, facilitate concentration, and create excitement and all of the other effects mentioned in part d of this section.
- f. **Colour and form:** Based on the findings, colour is noticed first by designers unless the form is very special. This finding also depends on different factors such as size, being inside or outside the object, and proximity.
- g. **Colour education at universities:** The findings suggest that most of the colour and form related courses focus more on form than on colour. This can cause problems for designers such as not providing them enough formal education about colour and light, not providing enough hands on

experience, and restricting them to a very limited colour palette that is then used in all applications. Developing a better colour curriculum can perhaps help designers in this situation.

- h. **Do designers utilize colour research in their designs?** Some designers do apply colour research in their designs, however others do not. This can be due to their familiarity with shape instead of colour, not having enough of a budget to do research, and misunderstandings regarding the use of some colours such as primary colours for young children.

After examining all of these data and insights, there were two other issues that the arguments raised:

(1) Using bright colours in a children's environment is not always a good choice. Some designers do so because of a misunderstanding about the use of colours, a lack of knowledge about the scientific aspects of colour, or for marketing purposes.

(2) Marketing for this age group is an important issue. Designers should speak to other adults to help them in designing children's environment or in observing and learning from children by spending time with them. Perhaps the best idea can arise by creating a balance between the perspectives of adults and children.

In conclusion, designers must understand the interdisciplinary aspects of colour. Also design departments should improve their colour-related courses and establish a faculty having a multidisciplinary background who are able to

examine colour issues from different points of view. In this way designers can design better places for children and can also better convince clients and parents about their colour choices based on the scientific bases behind them. For example designers can better explain the psychological and physiological effects of colours, and how primary and bright colours are not always the best choices for children. This can be achieved if design programs incorporate better colour education into their curricula in order to nurture better designers.

Recommendations for designers who work with colour

The findings from this study can be useful to whoever works with colour, especially new designers who don't yet have enough experience in this field. Below is a summary (compiled with the help of different resources) of some functional guidelines and reasons why colour is an important element in children's interior environments:

- A designer's focus should be on what a child needs. Children's needs are varied, and could include desires to feel loved, safe, and respected (see e.g. Mahnke, 1996). As designers, we can better understand what a child's needs are if we choose to listen to children, observe them, spend time with them and take them seriously. In this way we can take another step forward in designing better environments in which young children can learn better and having a feeling of security.
- Designers can use colour to help make things stand out from their surroundings and easier to find. Using different forms, colour and materials can help to create a better harmony in the environment (Ware, 2008).

- Designers should work to produce innovations in colour and use colours in ways that are marketable (Holtzschue, 2006). However, fashion is not a good influence for children's design, despite the fact that many designers use fashionable colours to attract the parents' attention (given that parents are the ones who tend to make the decisions for this age group).
- Colour can support developmental processes. Being sensitive to each age group's different responses to colour is a key to creating an environment appropriate to their educational requirements. Knowledge about even the basic elements of colour and child development can be used to increase productivity in children (see e.g. Engelbrecht, 2003). It also can help to create a better harmony and balance in children's environments.
- Designers can create environments catered to a child's needs. However, care must be taken not to under- or over-stimulate, and attention must be paid to how colours are chosen and their effects (Mahnke, 1996). For example, if a strong red is desired in one place, it should be used either sparingly or in a space where users will stay for only a short amount of time.
- Colour is merely light but a form of light that is experienced so strongly that it is often seen as a physical entity. Therefore, having a basic knowledge about light can help designers to make better colour and light choices and create better harmony in an environment.

Generally-speaking, therefore, a functional colour scheme should be one that supports a structure's intended purpose and create positive emotional and

physiological effects, while at the same time avoiding over- and under-stimulation (Engelbrecht, 2003). Having the ability and skills to create the environment with these three goals in mind are necessary to be able to successfully design using colour.

Limitations of this study

There were some limitations for this study. The most significant one was not having access to some of the best resources in colour design. This was because much of the colour research is in German, which makes it difficult to access to a non-German speaker such as myself. Another limitation was the limited scope of the interviews and the demographics of the participants. All of the people interviewed were in the Canadian provinces of Ontario and Quebec, and almost all of the survey participants were from North America. This makes the results of the study heavily based on a North American perspective.

For the purpose of this study, there was a focus on qualitative analysis and in some places quantitative analysis was combined with qualitative analysis. However, after finishing this research, it seemed better to compare data from insights into the quantitative data instead of just focusing on the qualitative analysis. This would provide the opportunity to get better results.

Further implementation

Based on the results of this study, the following recommendations can be offered for further study.

While there are a number of studies about children and colour, little research has been done on the symbolic and cultural significance of colour in a children's environment and from cross-cultural perspectives. Yet all of the most authoritative sources agree that this aspect of colour is crucially important. Future researchers should consider if or how the same principles of environmental design for children and colour can apply to all cultures and children from different socio-economic backgrounds. This is especially true here in Canada, a multicultural society.

Another issue is the marketing aspects of colour. Colour is so important that each year thousands of colour gurus attend at different design conferences in different places to determine what the colour fashions of that year will be. This indicates that the marketing of colour is very important, even for children who are still not as tainted with or influenced by fashion and marketing trends. As mentioned before, there are different perspectives on this issue. Some designers get help from parents and educators while others believe that the best sources of information are children directly. Creating a balance between children's needs and parent's needs for their children is the best solution. In this way designers can learn about children by both spending time with them to better determine what their needs are, at the same time as asking useful indirect questions from their parents and educators. This issue requires further investigation from different perspectives in order to create some sort of balance between the two, something that would help a lot of designers.

Another topic that needs further study is the issue of form versus colour.

“Man responds to form with his intellect and to colour with his emotion; he can be said to survive by form and to live by colour” (Sharpe, 1974, p 123). This statement shows the importance of both colour and form and how they work together. There should be further investigation to see which one works better and which is more eye-catching in particular contexts in both adult and children's environments. The results obtained from this study suggest that colour is more eye-catching; however, this study investigated only a small number of people and environmental contexts. Further and more in-depth investigation is needed for better results.

The interviews and surveys conducted in this study indicate that most designers learned about the use of colours from their own experiences. Most of the colour courses in college and university are form and colour courses where the focus tends to be more on form rather than colour. Hence, most designers are experts in form rather than colour. This issue merits further investigation in order to assist in the creation of a better colour curriculum in the design departments at universities in order for designers to learn about some of the more basic elements and factors in colour design.

A significant observation pertaining to research on children's environments and colour is that there are not a lot of studies in this field; the few that do exist focus largely on school environments. That means that any kind of study on colour and children's play environments can be useful for the design of learning environments for young children.

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Glossary

Additive mixture: Colour that is seen as a result of light only.

Full-spectrum lighting: Polarized lighting which combines full-spectrum fluorescent lamps with polarized diffusers to provide lighting characteristics of natural daylight.

Harmony: The pleasurable and combined effect of two or more colours.

Hue: The name of a colour: red, orange, yellow, green, blue, or violet.

Palette: A group of colours used by an artist or designer, or in a specific design, group of designs or body of work.

Saturation: The degree of purity of a colour. A fully saturated colour can contain one or two of the primary colours but never the third.

Subtractive colour mixture: Colour seen due to the absorption of light.

Value: Relative light and dark, with high value samples being light, and low-value samples being dark.

Appendices

Appendix 1: Interview questionnaire

The objective of this study is to understand the role of designers in using colours in children's environments and to develop a set of guidelines in this regard to better enable children (aged 4-7) to learn while they play. I chose the 4-7 years age because they still can't read and they are very visual. And Colour is the most important visual tool. And the most important thing is they learn through play. Now my question for my thesis is:

Do designers utilize published research about the impact of color in their design when designing a children's play environment?

- If yes, how so? How can this use be improved?
- If no, why not? How can they be made aware of this research?

Interview Questions:

1. Overview Questions:

1- Designer Name _____

2- Gender M / F

3- What is your design specialty?

4- What is your educational background?

2. General Questions:

5- As a designer for children, are you familiar with the psychology of child development? Which theories? Or which person? Which one do you think helped you more: the things that you learned from the school or what you learned based on your need for your projects?

6- Do you think color facilitates children's learning (Do you consider color to be an educational theme facilitator? If yes how? If no why not?)

7- When children play a physical game, they learn motor senses such as balance and muscle strength through play. What things about color would enhance children's learning behavior through play?

8- Have you ever designed anything to help children learn something? In that situation did you consider any color preference?

9- Do you know at what age a child's recognition of colour is fully

developed?

10- Do you think that there is a difference between visual perception in children and adults? (Like form, colour)

3. Colour specification questions:

11- What are your thoughts about children's perceptions of colour? How do you apply them in your design? Can you give me an example?

12- As a designer for children's related environments, do you consider how children respond to light? How you use these two together?

13- In some books it is stated that "colour plays an important, but secondary, role in recognition"¹ and that the initial recognition is of form. What is your opinion on this? Which one is more eye-catching?

14- When you apply colour in an environment, what is the most important aspect to determine?

- Which one of the following is the most important to determine:

- a. The proposed use of the space
- b. The size of the space
- c. The orientation of the space
- d. The length of time the space will be occupied by various people and their activities during that time
- e. The existing colors surrounding the space under consideration
- f. The age of people using the space

15- Should we use colours differently when designing places for children or adults?

- a. If yes, how?
 - b. If no, why not?
-
-

16- What kind of issues influence whether you pick warm or cool colours in your designs? (For example selecting color not by the actual colours of the object like red whale because children like it), Do you have any kind experience in this case or any examples?

17- In some books, it is claimed that "colour study requires only six names for colours: red, orange, yellow, green, blue, and violet.". Do you agree with this statement? Are there any other colours that you think is important?

-do you have your own colour pallet? Do you use specific colour system?

18- Some research discuss that younger children like bright colours more than older children. I mean the different level of brightness that the different age groups feel towards colour? You may know these kind of effects. How do you apply this in your design?

3. Closing questions:

19- Which manufacturer's colours do you work with?

20- You learned something in your colour course in the university. How do you think that universities can improve their colour programs?

Which books did you read for this course? Was it more theoretical or practical course? Which one helped you to learn better your study at the university or your own study after the university? Which books did you study to learn more about colours?

21- Do you have any other comments?

Thank you for participating! Your time and effort is greatly appreciated.

Appendix 2: Interview consent form

I, _____, voluntarily agree to participate in a research project conducted by Naseem Khalili who is taking IDES 5202 in the Winter 2010 semester and is supervised by Wonjoon Chung, School of Industrial Design, Carleton University.

Purpose: The objective of this study is to understand the role of designers in using colours in children's environments and to develop guidelines in that regard to better enable children (aged 4-7) to learn a particular subject matter (e.g. game rules, social behaviours, etc.) while they play.

Tasks and duration: You are asked to take part in an interview to help the researcher understand how designers use colours in children's environments and how such use can be improved. The interview will take about 45 minutes of your time.

Right to withdraw: You may withdraw from participation at any time without prejudice and you may omit answering any specific interview question if you choose.

Potential of risk or discomfort: There are no known risks, physical or emotional, to participate in this study.

Anonymity/confidentiality: The data collected from this series of interviews will be stored and analysed collectively and used only for the stated research and purpose. The data will be accessible only to the researcher, her supervisor and the committee members of this research. The data will be destroyed after

analysis.

This project was reviewed and received ethics clearance by the Carleton University Research Ethics Committee. If you have any concerns regarding how this study was conducted please contact:

Professor Antonio Gualtieri (613-520-2517 or ethics@carleton.ca), Chair of Research Ethics Board.

If you have any questions for the researcher or if you want to be updated about the result of the research, please contact:

Naseem Khalili (613-878-6164 or nkhalili@connect.carleton.ca)

If you have any questions for the researcher's supervisor please contact: Wonjoon Chung (613-520-6606 or

wonjoon_chung@carleton.ca)

I have read the above description of this research project. I acknowledge that

I have received a personal copy of this form. I agree to participate in this

research voluntarily and I understand that I may withdraw at any time.

Researcher's Signature: _____

Date _____

Participant's Signature: _____

Date: _____

Appendix 3: Survey questionnaire

Survey for Designers

1. Overview Questions

The objective of this study is to understand the role of designers in using colour in children's environments and to develop a set of guidelines in this regard to better enable children (aged 4-7) to learn more while they play. (For the purposes of this survey, a children's interior environment is considered to be a space where children can play and learn, such as a children's museum, playrooms, etc.)

Please note that your responses are confidential and the copy of this survey will be destroyed once the data has been collated.

Your participation in this survey is greatly appreciated. Thank you!

1. Overview Questions:

Name:

Company:

City:

* 2. Professional Background

What is your
design
specialty?

What is your
educational
background?

2. Colour Specification Questions

Please rank the options to the following questions, with 1 being the most important

3. In your opinion, colour in children's environments can be used to:

	The most important: 1	2	3	4 : The least important
Increase their imagination	☐	☐	☐	☐
Improve understanding of the size and proximity of physical space	☐	☐	☐	☐
Improve recognition of different functions in the environment	☐	☐	☐	☐
Motivate and influence actions	☐	☐	☐	☐

Other (please specify)

Survey for Designers

4. When choosing a colour for a design application, which one of the following is the most important to determine?

	The most important: 1	2	3	4	5: The least important
The proposed use and length of time the space will be occupied by various people	☐	☐	☐	☐	☐
The size of the space	☐	☐	☐	☐	☐
The orientation of the space (e.g. facing north or south...)	☐	☐	☐	☐	☐
The existing colours surrounding the space under consideration	☐	☐	☐	☐	☐
The age of people using the space	☐	☐	☐	☐	☐
Other (please specify)					

5. When designing an indoor space (e.g. exhibition, indoor playground, playroom) for preschool children, do you take into consideration any colour preferences that can help children to learn specific subject matter?

- ☐ If yes, how?
- ☐ If no, why?

please explain your reasons here

*** 6. With what subject matter do you consider the use of colour to be important for children?**

Survey for Designers

7. Do you agree with this statement:

"A child's rejection or acceptance of certain colours is a reflection of their development into adulthood"

☐ Yes

☐ No

please explain your reasons here

*** 8. In your opinion, what are some differences in the use of colours when designing a space for children versus adults?**

9. Do you know of any study or research about the impact of colour on a child's learning behaviour?

☐ Yes

☐ No

If your answer is yes, can you briefly describe what it is?

If your answer is yes for question 7, please answer question 8. Otherwise go to page3.

10. Do you apply the ideas from that research on your colour selection in designing children's environments?

☐ Yes

☐ No

If your answer is yes, how does it effect your colour selection?

3. Closing Questions

Survey for Designers

11. In your opinion, which is more eye-catching: colour or form for children?

- ☐ Colour
☐ Form
☐ It depends

please explain your reasons here

12. Which manufacturer's colours or colour system do you work with?

- ☐ Benjamin Moore
☐ Pantone
☐ Behr
☐ Sico
☐ CIL

Other (please specify)

13. Do you have any other comments on how you think the use of colour can be improved in preschool children's environments?

Appendix 4: Summary of “Seven Myths about Lighting and Colour in Educational Architecture” (Fielding, 2006)

Myth # 1: *Uniform brightness level.*

“Many educational ‘specs’ and building codes call for a uniform brightness of 55-foot candles in academic spaces. However for holistic thinkers in 21 century, it is a concept that has passed its time.”

Myth # 2: *Primary colours are best for children.*

Research shows that “children are wonderfully sensitive and responsive to nuances in both lighting and colour. For example, children are particularly attuned to the colours of nature and human skin tones, and yet these are completely out of the primary range.”

Myth # 3: *Red incites aggression, green is calming.*

If designers use colours carefully all can be helpful to different learner age groups. “A good application depends on the cultural and climactic context, available resources and lighting... Utilizing more saturated accent colours in selected areas is more important for providing a varied, stimulating learning environment.”

Myth # 4: *Neutral colours are ideal for learning environments.*

“This is the same reasoning that was used in the 1960s and 70s to justify the proliferation of sterile glass, steel and aluminium boxes in cities around the world... This strategy of neutral design backfired and resulted in a period of architectural history often considered soulless. There is rarely a good reason to

take a neutral approach with educational architecture.”

Myth # 5: *It's best to use all the same lamp.*

This can be true for managing and maintaining the environment but has nothing to do with how children learn. “Businesses can’t compete using this kind of approach—if businesses don’t respond to what consumers want, competitors will win the business. Learning organizations are becoming more like businesses; the successful ones are focusing on the educational consumer, not on their own convenience. Stock a variety of lamp types, and prioritize the needs of the learner.”

Myth # 6: *It's best not to use natural light in gymnasiums.*

It is often assumed that natural light is difficult to control, but natural light is perhaps the single-most important element in the learning environment.

Eliminating natural light in gymnasiums because it’s difficult to control glare is a lazy approach to design. Using north light, filtered light, and adjustable lighting control devices are just a few ways to utilize natural light in a competitive athletic environment.

Myth # 7: *Performance spaces should not have any windows.*

“This myth is based on the assumption that it’s important to control the lighting...After hundreds of hours with drama, dance and music performers, my experience is that performers would prefer spaces that more closely resemble artists’ lofts with lots of light and views of the city, landscape, or campus green” (Fielding, 2006).