EXPLORING CLASSROOM DESIGN FOR AUTISTIC CHILDREN

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Abstract

This research study attempts at identifying how classrooms should be designed and built to limit noise within the learning environment for autistic children. The purpose of this study is to uncover a connection between how noise within a school's classroom affects the behavior of autistic children. As the number of individuals with autism continues to grow, it is important to understand their background and traits in order for an attempt to be made that allows for interior designers to create interior environments that limit distractions and allow for focus, growth, and safety. This research studies how parents of autistic children observe the way their children interact and behave with various interior elements such as lighting, color pallet, and finish selections within any built environment. This study also gathered information on the perspective of teachers and teaching staff on behavior changes they observed their autistic students participating in while solely in the school setting caused by various noises within learning environment. The research gathered in this study is an attempt to better understand how classrooms should be designed in order to be more inclusive for the autistic community.

Dedication

This work is dedicated to my Grandpa Cable and my cousin, Benjamin. These two men have taught me so many things about life, learning and discovery. I am forever grateful for the opportunity they gave me to open up my mind to think beyond myself and to do good for others.

Chapter 1: Introduction and Literature Review

Introduction:

Autism spectrum disorder (ASD) or autism is a disorder that alters the development of an individual which can cause substantial behavioral, social, and communication challenges. Autism is a cognitive disorder which often inhibits how individuals with autism interact, behave, communicate, and learn. No two ASD individuals are identical and there is a wide range on the autism spectrum will depend on how independent or more challenged the individual is (CDC, 2020). Improvements of diagnostic data used to identify those with autism spectrum disorder (ASD) have significantly changed in many aspects to enrich their quality of life. However, one area that is significantly lacking to ensure this higher quality of life is the interior environments in which they are interacting within. Whether it is in the home, an education establishment, or recreational facility, it has been noticed that there is a need for further development and change the way interior spaces are built to better serve the needs for the ASD community. Unfortunately, most interior spaces are not currently designed to accommodate the needs of the autistic community. Research supports that there is a need for interior designers to create more inclusive environments that will satisfy the needs of those with autism in order to function more efficiently within society.

Interiors need to change in order to enhance the experience autistic individuals have within built environments. In order to ensure that certain aspects are taken into account while designing for those with autism, one needs to have an understanding of how individuals with the disorder tend to react to certain common interior design elements. It should also be understood how certain design changes or disruptions within an interior environment can cause either a positive or negative transformation in behavior for an autistic individual.

Behavior is defined as “the way in which someone conducts oneself or behaves” (Merriam-Webster, n.d.). Furthermore, behavioral outcomes are obvious behaviors that are provided to us as observables and therefore can be seen directly (Lourenco, 2021). If we continue to educate ourselves on the different needs of these individuals, we can then create spaces that are not only more pleasant to be in for the users but also allow for a better quality of life. If done with care and consideration, these spaces could potentially help with a more positive development for autistic children.

Individuals with special needs require certain care and consideration while designing spaces. This theory should be considered regardless of whether an individual has a physical or neurological disability and should be practiced when it comes to designing for those who have autism spectrum disorder. Autism is a developmental disability which continues to have a growing amount of children diagnosed with the disorder each year. According to the CDC, currently 1 out of 44 children in the United States are diagnosed with autism spectrum disorder where the numbers were 1 out of 54 children diagnosed in 2016 (Autism Speaks, 2021). Although a child may be diagnosed with autism, the disorder has a spectrum of different impairments and limitations which should be considered for each individual child. For example, some children may develop the ability to communicate verbally while others may be nonverbal their whole life. Information is processed neurologically differently for an autistic child and when the child is overwhelmed, can lead to outbursts of behavior and repetitive movements such as flapping hands and rocking. Autistic children perceive their environments differently and often have heightened sensory sensitivity, meaning that their needs and overall wellbeing should be considered in all aspects of a design.

When it comes to designing learning environments, such as classrooms, much care should be considered and the design should reflect the needs for children. A classroom is a place for a child to grow, learn, and make friendships. As mentioned previously, autistic children tend to have heightened sensory sensitivity, especially to noise, which is defined as any sound that is undesired or the inhibits one's hearing of something (Merriam-Webster, n.d.). Unwanted noise within an environment can cause autistic children to recede and not excel which is why research needs to be conducted in order to further understand the phenomenon.

When a child is unable to concentrate and focus on tasks due to their environment, the result can be life altering in ways such as lack of advancement academically, isolation, and behavioral outbursts. Academic growth is essential as it refers to the academic progress that is made over a period of time and can be measured from the beginning to the end of a defined period (Education Reform, 2013). Not only are autistic children unable to block out unwanted noises but they also tend to fixate on sounds such as ventilation systems or people talking in another room. Such distractions interfere with their everyday life and can hinder their social experiences with other individuals. According to the APA Dictionary of Psychology, social interaction is:

> Any process that involves reciprocal stimulation or response between two or more individuals. These can range from the first encounters between parent and offspring to complex interactions with multiple individuals in adult life. Social interaction includes the development of cooperation and competition, the influence of status and social roles, and the dynamics of group behavior, leadership, and conformity. Persistent social interaction between specific individuals leads to the formation of social relationships.

> It is only through close observation of social interaction that social organization and social structure can be inferred (American Psychological Association, n.d.).

Interior designers need to start seriously considering the autistic community within the classroom as their individual growth and safety can be at risk with the way these environments are currently being built. Safety is “the condition of being safe from undergoing or causing hurt, injury, or loss” (Merriam-Webster, n.d.). Unfortunately, today most autistic children tend to cope with their surroundings and can be observed participating in behavior that involves covering their ears, flapping their hands, or humming to themselves when they are over stimulated. Meltdowns and other outbursts of behavior can also be caused from the inability to block out noise which can cause autistic children to seek out “safe spaces”. “Safe spaces” can be defined as “places or environments in which a person or category of people can feel confident that they will not be exposed to discrimination, criticism, harassment or any other emotional or physical harm” (Oxford Dictionary, n.d). In order for autistic children to excel, noise within the classroom setting needs to be acoustically controlled in an attempt to enhance their overall wellbeing.

Literature Review:

Definition of autism:

Autism spectrum disorder (ASD) is a neurodevelopment disorder which lasts the lifetime of the individual diagnosed. Adjorlu, Hoeg, and Mangano (2017) explain common characteristics to be severe impairment in behavioral, communicative, and social skills. According to Diagnostic and Statistical Manual of Mental Disorders (DSM-5), autism spectrum disorder can be characterized into three levels of severity:

The third level is the most severe, requiring very substantial support in daily living skills (DLS) due to serious deficits in verbal and nonverbal communications skills. The higher functioning individuals placed in the first and least severe level of the DSM-5 are capable of verbal communication but still require support due to difficulties processing sensory input and understanding social cues (Adjorlu, Hoeg, Mangano, 2017).

Multiple studies (Paul, Chawarska, Cicchetti, & Volkmar, 2008; Wetherby, Watt, Morgan, & Shumway, 2007) have developed a description of common communication characters that autistic children have been observed taking part in during the ages of two and three (this is the typical age that a child is diagnosed with autism). Chawarska and Volkmar (2005) took the findings of these studies and summarized them into the following characteristics:

- Abnormal gaze patterns;
- Limited social referencing and sharing of affect;
- Low frequency of joint attention, showing or commenting;
- Inconsistent response to name;
- Low frequency of nonverbal communication;
- Failure to respond to or use convention gestures;
- Limited pretend play;
- Limited motor or vocal imitation;
- Limited interest in people and interactive games;

- Delayed onset and development of spoken language;
- Unusual vocalizations (Schoen, Paul, Chawarska, 2011)

Autistic children tend to resist environmental changes and can have a difficult time adjusting to alterations in their daily routines. Furthermore, when they are exposed to certain sensory input, autistic children tend to behave with abnormal responses. Up to 70% of individuals with autism also have at least one psychiatric comorbidity; these include intellectual disabilities, mood and anxiety disorders, and ADHD (Schafer et al., 2012).

Noise:

Noise can be defined as “the unpleasant sounds which distract the human being physically and physiologically and cause environmental pollution by destroying environmental properties”. When a noise is increased and elevated in an individual’s environment a negative impact on their psychological and physiological health can occur (Kanakri et al.,2017). Excessive noise can interrupt task performances and can cause one to have a startled response, muscle tension, freeze in place, and increase the risk of displaying aggressive behavior. Additionally, noise can increase blood pressure, accelerate a heartbeat, prompt muscle reflexes and cause sleep disturbances (Kanakri et al.,2017).

Sound within an interior space can be at times overwhelming. Interior spaces should have adequate acoustical buffers and noise control that take into consideration what the space is used for in terms of users of the space and the activities that take place within it. The process of measuring sound is important in all spaces whether the space is a restaurant, mall, church, school, or residence. Noise should be present but not overwhelming for all users of the space. Sound travels in waves and solid building materials such as glass windows, stud walls, and concrete floors will have vibrations take place at a variety of frequencies. What is heard during this vibration process is a fluctuation of air pressure produced by surfaces that are vibrating (Tetlow, 2013). A decibel is commonly used to quantify acoustics sound levels that are relative to a 0 dB which is the average human's typical threshold of perception. Hertz (Hz) is used to measure sound frequency and cycles per second. The frequency in which the pressure is fluctuating will determine the pitch. Most sounds consist of a combination of many frequencies (Tetlow, 2013).

Noise criteria (NC) are curves which identify desirable background sound levels. Higher frequencies are heard louder than lower frequencies of the same dB level; NC curves allow higher dB levels at lower frequencies. Noise criteria is also used to rate the indoor noise for various interior spaces. This single numerical index is commonly used as a tool to define design goals to determine the maximum allowable background noise in a given space. This numerical index is primarily applied to noise that is produced by ventilation systems but can also be applied to other noise sources. Noise criteria is displayed by using multiple curves which define the maximum allowable "octave-band sound pressure level corresponding to a chosen NC design goal" (Tetlow, 2013). For example, a private bedroom should have a lower NC rating than a hotel lobby.

Sound absorption should be considered in material selection while designing spaces and knowledge of what the space will be used for should able be considered. Materials such as carpet and curtains absorb sound while hard surfaces such as wood and glass will reflect sound. When applied properly, "absorptive materials will improve speech intelligibility and the clarity of music". Noise reduction coefficient (NRC) is a single number which measures the amount of sound energy that is absorbed when a particular surface is struck. NRC is commonly used to rate acoustical ceiling tiles and walls panels but can also be used to rate floor coverings and other construction materials (Tetlow, 2013).

Auditory processing and autism:

Studies have shown that there are brain processing differences when comparing an individual with autism with an individual who does not have autism; it is common for the auditory perceptual capacity to be increased in autistic individuals (Fairnie & Remington, 2017). Additionally, studies have also shown that there is less activation of the temporal lobe processing network when it comes to autistic individuals (Boddart, et al. 2004). Such results suggest there is a dysfunction in certain perceptions of sound and integrating complex sounds when it comes to individuals who have autism. With this increased auditory perception, autistic individuals tend to show superior pitch perception and better identification of, and memory for, musical notes (Heaton, Hermelin, & Pring, 1998). Akin to the findings in the visual domain, there also seems to be local-processing bias with auditory stimuli (Fairnie & Remington, 2017).

It has been suggested that both the strengths and difficulties seen with respect to auditory processing in autism might be sub served by increased perceptual capacity. For example, being able to process more auditory information at any given time could offer and advantage on auditory detection tasks, but also lead to an overwhelming level of arousal (Fairnie & Remington, 2017). Without having the ability to filter out unwanted noise on their own, individuals with autism are left distracted by uncontrolled sound within their environments making it often difficult for them to preform even simple tasks and interact with others. However, it has been suggested that the way an interior spaces have been built and designed can either help or hurt individuals with autism. As the primary source and controller of the majority of sensory inputs, the built environment can potentially play a tremendous role in exacerbating or alleviating the challenges faced by those along the spectrum of autism (Mostafa, 2018).

When the research team from the Helen Hamlyn Centre for Design began to look at the design of domestic environments for autistic adults, it was clear that many of the usual design, research, and investigation techniques were not going to be of assistance. This is because some of the characteristics associated with autism spectrum disorder make it difficult for a design researcher to conduct inquisitional type research. For example, some of the people that Kingwood support have learning disabilities with limited verbal communication, making it difficult to ask what they liked or did not like about their current living environment. An important part of the normal design process is prototyping and testing concepts to gauge how problems have been resolved and incorporated into a solution. Some people with autism spectrum disorder may have problems with situation projection making this difficult, i.e., producing pictures and plans of interior spaces and asking “do you like this?” is difficult as they may struggle to conceptualize and form a mental picture of an imagined three- dimensional space from a two-dimensional drawing (Lowe, Gaudion, McGinley & Kew, 2014).

The importance of this line of auditory research is further emphasized when considering the difficulties that seem to accompany these areas of ability. Autistic individuals often show hypersensitivity to certain sounds, leading to great distress in noisy environments (Gomes, Pedroso, & Wagner, 2008). Autism is associated with abnormal auditory behavior, including aversive reactions to everyday life sounds. In addition, autistic children are often initially misdiagnosed as deaf (4). An abnormal perception of speech-like sounds in childhood may account for inadequate behavioral response to sounds and thus for language impairment typical of autism (Boddaert, et al., 2004). Clinical observations and testimonies reveal the high levels of anxiety that can surround auditory processing (Grandin, 1995, 1997). Without having the ability to block out wanted noise, autistic individuals tend to partake in a variety of coping behaviors that range from grimacing and ear shielding to screaming (Attwood, 1998).

Sound sensitivity and behavior:

Autistic children have a heightened sensitivity when it comes to their senses-this can be observed best when it comes to sound and noise. Autism is “associated with abnormal auditory behavior, including aversive reactions to everyday life sounds”. In addition, autistic children are often initially misdiagnosed as deaf. An abnormal perception of speech-like sounds in childhood may account for inadequate behavioral response to sounds and thus for language impairments typical of autism (Boddaert et al., 2004).

Sensory processing plays a large role when it comes to observation and interpretation in the behavior of young autistic children. Parents and professionals alike are recognizing that if a child has poor sensory processing abilities it can affect their sensorimotor, cognitive and social development which can be observed in their performance of daily life activities (Dunn, 1997). Furthermore, the processing of auditory information is essential when it comes to functioning and learning. Autistic children often will take part in abnormal behaviors when auditory-based tasks are performed which is then amplified when background noises are also present. It is often observed that autistic children “distractibility or inability to function in noisy environments, unresponsiveness to discriminative auditory stimuli, and difficulty attending to auditory information”. Background noises cause autistic children to have a hard time with auditory filtering, which is the capability to hear speech stimuli, function, and complete tasks (Schafer et al., 2012).

Bromley, Hare, Davidson, and Emerson (2004) reported that hyper-reactivity in response to auditory stimuli affects 70% of autistic children. In order to help combat this heightened auditory response, some coping equipment solutions have been designed in order to protect autistic children from auditory stimuli that could be considered harmful. These coping equipment solutions can be noise-cancelling headphones, earplugs, and earmuffs (Ikuta et al., 2016). Although these devices are used to block unwanted sound out to allow autistic children to better focus on tasks, there is no evidence that they assist with the behavioral or emotional problems that autistic children tend to have (Ikuta et al., 2016).

School design:

It is estimated that approximately 60% of autistic children attend a mainstream school in developed countries (Department for Education and Skills 2006; Wing 2007). However, it is typical for these children to experience being misunderstood, bullied and often times alienated at school which may be caused by their social interaction with others and emotional and behavioral internal challenges (Zainal, 2016).

Creating an atmosphere that promotes the development of autistic children is critical in their learning environments. There are different design elements within the learning environment that can promote this. In order to enhance the development of autistic children in their learning environments two main considerations are to provide a space that is clean, well-ventilated and has enough room for activities to take place. There should be spaces that allow the children to participate in group activities as well as individual activities (Noiprawat & Sahachaisaeree, 2010). Noiprawat and Sahachaisaeree go on to say that “the room must not be disrupted by noises from the outside. More importantly, the area should not be open or accessed to passers-by or outsiders when they are doing activities in order to minimize the stimuli” (2010). Acoustics play a significant role in the functioning of autistic individuals and noise should be controlled within interior environments to better provide an environment which promotes learning and social growth. This criterion proposes that the acoustical environment be controlled to minimize background noise, echo and reverberation within spaces used by individuals with ASD (Mostafa, 2018).

The space should also be functional, the primary aim of the Kingwood Trust, a facility which cares for individuals who are non-verbal and autistic, is to provide environments for its residents where they can lead as full and rewarding a life as possible. Such environments will harness residents' strengths and special interests to enhance motivation and confidence. In particular, well-designed environments which achieve this aim will support:

- Independence: giving residents choice in how they live and with whom they share their home is empowering. Enabling them to do things by themselves increases self- esteem.

- Social interaction: providing a variety of spaces allows residents to engage in social activities on their own terms. Home environments which can be adjusted to the desired level of social engagement or privacy can result in increased social interaction.

- Access: allowing access to the whole building, especially outdoor spaces, creates a sense of ownership and freedom. Offering good access to the local community can provide residents with purposeful activity.

- Evolution: providing home environments that respond to the changing needs, interests and aspirations of residents can further their self-development (Lowe, Gaudion, McGinley & Kew, 2014).

The most cited challenges and related design strategies were organized into five categories (themes): social and communication, sensory, imagination and perception, safety, and behavior. The lack of sociability and the tendency to be alone were two common autism- related challenges mentioned by architects (Nagib & Williams, 2016).

Safety within the design should also be considered as autistic individuals often do not fear dangers the way they should. For example, elopement, that is, the tendency to escape from home, is one of the top autism-related challenges noted by architects. Design strategies to address this challenge range from using low-tech locks or deadbolts to sophisticated security systems. The lack of a sense of danger among those with autism is another concern for architects. The architects highlighted frequent requests by families for safety-related strategies (Nagib & Williams, 2016).

The overwhelming sensory input may trigger negative autism- related behaviors such as aggression and repetitive movements. Architects, therefore, recommended having a sensory-free room or sensory space in the house where the child can retreat to reduce sensory input and relax. They also pointed out the importance of having this quiet space in public buildings to create an autism-friendly community (Nagib & Williams, 2016).

This room (spatial choosing session in the dark room/photography space) was selected on a pre-visit to the school as an ideal ‘control’ location to insert a series of spaces. This was acoustically and visually quiet, in an undisturbed location, and it also had many variations of artificial lighting. A series of 4 environments were installed as options, which came in the form of pop up tents of varying size and shape. Additional options included a weighted blanket, a Pilates ball to sit and possibly rock on, and a static bean bag. Again, choices were always between two items, and the options offered were varied depending on the ability of the child. Once the optimum learning environment was established, a learning activity was undertaken, set on a light box (choice of 'on' or 'off') with options of colored Irlen overlays which can minimize or eliminate glare (Lawson, 1998). A light box was selected, as glowing with upward light has been identified as beneficial for some people with autism (Bogdashina, 2013) (Love, 2018).

Chapter 2: Methodology

Rationale for this study:

The purpose of this study is to provide more information on how certain noises affect autistic children while at school in the classroom environment. It is necessary to collect more data on how noise affects these children as they have an increased sensory sensitivity which makes it difficult for them to concentrate. Lack of concentration and overstimulation often leads to change in behavior such as outbursts, covering their ears, or participate in repetitive a movement which in turn often puts the child in a position where they are more isolated from peers and teachers. If researchers and designers can understand more on what triggers these coping mechanisms and outburst perhaps then they can create spaces that allow autistic children to feel more comfortable and safe within their environments and allow them the opportunity to thrive instead of just survive.

Purpose of this study:

The main purposes of this research are:

- To increase autism awareness as well as acknowledge the autism community when it comes to designing interior environments.
- To further understand noise within a classroom environment and how it affects autistic children.
- To understand how different finishes, furniture, mechanical, electrical, and plumbing features of an interior environment impact the behavior of autistic children.
- To make spaces more comfortable and safe for autistic children.

Hypothesis:

Hypothesis 1: There is a correlation between acoustics within an interior space and autistic children's behavior.

Hypothesis 2: There is a correlation between acoustics and social interaction and academic growth for autistic children.

Hypothesis 3: There is a correlation between finishes, furniture, mechanical, electrical, and plumbing on the behavior of autistic children.

Research question:

The research conducted in this study attempts to investigate existing classroom design conditions and how noise within these environments affect the behavior of autistic children. It seeks to make an attempt at answering the question on whether there is a relationship with how noise in the classroom environment can affect the social interaction and academic growth for autistic children. This study seeks to discern what are the common causes of noise within the classroom that tend to disrupt the concentration of the children; it also attempts to investigate which finish materials and furniture provide for better sound absorption. The research investigates the overall perspective of parents with autistic children and their observation on how their child generally will behave and interact within built environments. Additional data was collected from teachers and teaching staff regarding their observations on changes in behavior the autistic children will participate in due to noise within the classroom setting. This is an attempt to discover how classroom environments should be designed in order to make a positive contribution to the overall well-being of autistic children. Any risk factors that were uncovered during this research were noted and highlighted in order to avoid designing future interior environments that may not be as inclusive.

Methodology for Phase 1: Online Survey:

Purpose:

The first phase of this research study was an online survey given to parents who have children with autism spectrum disorder to complete on their own in their home environment. The survey was shared with potential participants through email, social media posts, and announced on a podcast. The email and social media posts provided a link with access to the survey while the podcast host posted the link to the survey on their website. The main objective of this survey was to get more information from parents on what behaviors they observe their children doing in built environments. The survey was given to parents of autistic children as some of the children are unable to communicate; observations from parents regarding their children within interior environments took place in order to gather more efficient data.

Participants:

The research set forth with the goal of obtaining 100 parents who have autistics children between the ages of 3-10 to participant in the survey. An age range was determined in order to eliminate a large age gap between the children. The ages 3-10 was selected due to the neurological stage of the brain in terms of learning and development.

Recruitment of participants:

An email with a letter that described the study was sent out to the participants. The letter discussed the study as well as the benefits that could be produced with the research preformed in order to help understand and give children with autism a better built environment. A link was provided for the participants to access the survey if they wished to participate in the study.

Instrument:

The Phase I Survey consisted of 25 questions which addressed how the use of finish materials, color selection, lighting, and layout of a space may contribute with the interaction and behavior children with autism spectrum disorder have in their general built environments. The purpose of this study is to gather more information on how autistic children view and interact within their built environments as well as make an attempt to identify and connect common behaviors autistic children are seen participating in due to their interior surroundings. Examples of questions asked in the survey are provided below:

- Do interiors that have efficient acoustic absorption noticeable with the behavior of your child?
- Are spaces with exterior windows that produce efficient natural light noticeable in your child's behavior within the environment?

A five-point Likert scale was used for the parent participants to rank the importance of contrast in the observed behavior they notice their child partake in within the interior environment. Final open-ended questions were provided for parent participants to further explain any additional behaviors that were observed but that were not addressed in the survey.

Procedure:

It was imperative to get the research announcement out to the appropriate group of potential participants. The researcher reached out to an employee at Boorman Counseling out of New Richmond, Wisconsin and asked if they would be interested in sharing the announcement.

The founder of Boorman Counseling approved the request and agreed to share the research announcement on their Facebook social media page and also announced the research on their podcast in November of 2019. Furthermore, the original contact at Boorman Counseling is also a member of the Autism Support Group of St. Croix Valley and they shared the research announcement on their Facebook and Instagram social media pages in November 2019.

The researcher shared the research announcement on a Facebook account in November of 2019 encouraging valid participants to participate in the research study as well as to share the announcement on their own social media pages. The researcher also reached out to family and friends that are parents to autistic children via email encouraging them to participate in the research study as well as share with other parents they know. Correspondence with parents took place throughout the month of November, 2019.

Methodology for Phase 2: Online Survey:

Purpose:

The first phase conducted in this study was the distribution of an online survey which was given to parents of autistic children. The second phase conducted in this study was to distribute an online survey for teachers and teaching staff of autistic children. The survey was created and accessed by a link through Quadrics software which was then shared with the potential participants via email. The main objective of this survey was to gain a better understanding on acoustics within the classroom environment and to attempt at identifying common behaviors that autistic children partake in due to their environment. The distributed survey can be found in Appendix C.

Participants:

The initial goal for this study was to collect a total of 250 survey responses back from teachers and teaching staff from across the county. It was important to collect a large number of responses as more survey responses provide a better quality of data for analysis.

Recruitment of participants:

A letter of consent which explained the research study was sent out to the participants through email. The letter explained the researcher's objectives, the eligibility of the participants, benefits, and risks of the study as well as the prerequisite for informed consent. A link to the survey was also included in the letter if the participants wished to give their consent and participate in the research. Data collection took place from March 10, 2020 to April 16, 2020. The distributed survey can be found in Appendix D.

Instrument:

The Phase 2 Survey consisted of 15 questions which sought out information regarding teaching experience with autistic children, grade and subject taught, as well as how acoustics within the classroom environment impact the behavior of autistic children. The purpose of this study was to attempt at identifying acoustic qualities within a built classroom environment and to identify the behaviors of autistic children which are associated with the acoustical contrasts. Examples of questions provided for this study are as follows:

- Are there aspects of the physical environment that you believe reduce the noise levels? If so, please explain. Examples may include: carpet, rugs, curtains, etc.

- What types of behaviors do you see children doing that indicate that they are impacted by noise?

- In addition to air conditioner sounds, echoes, sounds from children in the classroom, sounds from other classrooms, and traffic noise, are there other acoustical environmental conditions that you feel negatively affect children with autism? Please describe and include any examples.

Procedure:

The researcher started with a web search on potential autism community organizations and groups who could help assist with getting the research announcement to the correct candidates for the study. The search led to The Organization of Autism Research and an email inquiry was sent out to the organization requesting to share the research announcement on their social media pages. A response came back from an individual at the organization requesting further information on the study which ultimately resulted in the survey getting posted on The Organization for Autism Research's social media sites. In March of 2021, a post was sent by the organization that shared the research announcement on both their Facebook and Twitter accounts.

The web search also led to the University of Arizona's Division of Genetics and Developmental Pediatrics. The researcher sent an email through the general contact information with information on the research study. A response was sent by a representative at the University agreeing to share the research announcement on their Facebook page which was posted March, 2021. The researcher also reached out to their contact at The Autism Support Group of St. Croix Valley and the member of the group shared the research announcement on their Facebook and Instagram social media page March of 2021.

The researcher shared the research announcement on their Instagram and LinkedIn accounts March of 2021. In addition to the social media posts, the researcher preformed a web search of the largest school districts by state and sent email requests to teachers and teaching staff across the country encouraging staff members that work directly with autistic children to participate in the survey. This type of distribution allowed the research study to comprise a wide range of potential participants.

Chapter 3: Data Analysis and Results

Rationale for this study:

A quantitative research approach was implemented in this study in order to further investigate how noises within learning environments affect children with autism. (Apuke, 2017) describes the method of quantitative research as one that deals with quantifying and analysis variables in order to get results. Furthermore, it provides examination and utilizes numerical and statistical techniques that are specific to answering questions such as how, how much, who, what, how many, where, and when (Apuke, 2017).

A quantitative research method was selected because it allowed the researcher to obtain data without disrupting natural settings through the use of questionnaire surveys. Additionally, a quantitative research method allowed for data to be collected and organized in numerical form allowing the arrangement of the data to be displayed mathematically in an attempt to explain noise issues within the classroom. Information provided by the teaching staff based on the familiar environment of the child's classroom was needed in order to establish patterns and themes as they relate to behavior and sound during analysis to eliminate any additional variables that may have altered the results of the study. The voice of the children's parents was needed for this study to create validity and truth behind the results found. The knowledge obtained through this study aims to create a new way of thinking when it comes to designing learning environments for children with autism.

Phase 1: Analysis and Results.

Participant demographics:

In total, 47 respondents participated in Phase 1 of the study. The respondents were parents to children with autism spectrum disorder between the ages of 3-10. The respondents were provided with a link in order to access the survey titled “Designing for Children”.

Interior environments:

The purpose of this study is to further understand how autistic children can be affected by the design elements and features within the built environment. It was important to provide the most genuine responses which is why it was decided to distribute the surveys to the parents of autistic children and not the children themselves. During data analysis, it was discovered how important children’s safety is in interior settings. Question number 14 asks, “I consider the interior layout of a space when thinking of the safety of my child”, in which 53% of the parents responded that it is promoter while 31% responded that it was a detractor and 16% were indifferent (Figure 3.1).

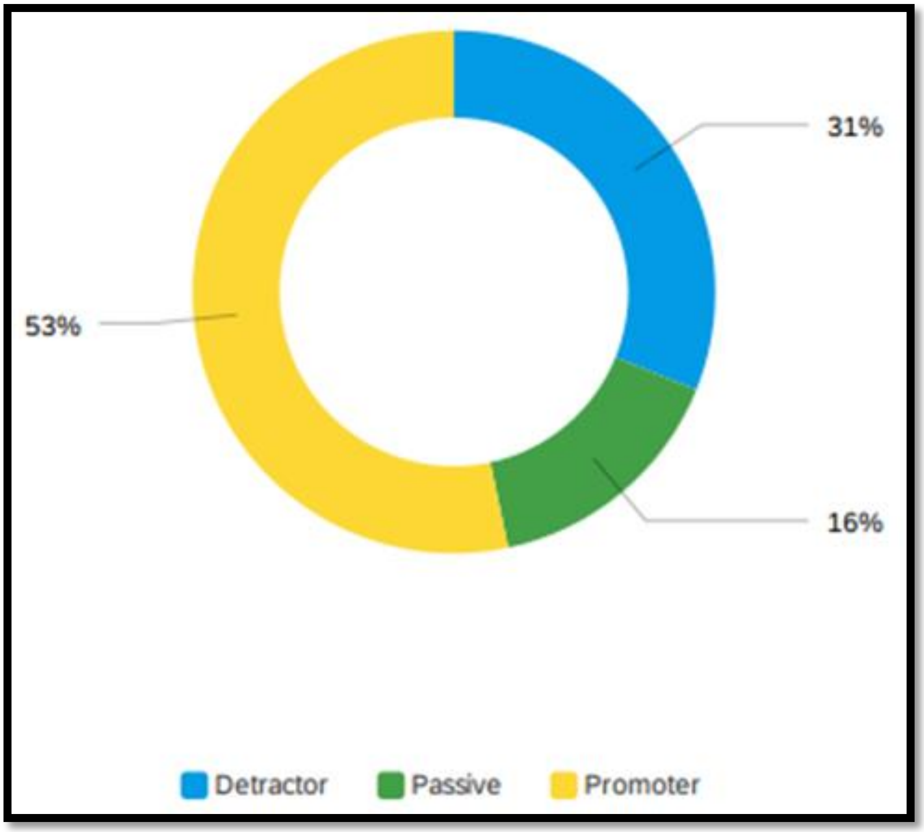

Figure 3.1 Parents Assessment on Consideration of Interior Layout of a Space When Considering the Safety of their Child

Built environments have various design elements within the space such as color pallet, layout of space, finish materials, and lighting which all have a contributing role in how individuals perceive interior spaces. Based on the data collected, colors and layout seem to not have as much as an impact on autistic children when compared to finish materials and lighting. Figure 3.2 asked the question if bright colors overstimulate or negatively affect their child while the question in Figure 3.3 asked if neutral color tones appeal to their child.

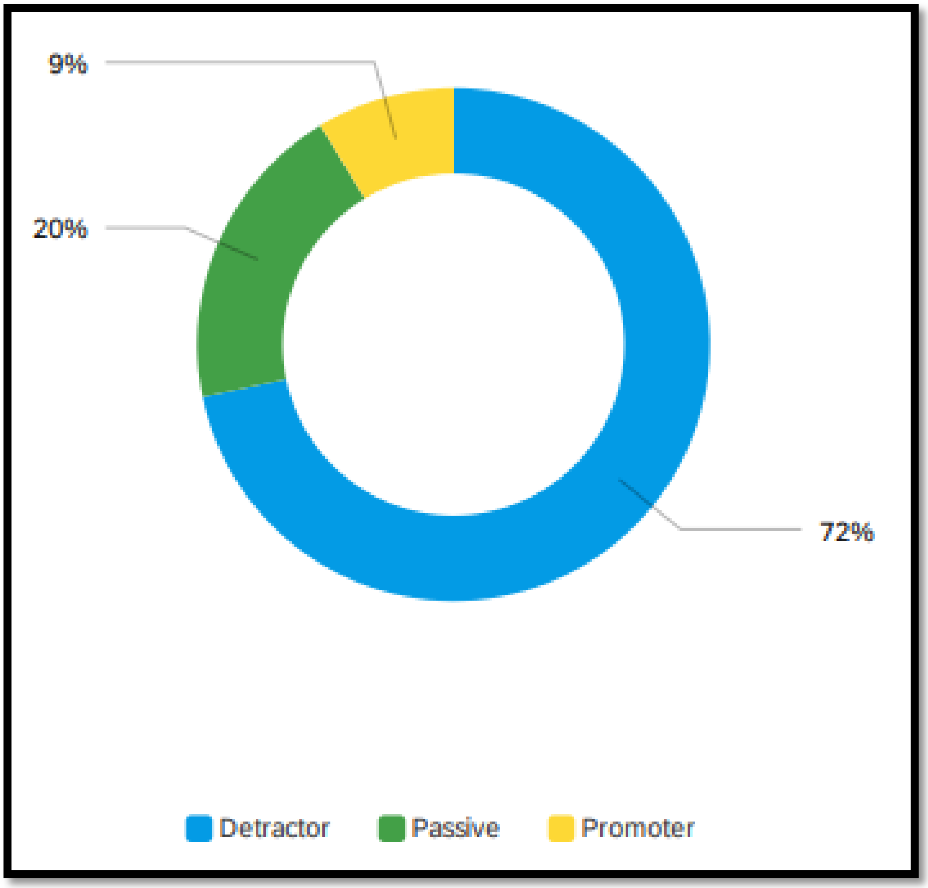

Figure 3.2 Parent's Assessment of Bright Colors Overstimulating or Negatively Affecting their Child

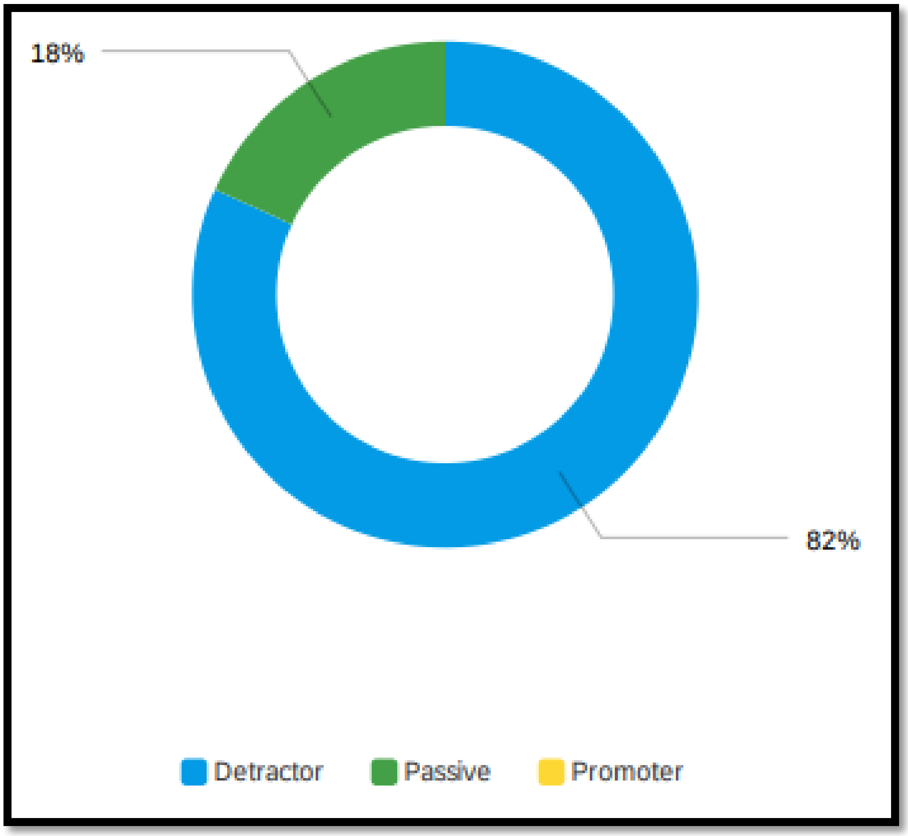

Figure 3.3 Parent's Assessment of the Appeal of Neutral Color Tone Colors on Their Children

This study also sought out to identify factors that may contribute to lack of concentration for the children in regards to their built environments. Question 19 asked the parents if an open space layout with minimal furniture is a benefit to my child's ability to focus and function in which 53% of the parents answered detractor, 20% promoter and 27% were indifferent (see Figure 3.4). Additionally, Figure 3.5 asked if certain patterns on flooring and furniture impact their child's ability to focus.

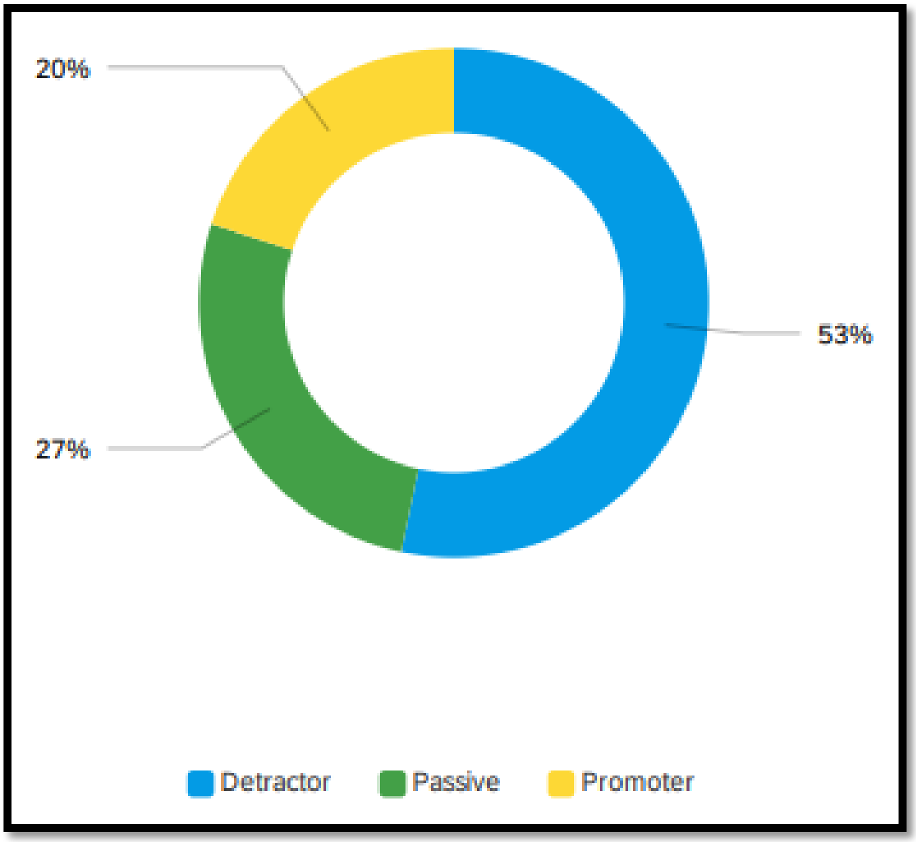

Figure 3.4 Parent's Assessment of the Benefit an Open Layout with Minimal Furniture has on Their Child's Ability to Focus and Function

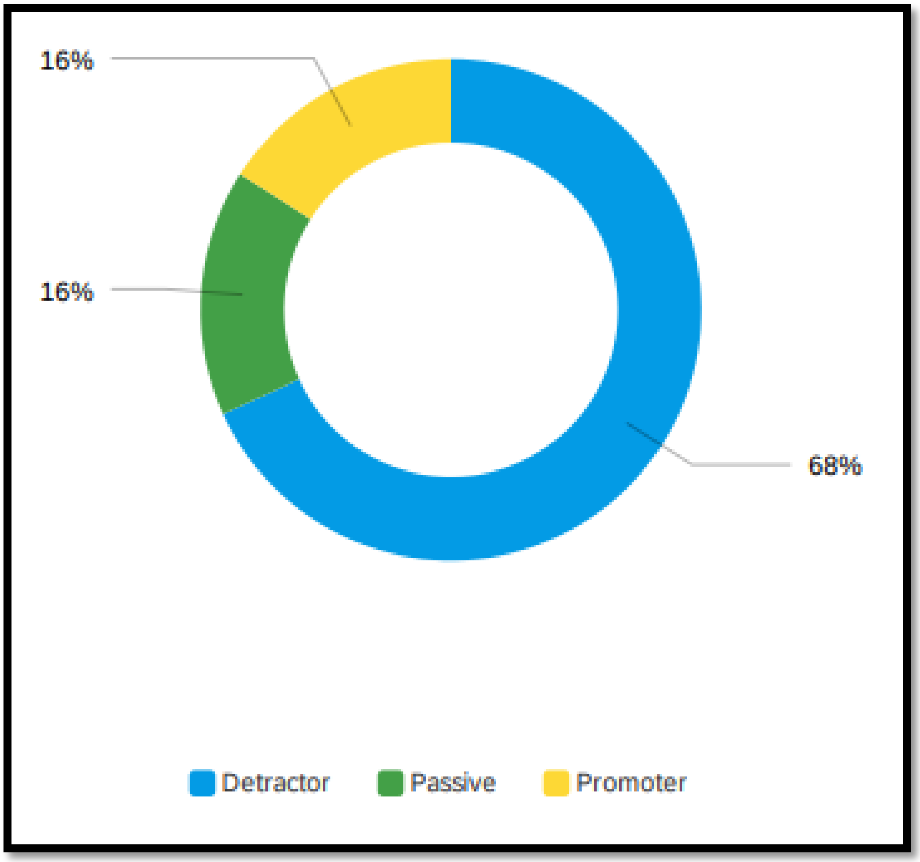

Figure 3.5 Parent's Assessment on Certain Patterns to Cause Child to Act Out

Questions on location and placement of interior spaces within the built environment where also asked. Figure 3.6, asked the question if the child prefers interior spaces that have exterior windows while Figure 3.7 results from asking if large windows with natural light is distracting to their child. Furthermore, the end of the survey allowed parents to further elaborate on information they found important to share. While one parent mentioned their child has "the best behavioral outcome" in a built environment that provides natural lighting another brought up the potential safety hazard of windows by stating "my son is drawn to windows because he wants to escape them".

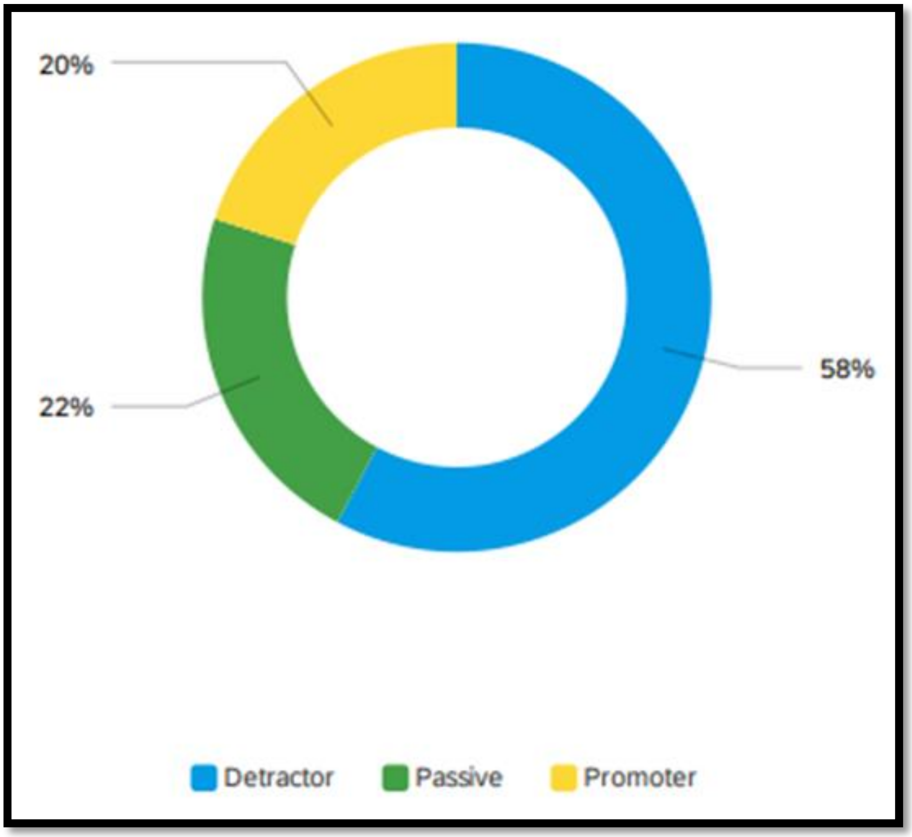

Figure 3.6 Parent's Assessment of Child's Preference for Interior Spaces with Exterior Windows

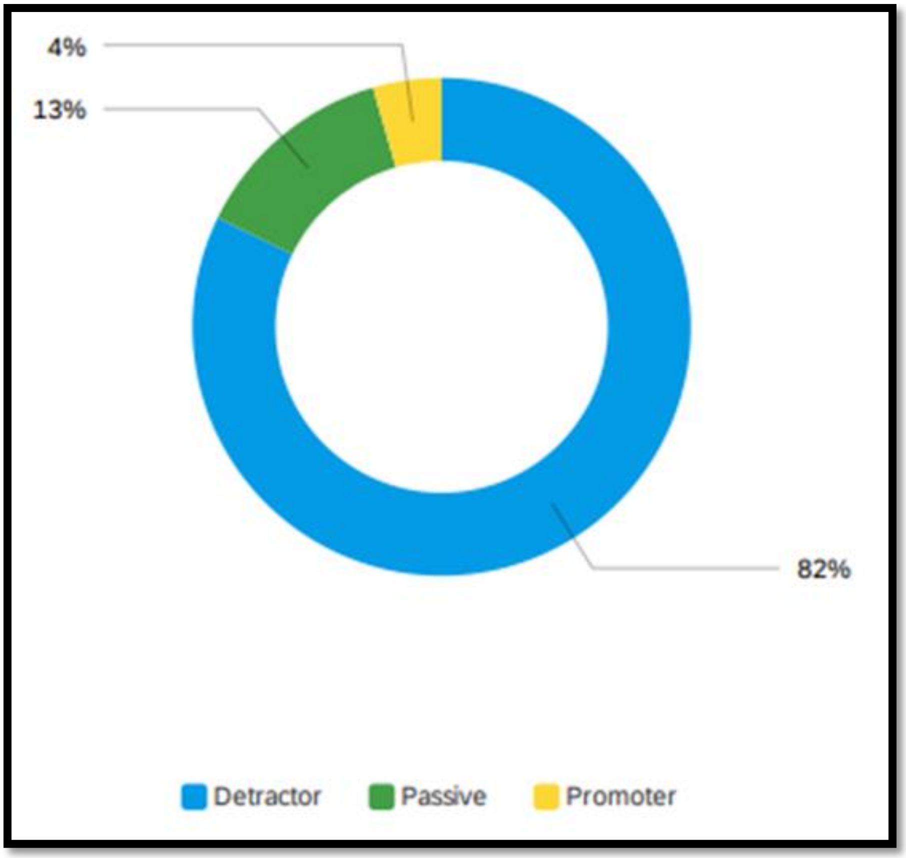

Figure 3.7 Parent's Assessment on Child's Distraction from Large Windows with Natural Light

The data displayed in Figure 3.8 asks the parents if they notice a significant behavioral difference with their child when they are in spaces that use fluorescent lights.

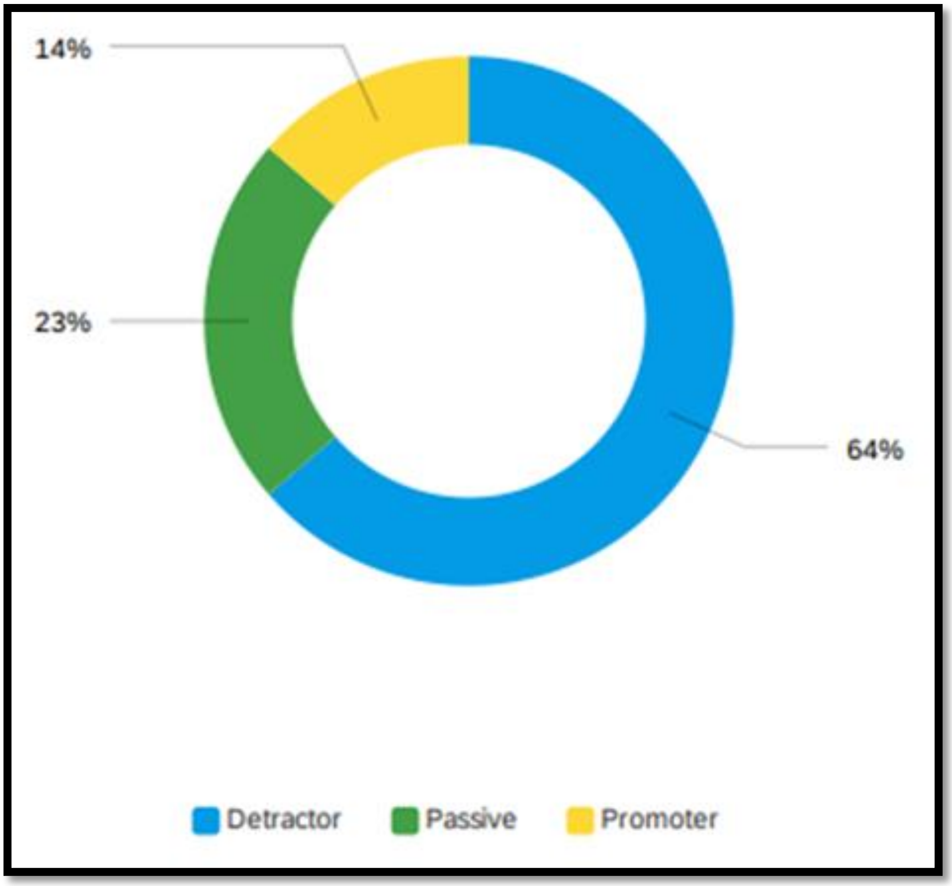

Figure 3.8 Parent's Assessment on a Significant Behavioral Difference with Child while in Spaces that use Fluorescent Light

Questions regarding different types of finish materials within a space were also asked. Figure 3.9 displays data that was collected from asking the question if their child prefers soft surfaces for flooring such as carpeting. It is interesting to keep such information in mind while comparing the data displayed in Figure 3.10 where it was asked if the child prefers a hard surface floor such as hardwood. The importance of having soft floor coverings in interior spaces that limit the child's injuries was mentioned by multiple parents in the written portion of the survey. Furthermore, one parent who has a child with severe autism wrote that their child will not walk on certain types of floors and will only go into the space if strapped into a stroller.

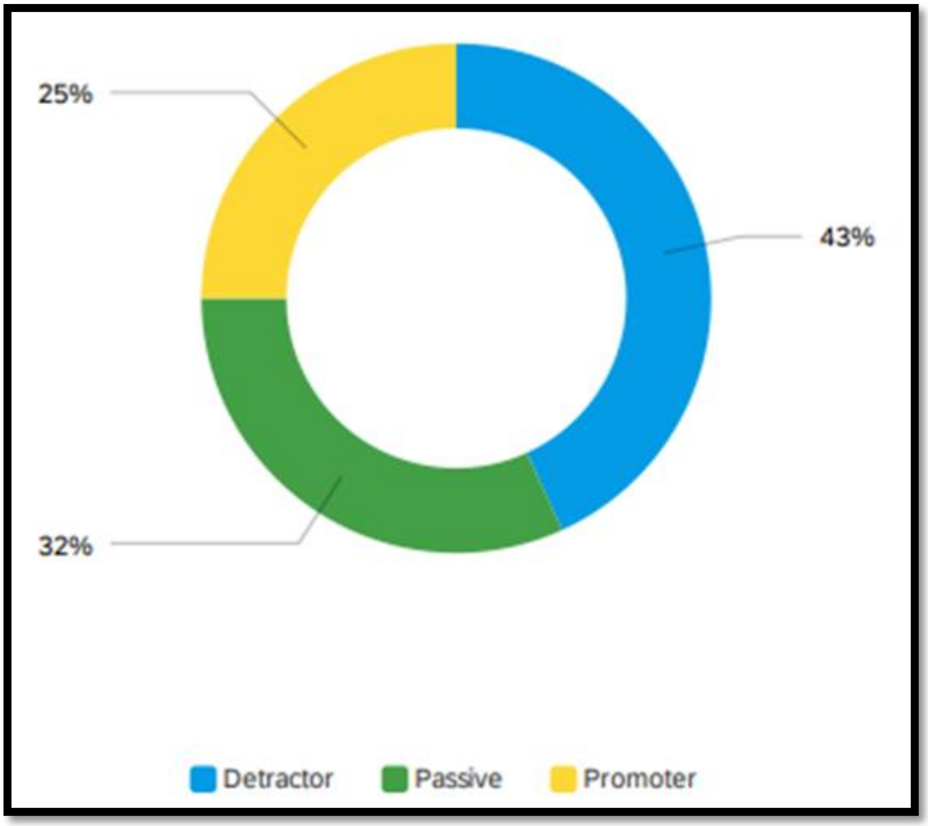

Figure 3.9 Parent's Assessment on Child's Preferences for Soft Flooring Surfaces such as Carpet

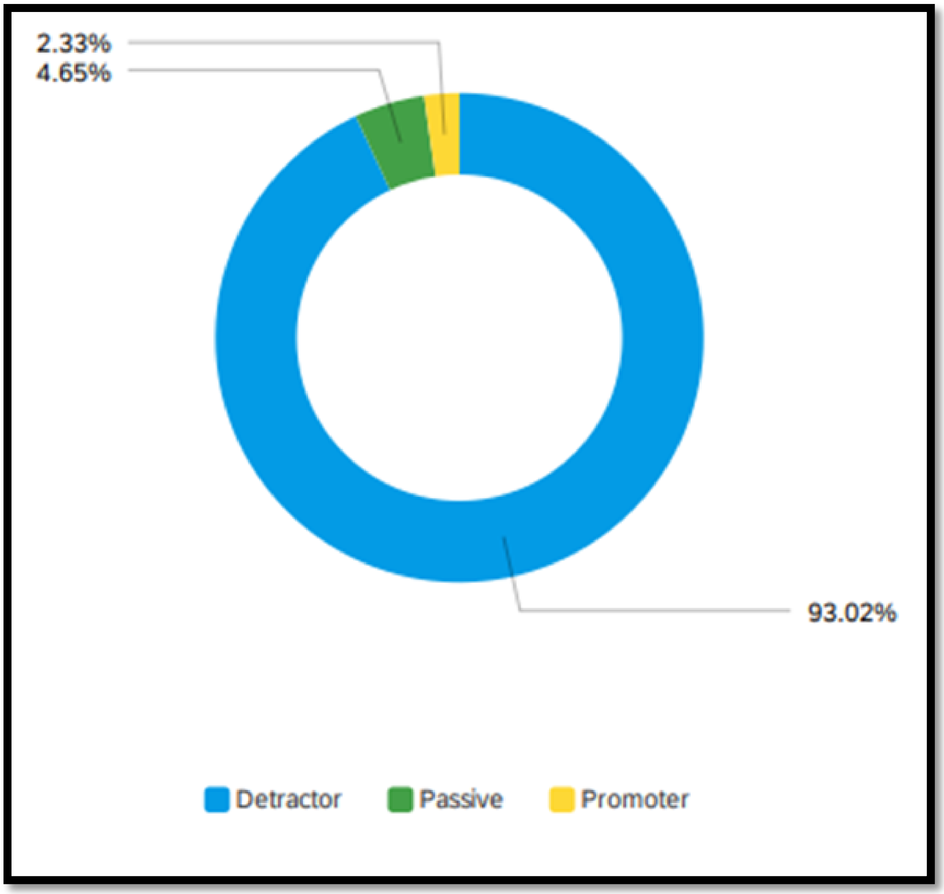

Figure 3.10 Parent's Assessment on Child's Preference for Hard Flooring Surfaces Such as Hardwood

Sound and behavior

The data collected suggests that sound within a built environment often causes the most disruption for children with autism. Question 18 from the parent's survey asked if background noise from other activities hinders their children's ability to focus, 59% responded with promoter, 13% responded with detractor and 28% were indifferent (reference Figure 3.11). Additional written information provided by a parent at the end of the survey stated that "the louder it is the harder it is to focus".

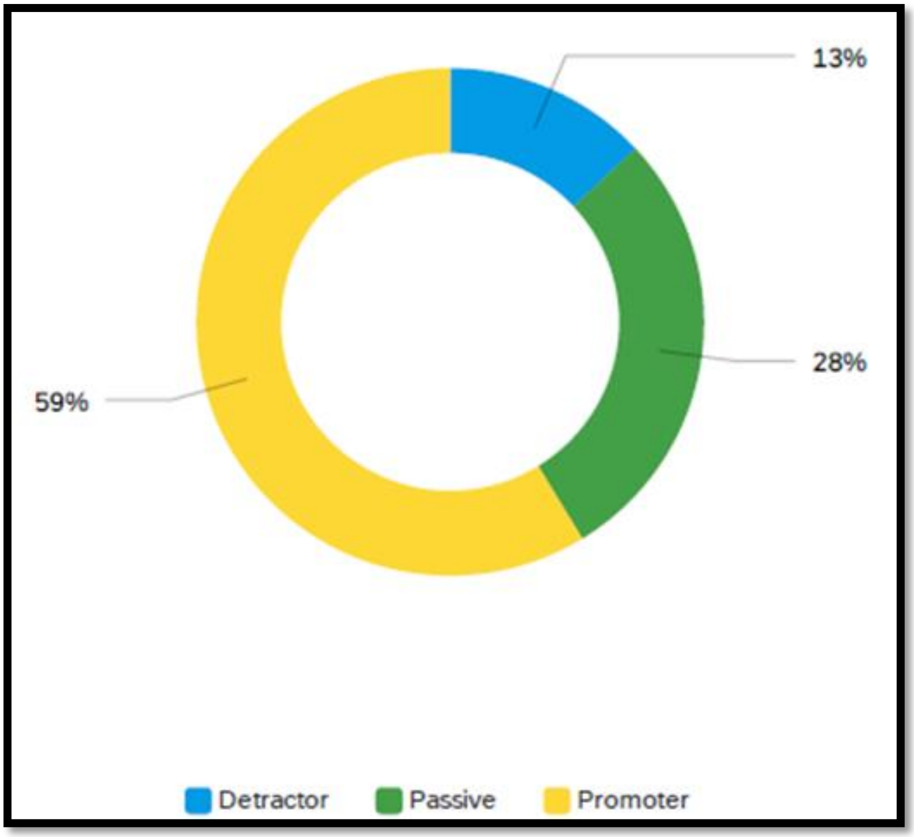

Figure 3.11 Parent's Assessment on Child's Ability to Focus with Background Noise from Other Activities is Present

Furthermore, parents were also asked questions that focused on noticeable changes of behavior in their children. Figure 3.12 displays data that reflects the question if excessive noise causes their child to act out.

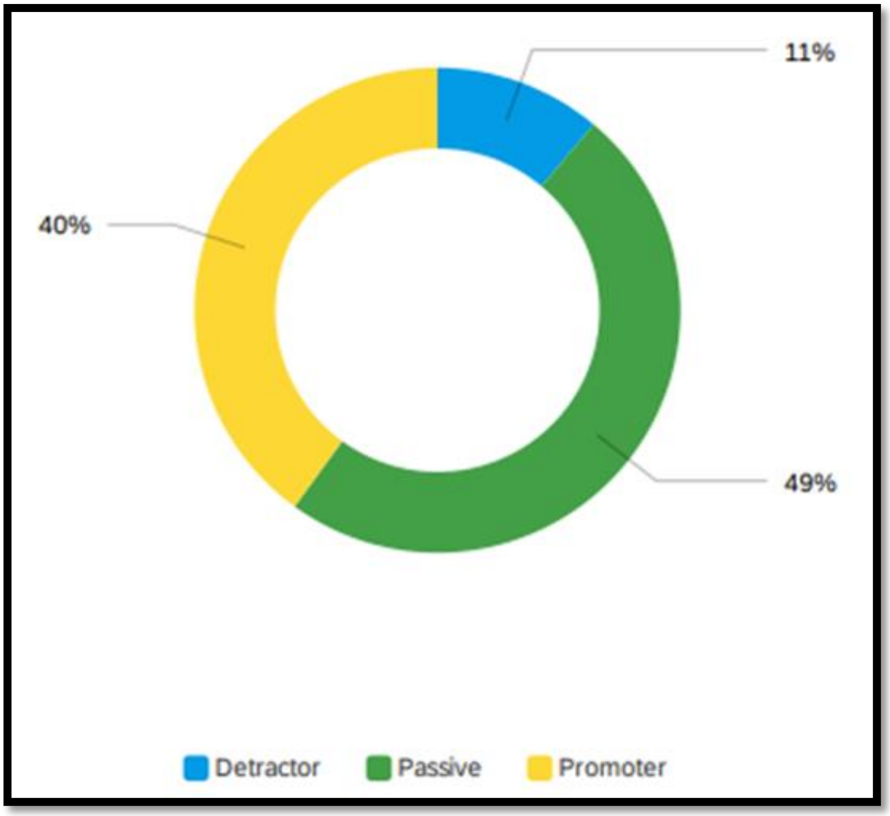

Figure 3.12 Parent's Assessment on Child's Act Out to be a Cause from Excessive Noise

The survey also addressed different types of buildings and their uses as well as considered crowd sizes. Question 21 asked the parents if their child enjoys engaging in large groups, 89 % of the participants responded detractor, 2% responded promoter and 9% were indifferent (reference Figure 3.13). Data displayed in Figure 3.14 shows results from question 20 which asked if there was a significant change of behavior that is noticed when their child is in loud spaces such as restaurants and malls. In the written portion of the survey, a total of 4 parents mentioned how too many people within a built environment will cause their child to have a behavioral change. One of the parents explained the change in behavior their child experiences is "amplified anxiety, anger and sense of discomfort".

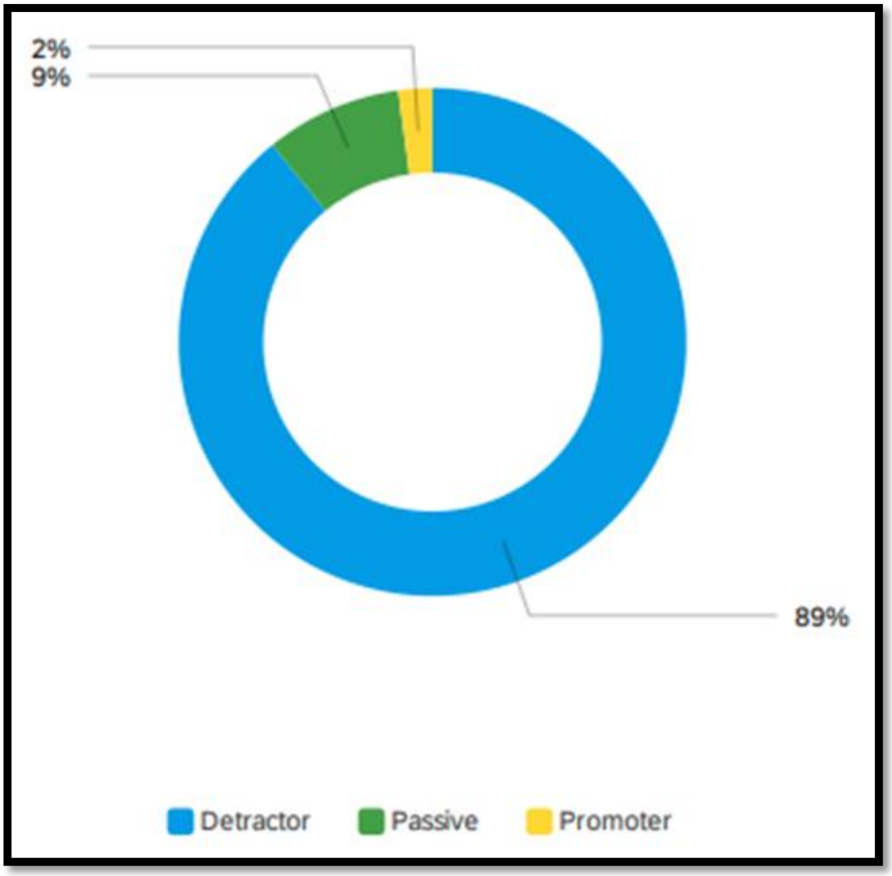

Figure 3.13 Parent’s Assessment on Child’s Enjoyment to Engage in Large Groups

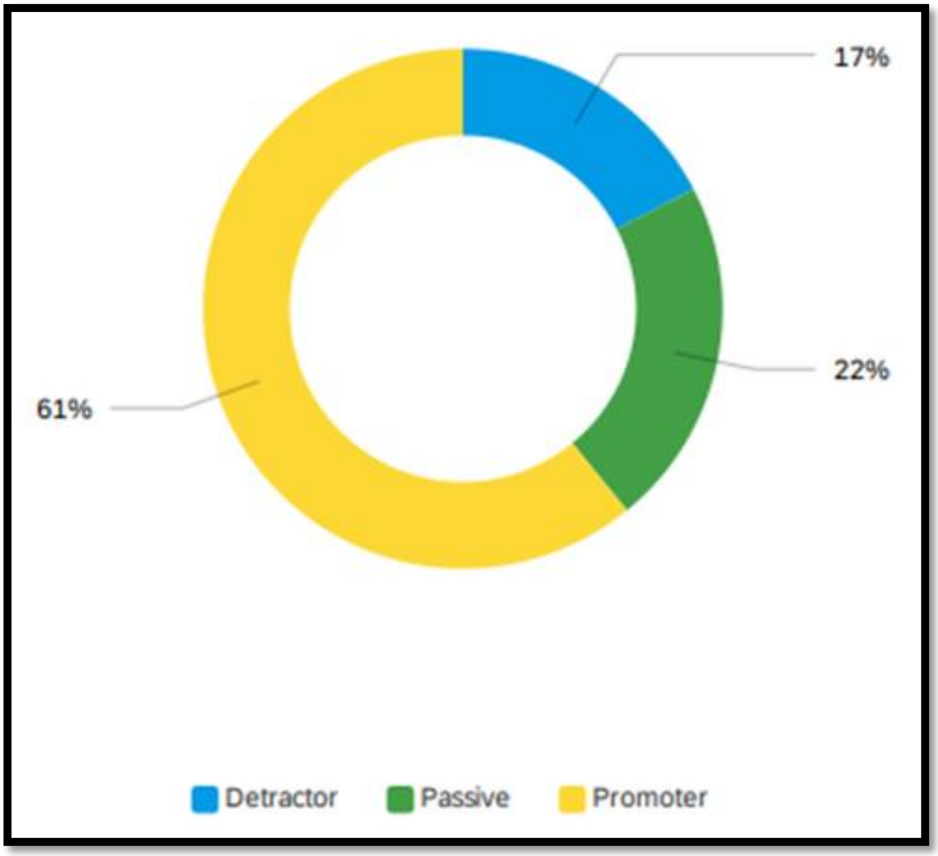

Figure 3.14 Parent's Assessment on a Significant Change of Behavior Noticed with Child When in Loud Spaces

Based on the respondent's data, in Figures 3.15 and 3.16, it is insinuating that there should be spaces provided in built environments that allow autistic children the ability to remove themselves from overstimulating situations. Question 3 asks when my child feels overwhelmed or overstimulated they seek out a "break space" such as a play tent or quiet corner (refer to Figure 3.15) while question 17 asked if the parents found it important that their child has a "safe place" or a space where they feel comfortable when they feel overwhelmed (refer to Figure 3.16).

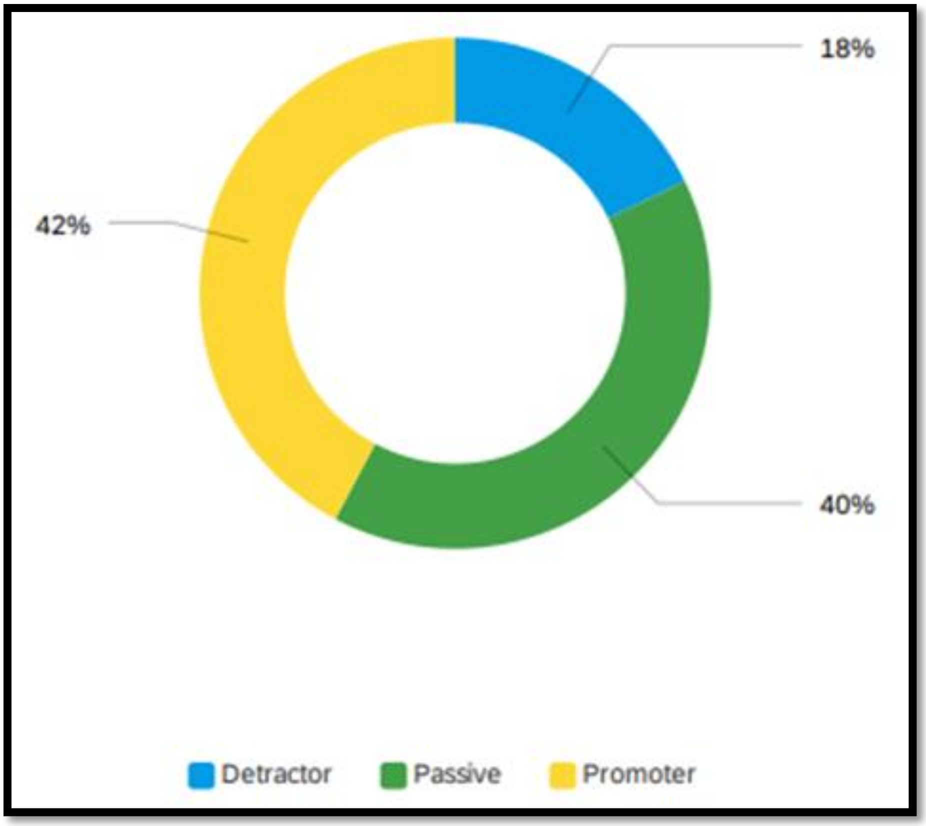

Figure 3.15 Parent's Assessment on Child to Seek out a "Break Space" when Overwhelmed or Overstimulated

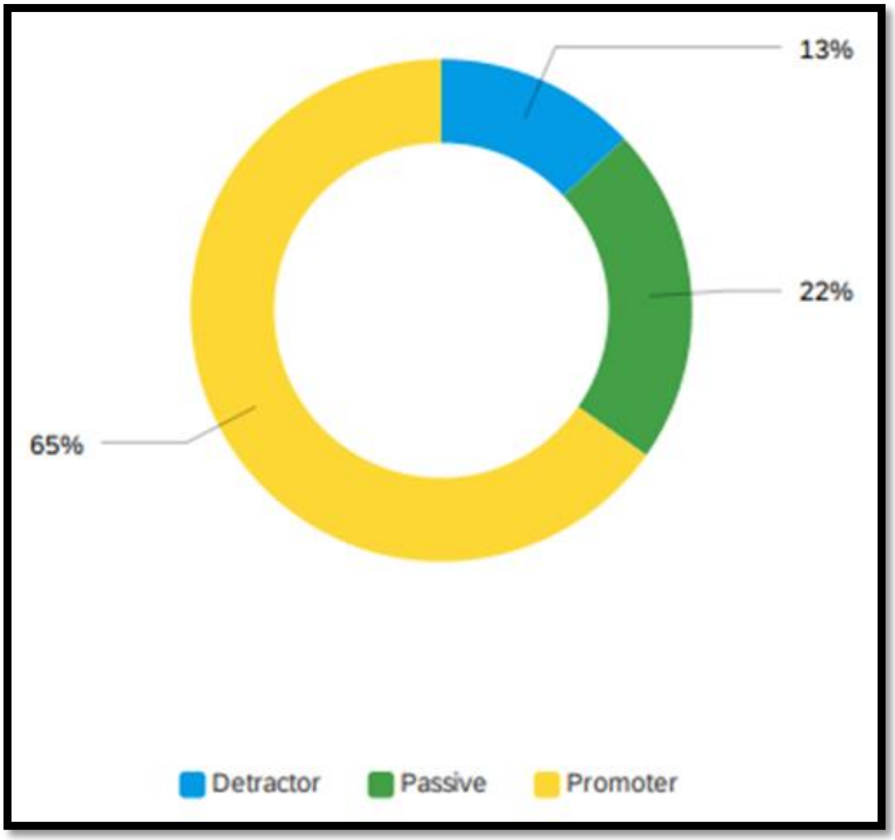

Figure 3.16 Parent's Assessment on the Importance of a "Safe Place" where Child can Feel Comfortable when Overwhelmed

It is interesting to analyze the data collected from question 4 which asked if interior spaces that have sufficient sound absorption also have a noticeable effect on their child's behavior; 27% responded with promoter, 36% responded with detractor and 38% were indifferent (refer to Figure 3.17).

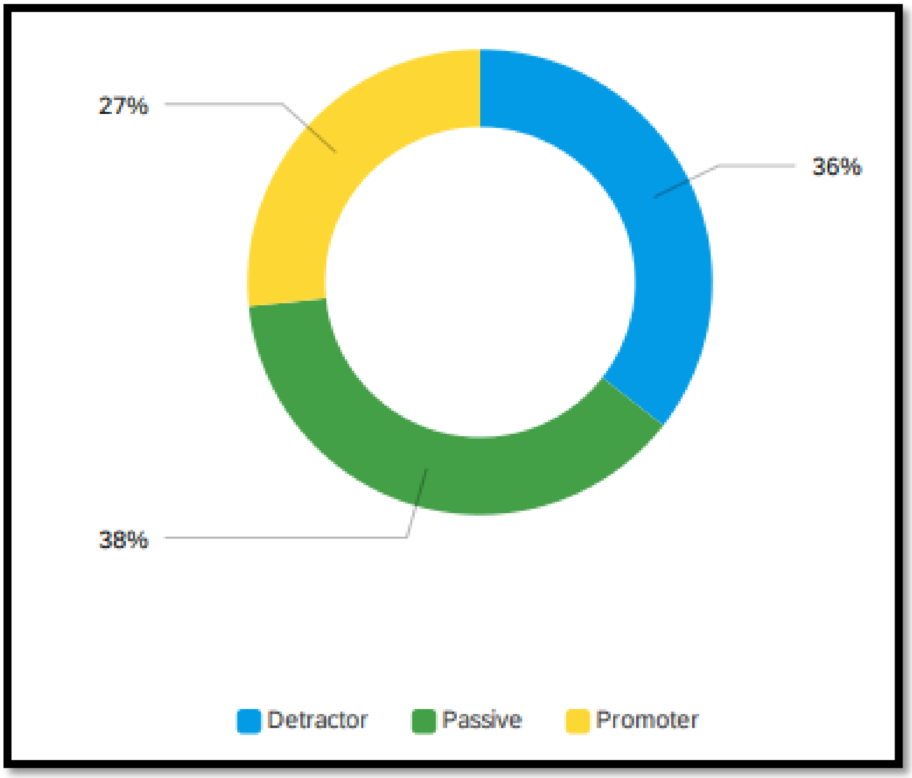

Figure 3.17 Parent's Assessment on Interior Spaces that have Sufficient Sound Absorption have a Noticeable Effect on Child's Behavior

Phase 2: Analysis and Results.

Participant demographics:

In total, 76 respondents participated in Phase 2 of the study. The respondents were teachers and teaching staff for children with autism spectrum disorder. In total, 89% of participants were female, 10% were male, and 1% preferred not to answer. The years of teaching experience with children with autism were reported as the following groups: 1) less than 5 (n = 19); 2) 5-9 (n = 19); 3) 10-14 (n = 10); 4) 15-19 (n = 7); 4) 20-24 (n = 8); 5) 25-29 (n = 2); 6) 30-34 (n = 1); 7) 35-40 (n = 1); and 8) Prefer not to answer (n = 9).

Number of years teachers have worked at their current school were reported as the following groups: 1) less than 5 (*n* = 38); 2) 5-9 (*n* = 16); 3) 10-14 (*n* = 8); 4) 15-19 (*n* = 3); 5) 25-29 (*n* = 4); and 6) Prefer not to answer (*n* = 8). Figure 3.18 illustrates the current teaching level of respondents.

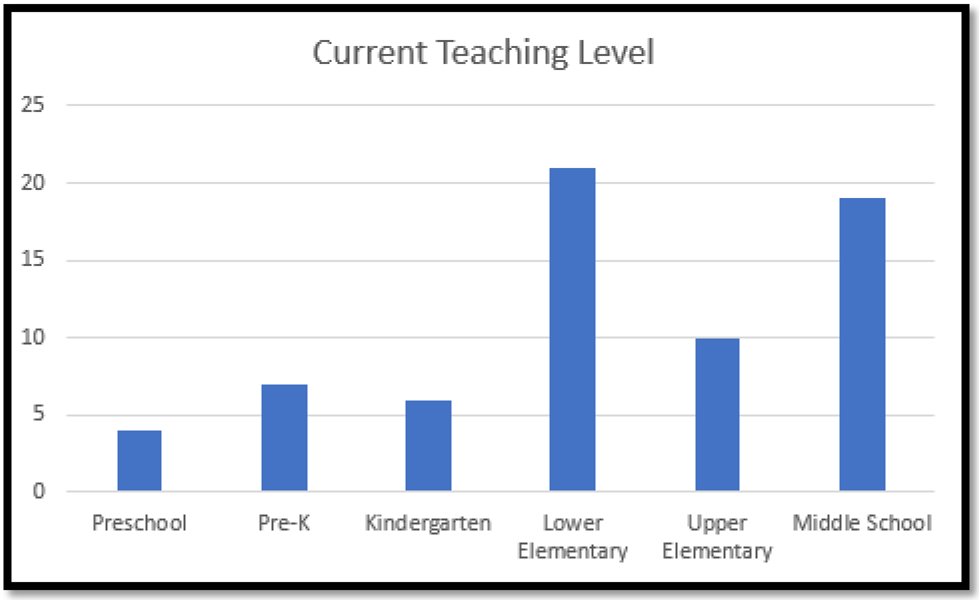

Figure 3.18 Current Teaching Level of Respondents

Number of hours the respondents spend each week with their students were reported as the following groups: 1) less than 5 (n = 11); 2) 5-9 (n = 6); 3) 10-14 (n = 2); 4) 15-19 (n = 6); 5) 20-24 (n = 2); 6) 25-29 (n = 9); 7) 30-34 (n = 16); 8) 35-40 (n = 12); 9) over 41 (n = 1); and 10) Prefer not to answer (n = 11). The participants were also asked how many children are in their class in which the responded in the following groupings: 1) 1-5 (*n* = 21); 2) 6-10 (*n* = 23); 3) 11-15 (*n* = 11); 4) 16-20 (*n* = 5); 5) over 20 (*n* = 3); and 6) Prefer not to answer (*n* = 13).

Interior environments:

For the purpose of this analysis, it was essential to discover which aspects of the learning environment the teacher valued as important. In an attempt at discovering such aspects, the teachers were given a list of statements which are shown in Figure 3.19 and were asked to evaluate each statement on a scale from “Strongly Disagree” to “Strongly Agree”. Out of the statements asked, it was revealed that the teachers and teaching staff believed that noise control, having carpet on the floor of the classroom, and having thick or sound proof walls were the top most important design aspects for autistic children within their learning environment.

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total
Using wood chairs and tables rather than steel chairs and tables is an important issue for children with autism	3	7	40	13	3	66
Thick or Sound Proof walls are an important issue for children with autism	1	7	21	15	22	66
Noise Control is an important issue for children with autism	3	2	3	20	38	66
Having wood panels fixed over the wall is an important issue for children with autism	1	7	47	10	1	66
Having a carpet on the floor of the classroom is an important issue for children with autism	4	4	18	14	25	65

Figure 3.19 Teacher’s Assessment on Built Learning Environment Statements

Data was collected then organized into common themes and clusters in an attempt to understand and visually display how the teachers and teaching staff perceive the positive and negative acoustical qualities of school rooms which allowed for a more direct focus on per room function information and are shown below in Figures 3.20, 3.21, 3.22, 3.23, 3.24, and 3.25.

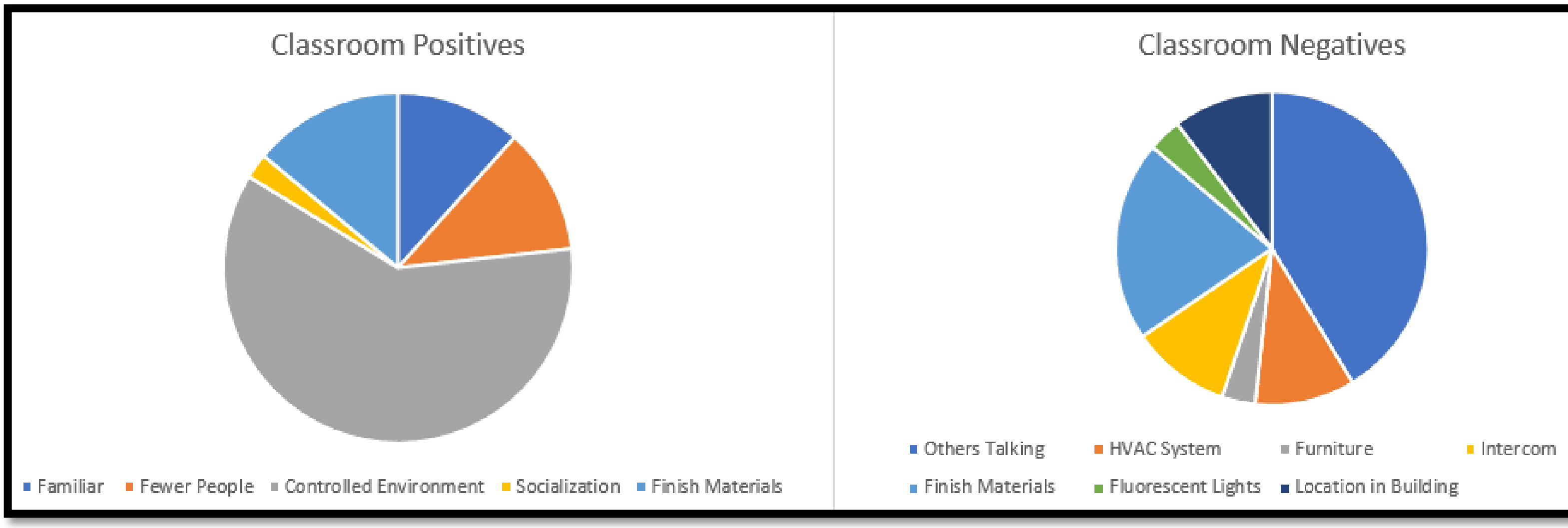

Figure 3.20 Positive and Negative Acoustic Qualities in Classroom

During analysis, it was inevitable to equate the positive and negative qualities in an individual side-by-side comparison. However, it was even more interesting to discover the similarities in information when comparing all of the positive qualities as one group and all the negative qualities as one group and making an attempt at finding common themes that are consistent with positive and negative aspects.

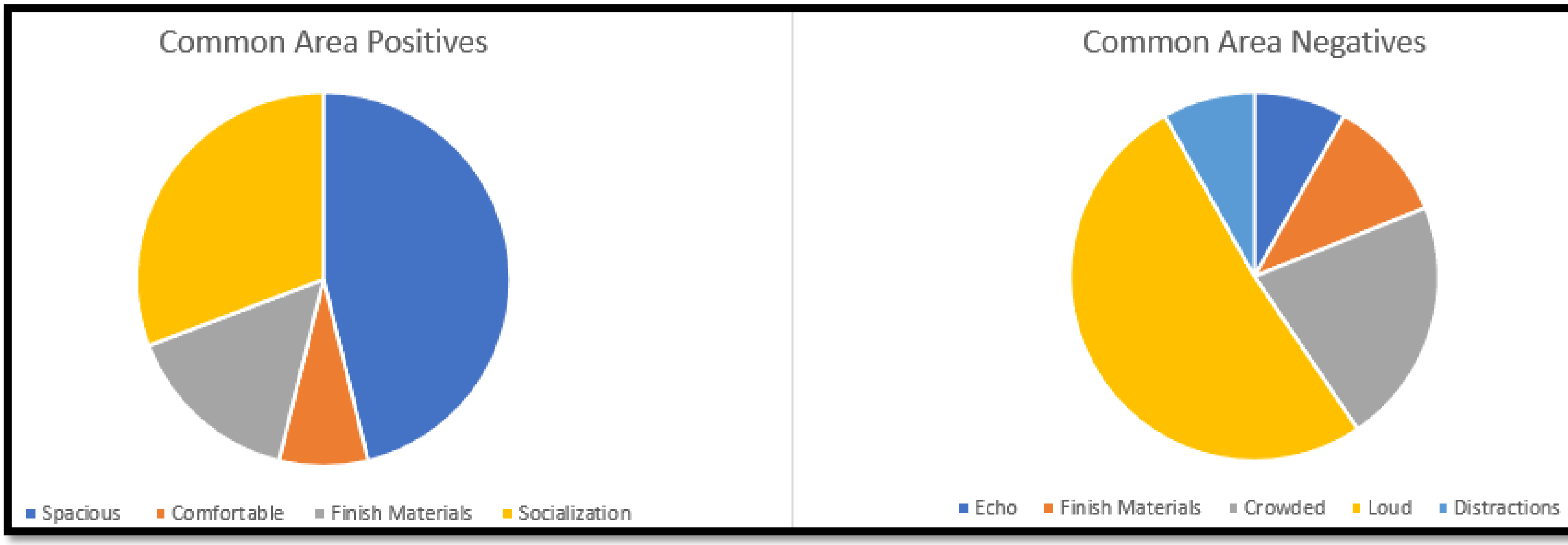

Figure 3.21 Positive and Negative Acoustic Qualities in Common Area

It was discovered during analysis that out of the 6 school rooms evaluated, 4 were described to have a negative acoustical quality that was described as loud, noisy, and echo. Looking further into the data, it can be viewed on Figures 3.21, 3.22, 3.24, and 3.25 that these qualities (loud, noisy, and echo) were recorded as being the main cause of the negative acoustical quality within the specific room rooms that teachers and teaching staff consider to be Common Area, Art Room, Music Room and Drama Room, and Art Room & P.E. Room.

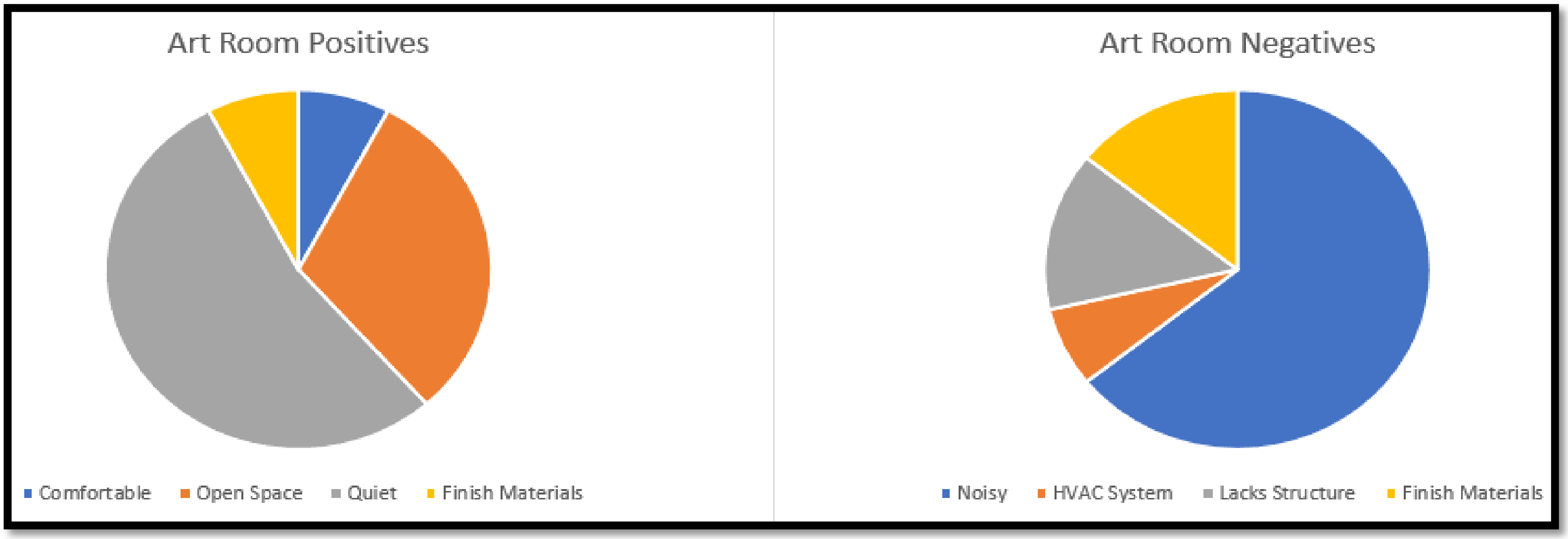

Figure 3.22 Positive and Negative Acoustic Qualities in Art Room

Additional investigation during analysis revealed 59%-94% of the negative acoustical qualities that the teachers and the teaching staff answered loud, noisy, and echo either solely or a combination of qualities for what are considered to be the Common Area, Art Room, Music Room and Drama Room, and Art Room & P.E. Room. More specifically, looking at Figure 3.21 which shows the negative acoustical qualities associated with what the teachers and the teaching staff consider to be their Common Area; results show that 51% of the teachers and the teaching staff mentioned loud as a negative acoustical quality and 8% of the staff mentioned echo. Figure 3.22 which shows the negative acoustical qualities associated with what the teachers and the teaching staff consider to be their Art Room; results show that 65% of the teachers and the teaching staff mentioned noisy as a negative acoustical quality for the environment.

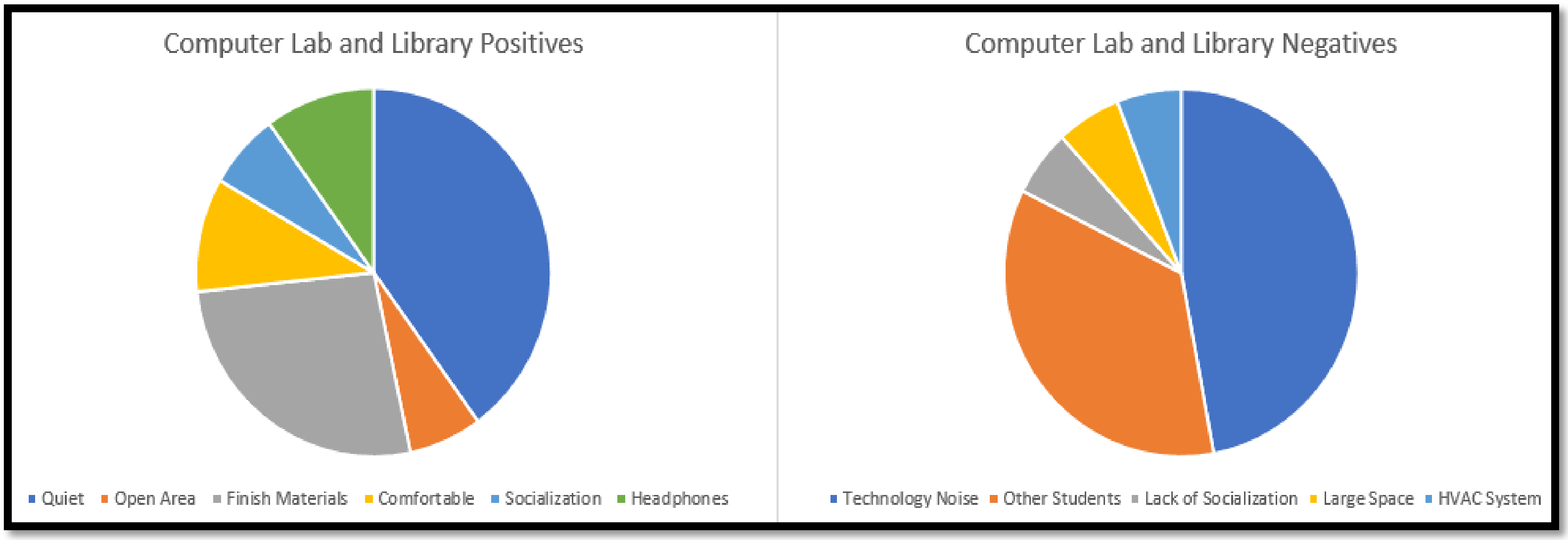

Figure 3.23 Positive and Negative Acoustic Qualities in Computer Lab and Library

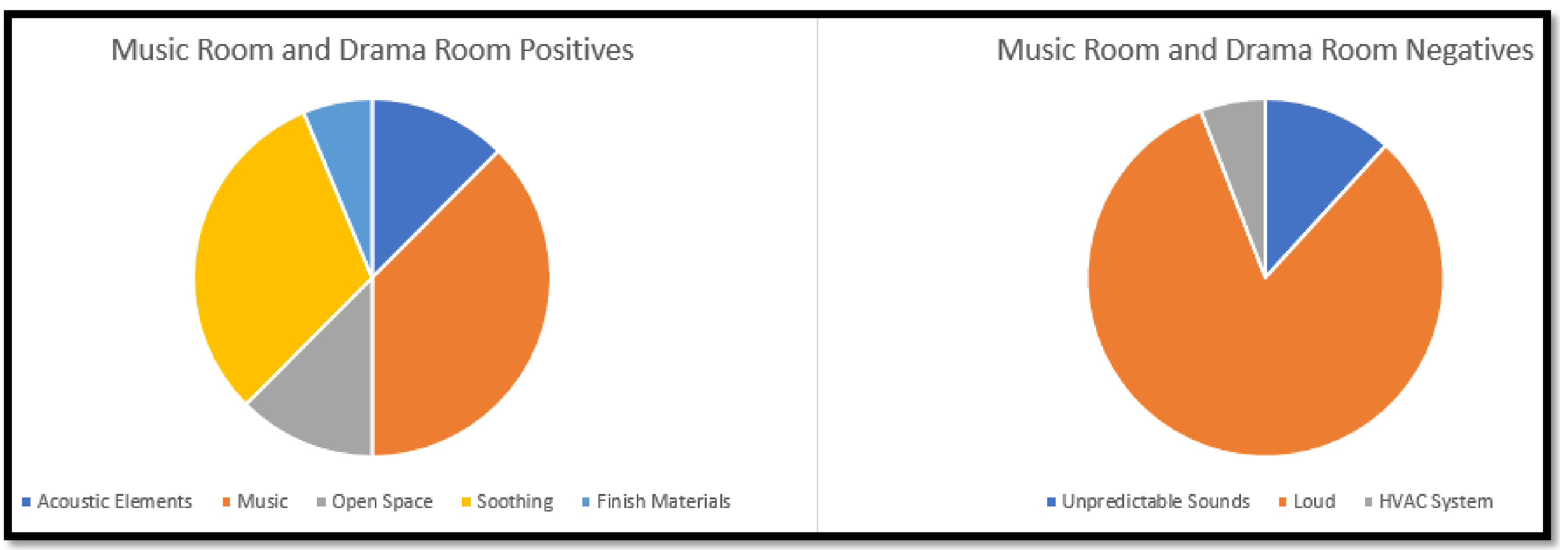

Figure 3.24 Positive and Negative Acoustic Qualities in Music Room and Drama Room

Figure 3.24 which shows the negative acoustical qualities associated with what the teachers and the teaching staff consider to be their Music Room and Drama Room; results show that 82% of the teachers and the teaching staff mentioned loud as a negative acoustical quality for the space. Figure 3.25 which shows the negative acoustical qualities associated with what the teachers and the teaching staff consider to be their Art Room & P.E. Room; results show that 49% of the teachers and the teaching staff mentioned loud as a negative acoustical quality and 45% of the staff mentioned echo.

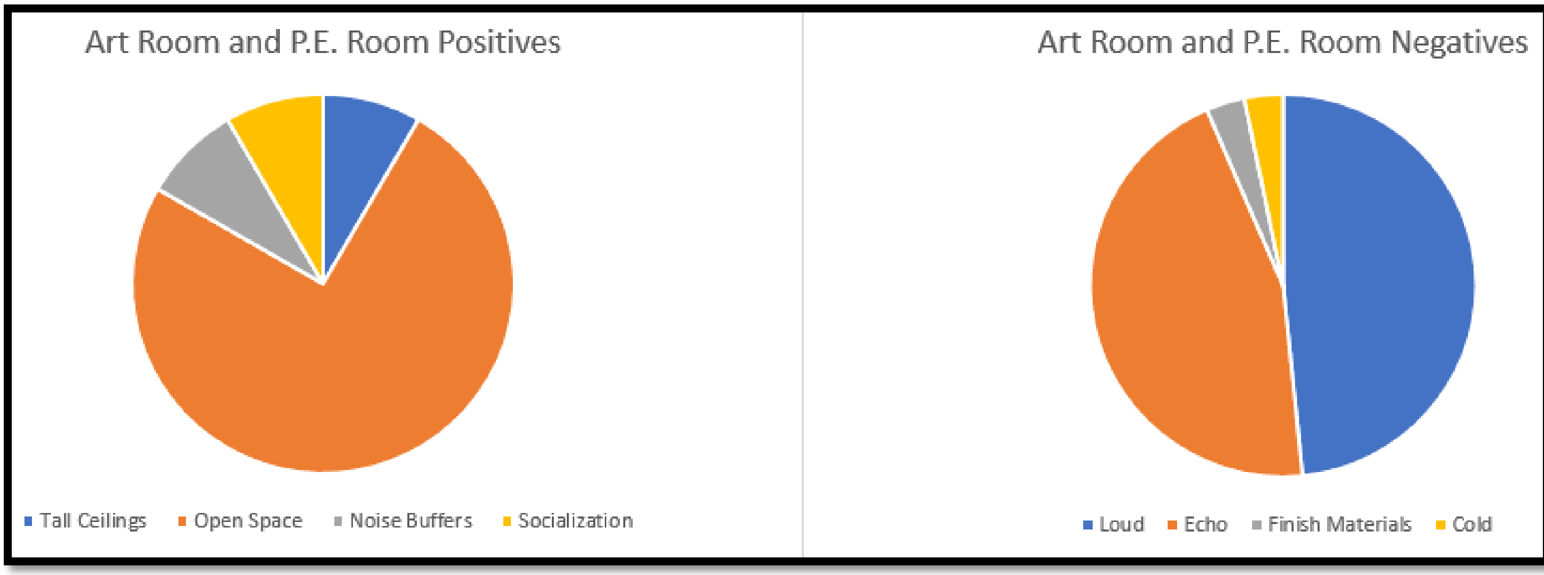

Figure 3.25 Positive and Negative Acoustic Qualities in Art Room and P.E. Room

Further investigation revealed all 4 rooms (Common Area, Art Room, Music Room and Drama Room, and Art Room & P.E. Room) shared a common positive acoustical quality that was described by the teachers and teaching staff as "open space" and "spacious". More specifically, looking at Figure 3.21 which shows the positive acoustical qualities associated with what the teachers and the teaching staff consider to be their Common Area; results show that 46% of the teachers and the teaching staff mentioned spacious. Figure 3.22 which shows the positive acoustical qualities associated with what the teachers and the teaching staff consider to be their Art Room; results show that 31% of the teachers and the teaching staff mention open space. Figure 3.24 which shows the positive acoustical qualities associated with what the teachers and the teaching staff consider to be their Music Room and Drama Room; results show that 13% of the teachers and the teaching staff mention open space. Figure 3.25 which shows the positive acoustical qualities associated with what the teachers and the teaching staff consider to be their Art Room & P.E. Room; results show that 75% of the teachers and the teaching staff mention open space.

The teachers and teaching staff were asked if there are aspects of the built environment that they believe reduce the noise levels and if so to please explain. Each response was recorded and then sorted into common themes for further analysis; the findings are illustrated below in Figure 3.26. It was discovered that carpets and rugs were considered to be the highest valued noise reducing aspect as such findings support evidence previously discover in Figure 3.26.

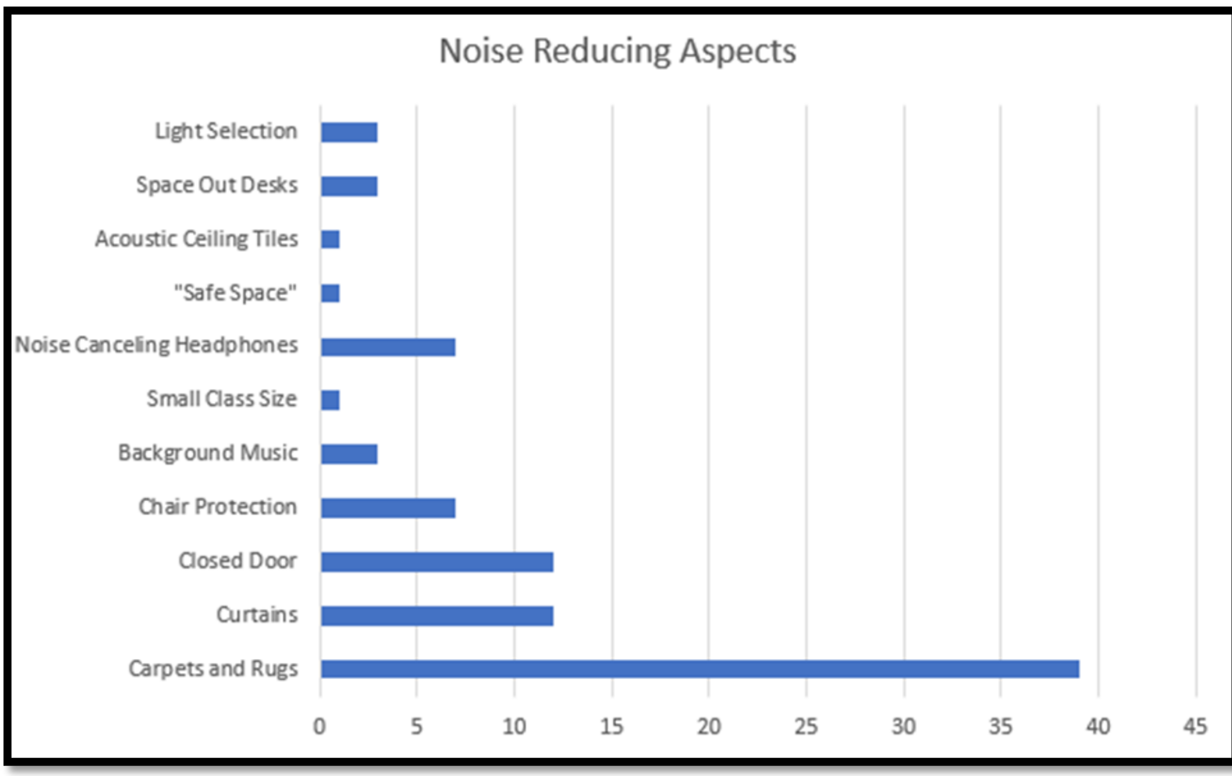

Figure 3.26 Teacher's Assessment of Noise Reducing Aspects in a Built Environment

Sound and behavior:

The teachers and teaching staff were asked to rank the acoustical environmental conditions of air conditioner sounds, echoes, sounds from children in the classroom, sounds from other classrooms, and traffic noise in regards to how negatively they impact the children's behavior which is illustrated in Figure 3.27. Results found during analysis indicate that teachers and teaching staff believe that traffic noise and sounds from other classrooms are the two acoustical environmental conditions that are negatively impacting the children's behavior as both shared the top results at 35% (Figure 3.27).

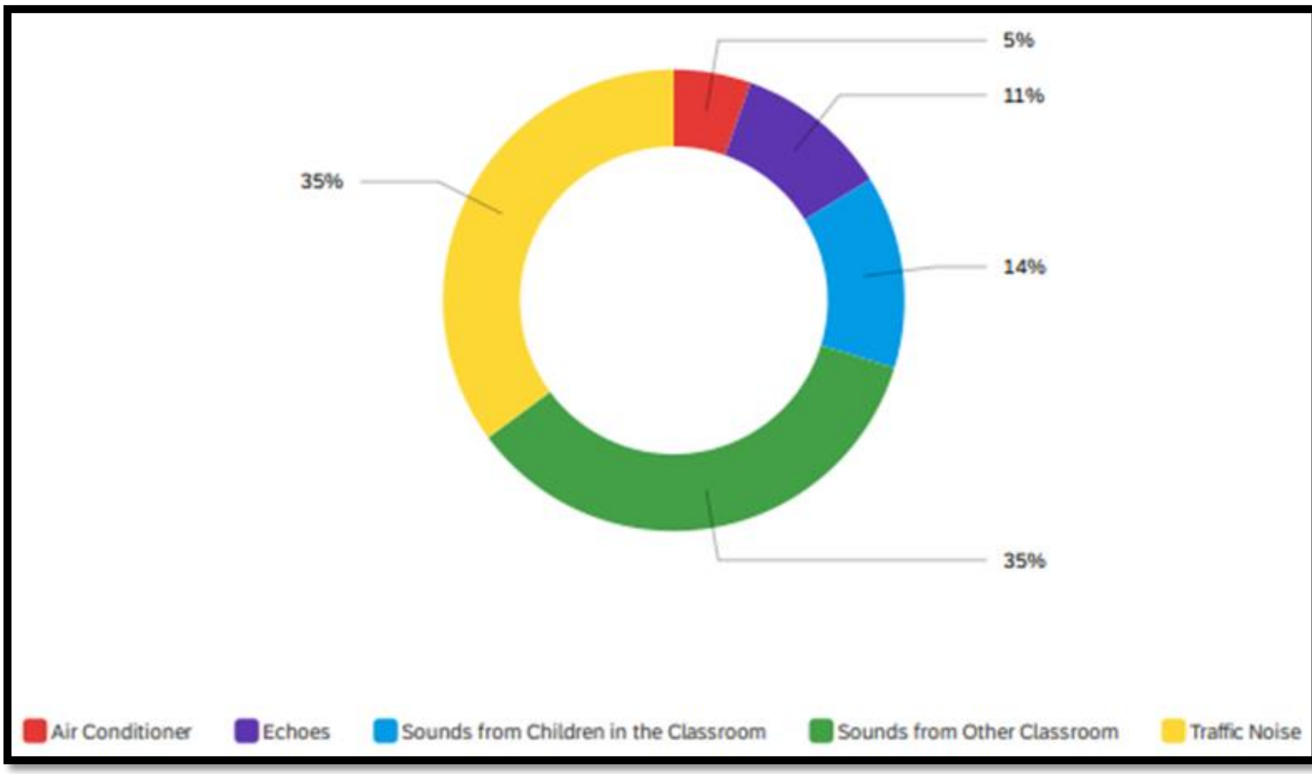

Figure 3.27 Teacher's Assessment on Acoustic Conditions Negatively Impacting Children's Behavior

The teachers and teaching staff were also asked in addition to air conditioner sounds, echoes, sounds from children in the classroom, sounds from other classrooms, and traffic noise, if they believed there are other acoustical environmental conditions that they feel negatively affect autistic children and to include a description with examples. These answers were analyzed and grouped into common themes which are displayed in Figure 3.28.

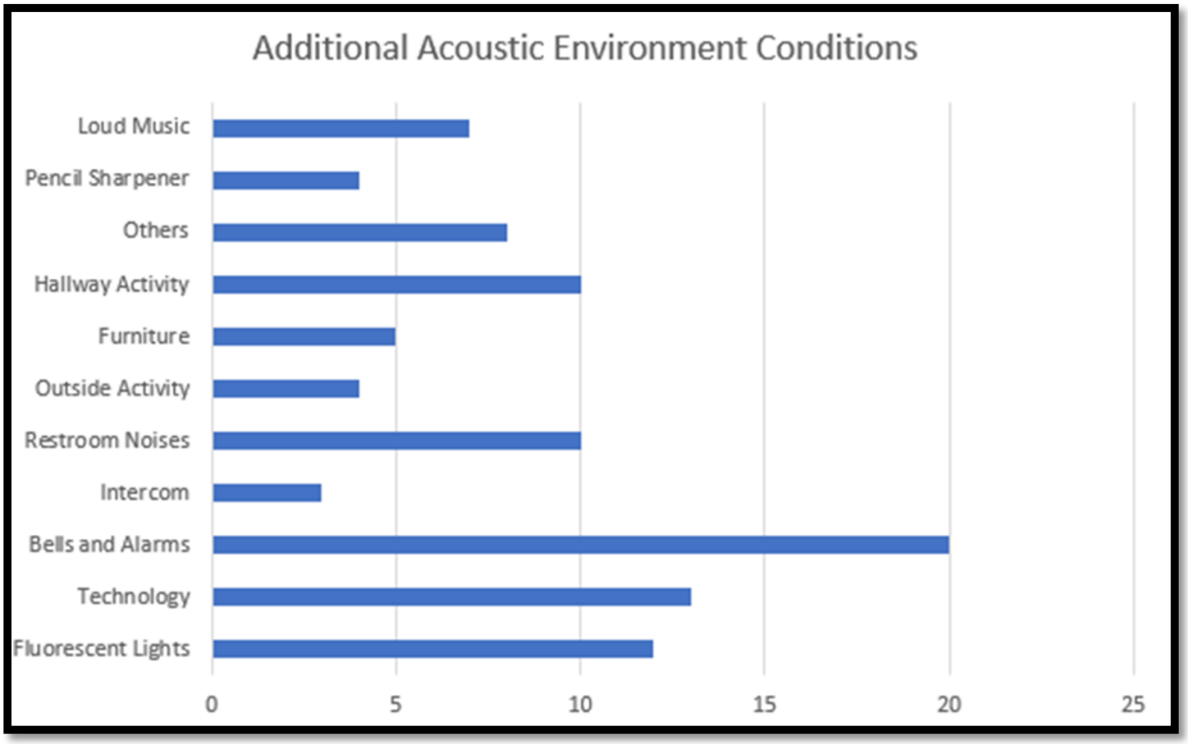

Figure 3.28 Teacher's Assessment of Acoustic Conditions that Negatively Impact the Built Environment

The top answer provided by the teachers and the teaching staff was bell and alarms in which 20 of the staff list it as a condition. The second top listed condition was technology where a total of 13 teachers and teaching staff made mention of technology noise distractions in the classroom. The descriptions and examples provided by the teachers and teaching staff that were then grouped into the theme "technology" ranged from answers that involved echoing from technology to microphone systems the teachers wear in the classroom due to the loud volume in the classroom. The same teacher that mentioned the in-classroom microphone system also mentioned being able to hear the muffled microphone sounds from other neighboring classrooms. One other response sorted in "technology" themed condition was a teacher giving the example of a non-verbal student clearly bothered by a noise and would cover their ears and it took a while for the teacher to realize that the sound source was coming from the "old" classroom computer that generates a humming noise and was affecting the student that the teacher admittedly tuned out.

The teachers and the teaching staff were asked what types of behaviors they see the children doing that indicate that they are impacted by noise the results were then analyzed and categorized into a common behaviors and themes and are shown in Figure 3.29.

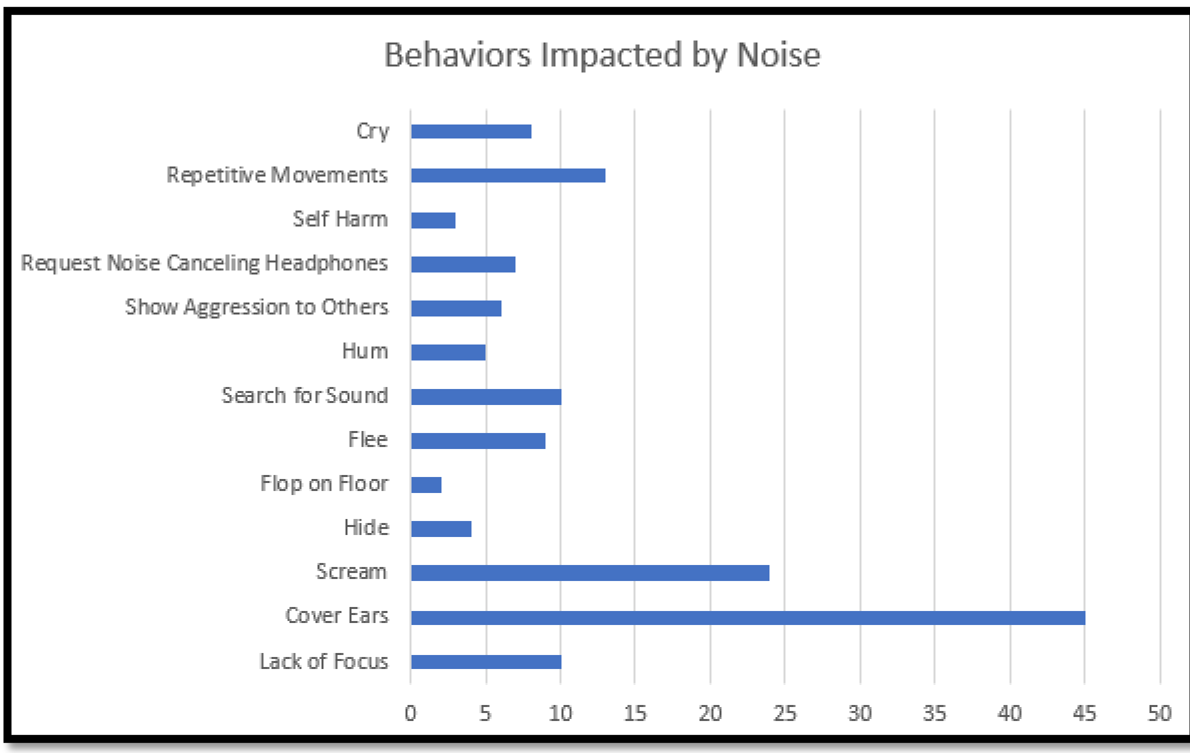

Figure 3.29 Teacher's Assessment on Common Behaviors Impacted by Noise

Results show that a total of 45 teachers and teaching staff mention "cover ears" as the behavior the children are seen displaying when impacted by noise. Some examples given by the teachers and the teaching staff included how some children will immediately cover their ears while one reported that some children will stick their fingers in their ears.

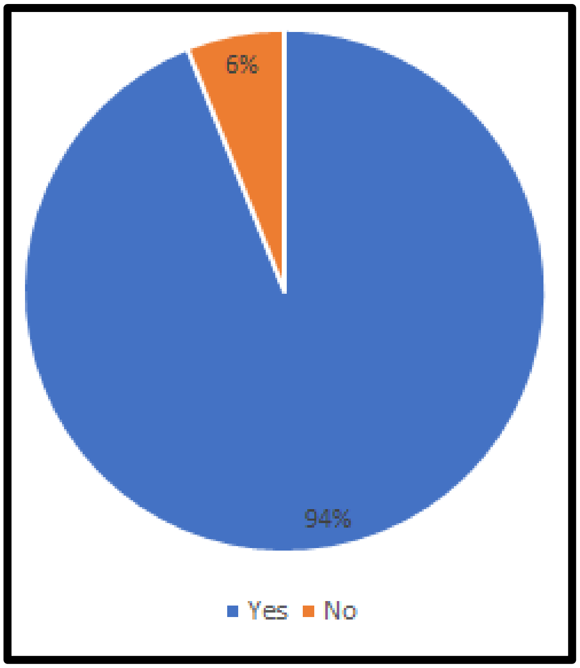

Figure 3.30 Teacher's Assessment of Children Covering Ears

Additional data was collected on ear covering when the teachers and teaching staff was asked, "do the children in the class ever attempt to reduce the noise by covering their ears or using 'ear defenders'?" which is illustrated in Figure 3.30. The results showed 94% of the teachers responding "yes" while the other 6% responded with "no".

Chapter 4: Discussion and Conclusion

Discussion:

The preliminary findings based on this study suggest that noise within a built environment can cause autistic children to behave differently but more research needs to be conducted in order to have a better understanding on how noise within the classroom can directly impact the academic growth and social interaction for autistic children. Focusing on the research question, "there is a relationship with how noise in the classroom environment can affect the social interaction and academic growth for autistic children", this study uncovered that most autistic children will often participate in observed behaviors such as covering their ears to block out unwanted noise, however, not all of them do. Every child is different and autistic children are often on different degrees of the spectrum. Though, conclusively autistic children tend to have heightened senses and this affects the way they perceive their environments (Kanakri et al., 2017). The inability to block out unwanted noise causes them to behave in ways such as covering their ears or participating in repetitive behavior. This is a coping mechanism that they use when overstimulated. Not only are autistic children unable to block out unwanted noises but they also tend to fixate on certain sounds which further increases their sensory overload.

Grouping of survey respondents:

The grouping methodology employed in Phase 1 data collection initially seemed like a valid approach as it was thought to provide the essential background information from the parents perspective as to how their child interacts within their built environment as well as to make an attempt at providing more insight when it comes to common behaviors the parents have witnessed their child partake in due to noise within the built environment. The grouping methodology employed in Phase 2 was equally as important as the voice of the teachers and teaching staff was necessary as an attempt to further understand that noises within the classroom environment can cause a negative impact in the behavior of an autistic child if the sound within the space is uncontrolled.

Built environments phase 1 interpretations:

It was evident that parents are concerned with the built environment that their child is interacting within but it was difficult to develop any true and consistent connections with the data provided. Out of all the questions associated with the built environment, the question that provided the most constancy with the parent's responses indicated that autistic children are not in favor of hard flooring material, such as hardwood, to be used as the flooring surface in the built environments they are interacting within. However, when comparing such findings with another question given to the parents on floor surfaces, it was indicated that only about a quarter of the respondents found soft surfaces, such as carpet, to be a favorable surface.

Built environments phase 2 interpretations:

Findings discovered during analysis indicate that noise control, having carpet on the flooring, and having thick or sound proof walls are among the top important design aspects that should be implemented in learning environments for autistic children according to the responses provided by the teachers and teaching staff. However, a further look into the collected data shows that noise control and finish material selection were the two issues the teaching and teaching staff identified more frequently as a concern.

The study discovered that the Common Area, Art Room, Music Room and Drama Room, and Art Room & P.E. Room tended to be the rooms that were considered to have the negative acoustical qualities of loud, noisy, or echo assigned to them. Additional investigation exposed each of these rooms also shared what the teachers and teaching staff considered to be a positive acoustical quality that they described as “open space” or “spacious” but the total result of mentions for each room ranged too much to explain a true connection.

Sound and behavior phase 1 interpretations:

The parent participant’s responses suggest that while background noise may be what prohibits their child the inability to focus, excessive or uncontrolled noises are not always causing the children to act out. Furthermore, although results were inconclusive on whether or not built environments that have a sufficient sound absorption have a noticeable effect on autistic children’s behavior, the study does suggest that it is most common for autistic children to not find it favorable to engage in large groups and that there is a significant change of behavior when the child is in loud interior spaces. The study also suggests that the use of “safe spaces” where the children can go to get away when they are overwhelmed is an important design feature to have for both the child and parent.

Sound and behavior phase 2 interpretations:

The results indicate that teachers and teaching staff consider traffic noises and sounds from other classrooms to be the acoustical environmental conditions out of air conditioner sounds, echoes, sounds from children in the classroom, sounds from other classrooms, and traffic noise, which provide the most negative affect on autistic children in a school setting. When asked to provide additional negative acoustic environment conditions to the list, the results indicated that bells and alarms were the most common condition reported by the teachers and teaching staff to have a negative effect on the children. Although it appears that bells and alarms are considered to have the most negative affect on autistic children, it should be mentioned that the past experiences shared by the teachers and teaching staff acknowledged that even if a certain acoustical environmental condition did not show up as often, it can still cause notable distress to the children. The results found in this study suggest that it is a common behavior for an autistic child to cover their ears while being impacted by noise.

Limitations of the study:

Limitations that were discovered from this study included the ability to only distribute online surveys which meant the inability to collect data through on-site research observation. The Covid19 pandemic resulted in many of the United States school districts to go from in-person teaching to teaching student's virtually regardless of age or care needs and the schools that were open restricted visitors from entering the facility.

Other limitations this study faced included the lack of responses from the teachers and teaching staff. It was mentioned multiple times during data collection how much stress the teaching staff is under with the changes in school structure brought on by Covid19. Some school districts refused to share the survey because of this reason. The disturbance in typical school structure may have also been the cause that contributed to the limited number of survey responses. To further develop this study, additional research studies on how noise can impact autistic children in a classroom environment should be conducted in order to make a more complete conclusion for the autistic community as a whole.

Conclusion:

Although the study provided sufficient evidence that noise within a built environment can indeed impact an autistic child's behavior, the findings were not sufficient enough to conclude that certain noises will have the same effect on all autistic children. Furthermore, more research should be conducted in order to further investigate the relationship between noise in the classroom environment and how it can affect the social interaction and academic growth for autistic children. Some of the findings discovered during data analysis indicated that material finish selections, such as carpet and rugs, can assist with sound absorption within the built environment allowing the child to better focus and concentrate within their learning environment. Data analysis made it apparent that strategies and different techniques are being utilized by parents, teachers, and teaching staff in the hope to find better solutions to deal with noise within built environments. However, additional research beyond this study needs to be conducted in order to gather more information on the noise and behavior phenomenon seen among autistic children. Furthermore, future research should include additional data collection which involves an on-site observation of the classroom to further gather information that may have been missed in survey format. The more researchers and interior designers know about how noise can impact an autistic child's behavior the more knowledge is obtained to create built environments that will increase their quality of life.

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Appendix A

CITI Certificate:

CITI PROGRAM

Completion Date 25-Nov-2019
Expiration Date 24-Nov-2022
Record ID 34358918

This is to certify that:

Kaitlyn Cable

Has completed the following CITI Program course:

Social & Behavioral Research - Basic/Refresher (Curriculum Group)
Social & Behavioral Research - Basic/Refresher (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

Ball State University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w7ee9f2b5-6da1-4150-ae3b-cae7c80fdb63-34358918

Appendix B

Designing for Children Letter of Consent:

<u>Study Title</u> Designing For Autism Spectrum Disorder
INCLUDE IRBNet #1531745-1

<u>Study Purpose and Rationale</u>
This study aims to discuss how spaces in built environments effect children with autism spectrum disorder due to finishes, colors, lighting, and function. Little research has been conducted on this topic and with the increasing number of children being diagnosed with autism spectrum disorder more research needs to be conducted in order to allow the children with autism a better quality of life.

<u>Inclusion/Exclusion Criteria</u>
The research will set forth with the goal of obtaining 25 parents who have children with autism between the ages of 3-10 and 25 parents who had children who not have autism between the ages of 3-10 to participant in the survey.

<u>Participation Procedures and Duration</u>
This research study will be an online survey given to parents who have children with autism spectrum disorder to complete on their own in their home environment. The survey will be shared with potential participants through email, social media posts, and announced on a podcast. The email and social media posts will provide a link with access to the survey while the podcast host will post the link to the survey on their website. The main objectives of this survey will be to get more information from parents with children who have autism and what behaviors they observe their children doing in built environments. The survey will be given to parents of autism children as some of the children are unable to communicate so observations from parents regarding their children within interior environments will take place in order to gather more efficient data. The survey will be closed December 2nd 2019.

<u>Data Confidentiality or Anonymity</u>
All data will be maintained as anonymous and no identifying information such as names will appear in any publication or presentation of the data.

<u>Storage of Data and Data Retention Period</u>
The data will be stored on a password protected computer until Spring 2021.

<u>Risks or Discomforts</u>
There are no perceived risks for participating in this study.

<u>Benefits</u>
To collect research that will allow designers to create spaces for children with autism to ensure a higher quality of life.

<u>Voluntary Participation</u>
"Your participation in this study is completely voluntary and you are free to withdraw your permission at anytime for any reason without penalty or prejudice from the investigator. Please feel free to ask any questions of the investigator before signing this form and at any time during the study."

<u>IRB Contact Information</u>
For questions about your rights as a research subject, please contact the Office of Research Integrity, Ball State University, Muncie, IN 47306, (765) 285-5052 or at orihelp@bsu.edu.

<u>Study Title</u> **Designing For Autism Spectrum Disorder**

****

<u>Consent</u>
I, ___________________, agree to participate in this research project entitled, Designing For Autism Spectrum Disorder I have had the study explained to me and my questions have been answered to my satisfaction. I have read the description of this project and give my consent to participate. I understand that I will receive a copy of this informed consent form to keep for future reference.

To the best of my knowledge, I meet the inclusion/exclusion criteria for participation (described on the previous page) in this study.

________________________________ ________________

Participant's Signature Date

<u>Researcher Contact Information</u>

Principal Investigator:

Kaitlyn M. Cable, Graduate Student
Interior Design
Ball State University
Muncie, IN 47306
Telephone: (920) 639-6682
Email: kmcable@bsu.edu

Faculty Supervisor:-

Dr. Shireen Kanakri
Interior Design
Ball State University
Muncie, IN 47306
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Email: smkanakri@bsu.edu

Appendix C

Designing for Children Survey:

Q1 Bright colors overstimulate or negatively affect my child.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q2 Neutral color tones colors appeal to my child.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q3 When my child feels overwhelmed or overstimulated they seek out a "break space" such as a play tent or quiet corner.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q4 Interior spaces that have sufficient sound absorption have a noticeable affect on my child's behavior.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q5 Excessive noise causes my child to act out.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q6 Certain textures of the furniture causes my child to act out.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q7 Certain patterns on fabric causes my child to act out.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q8 My child prefers interior spaces that have exterior windows.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q9 I notice a significant behavioral difference with my child when they are in spaces that use fluorescent light.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q10 My child enjoys age associated images such as cartoon pictures.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q11 My child is drawn to real life artwork and picture images.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q12 My child prefers soft surfaces for flooring such as carpet.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q13 My child prefers hard surfaces for flooring such as hardwood.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q14 I consider the interior layout of a space when thinking of the safety for my child.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q15 Certain patterns on floor covering and furniture impact my child's ability to focus.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q16 Large windows with natural light distract my child.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q17 I find it important that my child has a "safe place" or a space where they feel comfortable when feeling overwhelmed.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q18 Background noise from other activities hinders on my child's ability to focus.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q19 An open space layout with minimal furniture is a benefit to my child's ability to focus and function.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q20 A significant change of behavior is noticed with my child in loud interior spaces such as restaurants and malls.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q21 My child enjoys engaging in large groups.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q22 My child is drawn to water and water features.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q23 There are certain colors my child is drawn to.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q24 There are certain colors my child avoids.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q25 Location of furniture it taken into consideration for my child's safety.

0 (0)

1 (1)

2 (2)

3 (3)

4 (4)

5 (5)

6 (6)

7 (7)

8 (8)

9 (9)

10 (10)

Q26 Please further elaborate on any questions from the survey.

____

Q27 Provide any additional behavioral information that you observe with your child in regards to interior environments.

____

Appendix D

The Impact of Acoustical Environmental Design on Children with Autism Letter of Consent:

To Whom it May Concern,

My name is Kaitlyn Cable and I am a graduate student at Ball State University. The linked survey is the first stage of research I am conducting for my thesis. I am reaching out to you asking for assistance with distributing the survey "The Impact of Acoustical Environmental Design on Children with Autism" to the teaching staff that work directly with children who have autism. I hope the results found from this survey will be useful for designing future learning environments for children with autism.

Once completed, please submit survey via the link. I am hoping to have all responses to this survey by April 16th, 2021. Please email me with any questions or concerns at kmcable@bsu.edu.

I appreciate your participation.

Sincerely,

Kaitlyn Cable

Graduate Student

Master of Science, Interior Design

Ball State University Muncie, IN

Appendix E

The Impact of Acoustical Environmental Design on Children with Autism Survey:

1. Gender of rater:

Male (1)

Female (2)

Prefer Not to Answer (3)

2. How long have you worked with children with autism (years/months)?

____

3. How long have you worked at your current school (years/months)?

____

4. Level you currently teach (please select one):

Preschool (1)

Pre-K (2)

Kindergarten (3)

Lower Elementary (4)

Upper Elementary (5)

Middle School (6)

5. What type of classes do you teach (e.g. Music, Math, General, etc.)

____

6. What is the room number of your classroom?

____

7. How many hours do you spend with your students each week?

____

8. How many children are in your class?

____

9. In addition to air conditioner sounds, echoes, sounds from children in the classroom, sounds from other classrooms, and traffic noise, are there other acoustical environmental conditions that you feel negatively affect children with autism? Please describe and include any examples:

____

____

____

____

____

10. Please rank the following regarding how negatively they impact the children's behavior. If applicable, please add the items you mention in Question 9 to this list and include them in the ranking. (The most negative impact should be ranked number 1).

______ a. Air conditioner (1)

______ b. Echoes (2)

______ c. Sounds from children in the classroom (3)

______ d. Sounds from other classroom (4)

______ e. Traffic noise (5)

______ f. (6)

______ g. (7)

______ h. (8)

______ i. (9)

______ j. (10)

11. Are there aspects of the physical environment that you believe reduce the noise levels? If so, please explain. Examples may include: carpet, rugs, curtains, etc.

____

12. Describe the positive and negative acoustical qualities of the following types of rooms:

	Positives (1)	Negatives (2)
Classroom (1)		
Common Area (2)		
Art Room (3)		
Computer Lab & Library (4)		
Music Room & Drama Room (5)		
Art Room & P.E. Room (6)		

13 As a teacher for children with autism, please evaluate the importance of these aspects of the learning environment.

	Strongly Disagree (1)	Somewhat Disagree (2)	Neither Agree nor Disagree (3)	Somewhat Agree (4)	Strongly Agree (5)
Noise Control is an important issue for children with autism: (1)					
Having a carpet on the floor of the classroom is an important issue for children with autism: (2)					
Having wood panels fixed over the wall is an important issue for children with autism: (3)					
Using wood chairs and tables rather than steel chairs and tables is an important issue for children with autism: (4)					

Thick or Sound Proof walls are an important issue for children with autism: (5)

14. What types of behaviors do you see children doing that indicate that they are impacted by noise?

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15. Do the children in the class ever attempt to reduce the noise by covering their ears or using 'ear defenders'?

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