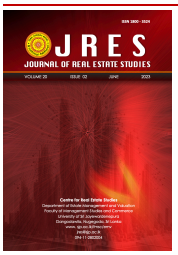

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The Impact of Greenery in the Window View on Visual Sustained Attention with Special Reference to Classrooms for Children with Down Syndrome

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ABSTRACT

One in every 700 babies worldwide is born with an intellectual disability such as Down Syndrome (DS), Autism Spectrum disorders, Cerebral Palsy etc. Architecture significantly enhances users' development skills by leveraging the environment to fulfil their mental and psychological needs, by boosting sustained attention in learning spaces. Based on existing literature, this research focused on the impact of greenery in window view of the classroom on visual sustained attention (VSA) of children with DS. Data of 19 participants (10 male, 9 female) of a selected school between the ages of 9 – 16 years (mean age – 11.42 years) was collected on existing and introduced levels of greenery in window view using three dimensional simulations and were analysed. The study revealed that the view with 40% to 60% of greenery at far view depth (Scenario B) has a positive impact on VSA over both the existing window view (Scenario A) and the window view with 80% to 100% greenery (Scenario C). However, scenario C did not show any positive impact over scenario B as assumed. One reason for this could be the inclusion of the sky view in scenario B, and the findings indicate that the introduction of greenery in the window view has a positive impact on VSA of children with DS, if the sky view is maintained. These findings can be used towards a design framework for classrooms in the future contexts of education in Sri Lanka.

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1. INTRODUCTION

The concepts of inclusion, inclusive architecture, inclusive education etc. are relatively new concepts to Sri Lanka. According to Muttiah (2016) sufficient attention is not given to these concepts by any sector, parents, education centres, or government in Sri Lanka. However, as per UNSECO, with the government's new plans and goals for inclusive education in the near future, this approach should foster learning environments in which

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individual needs are met and every student has a chance to succeed. Physical environmental needs are discussed mostly related to mobility or sensory impaired individuals. This creates a need to address the need for design interventions for intellectually impaired individuals as well. One in every 700 babies in the world is born with an intellectual disability such as Down Syndrome (DS), Autism Spectrum Disorders, Cerebral Palsy etc. (Roizen, 2002). Since the main issue they face with their impairment is the low level of cognitive functioning, architecture can play a vital role which supports them in their learning environments, which in turn supports in developing their skills and cognitive functioning, because the environment is the most powerful tool in fulfilling mental and psychological needs of a user.

1.1. Significance of the Study and Hypotheses

Even though there are existing studies in the proposed domain, this research focuses in detail on an aspect of the research findings by Tufvesson (2007), which is shown as 'inconsistent', particularly, related to the view of greenery in the window view in crafting a framework for the features of a classroom intended for the children with DS. Considering existing research, the following hypotheses were made.

- There is an overall positive impact of greenery in the window view on VSA of children with DS.
- Far view depth of greenery in the window view have a comparatively higher positive impact on VSA.
- Higher coverage of greenery in the window view has a comparatively higher positive impact on VSA.

1.2. Research Aims and Objectives

The main aim of this research is to complete a framework for design parameters for an optimal learning environment for children with DS, which in turn supports their cognitive development. A research gap in the study of Tufvesson (2007) for design parameters led this proposed research to develop a hypothesis for further studies on one of the design parameters. Given the research background, the main aim of this research is to find the impact of view of greenery in the window view on the sustained visual attention of children with DS. The key objectives are;

- To complete the framework for the features of a classroom intended for children with DS by Tufvesson (2007).
- To study the preference for greenery in the window view by children with DS.
- To study the ability of children with DS to attend to a given task without being distracted by varied scenarios of greenery.

Finally, the research findings will be used to complete a design framework, using the existing research findings by Tufvesson (2007), aimed at concentration of children with DS in the learning environment.

1.3. Scope, Assumption and Limitations

The limitations faced during the study was the difficulty in altering or experimenting with design features in their ordinary learning environments, due to their sensory needs, which highlighted the need to carry out the study with the use of virtual environments. Even though there are other factors of window view quality, the study only focused on the view depth and percentage of greenery through the view. The study assumed that Tufvessons's (2007) findings regarding design parameters for the children with DS are applicable here in Sri Lanka.

2. LITERATURE REVIEW

2.1. Intellectual Disability: Definition and Assessment

According to the American Association on Intellectual and Development Disabilities (AAIDD), intellectual disability can be defined as, "a disability characterized by significant limitations both in intellectual functioning and in adaptive behaviour, which covers a much of everyday social and practical skills. This disability originates before the age of 18" (AAIDD, 2010). As stated by American Psychiatric Association [APA] (2021), intellectual functioning can be measured with "individually administered and psychometrically sound tests of intelligence". Standard Intelligence Quotient (IQ) tests such as Wechsler Intelligence Scale for Children (WISC), Wechsler Preschool and Primary Scale of Intelligence and Wechsler Adult Intelligence Scale (WAIS) are practiced depending on the person's age. A score two or more standard deviation below the mean value is considered a significant deficit (IQ of 70 or below), and the deficit is categorized in four levels as Mild (IQ 50-69), Moderate (IQ 35-49), Severe (IQ 20-34) and Profound (IQ <20).

Meanwhile, the adaptive behaviour is assessed, based on semi-structured interviews and observations using tools such as Vineland Adaptive Behavior Scales and they are generally based on parent or guardian reports (Sparrow & Cicchetti, 1989). It assesses a collection of conceptual, social, and practical skills which are needed to be performed in day-to-day life.

2.2. Categorization of Developmental Disabilities

As AAIDD (2010) defines intellectual disabilities belong to a common subgroup of developmental disabilities. 'Developmental disabilities' is an umbrella term that includes intellectual disability, but also includes other disabilities that are apparent during childhood such as DS, Autism spectrum disorder (ASD), cerebral palsy, etc. Developmental disabilities can be cognitive or physical or both. Unlike in ASD and cerebral palsy where an intellectual disability may or may not be present, individuals with DS always have an intellectual disability. Therefore, in conducting further studies reducing compounding results, DS is chosen as the main-studied disability to maintain the consistency of the study.

2.3. Down Syndrome (DS)

DS is the most commonly occurring chromosomal condition. According to Pompon (2009), DS is resulted mostly by trisomy 21, which is having an extra (third) copy of the 21st chromosome. As stated above, it is the most common single cause of intellectual disabilities, and 70-80% of people with DS have an IQ range of 25-50 in the first 10 years of their lives (Menkes & Falk, 2005). Munagamage (2020) elaborates on the types of chromosome anomalies in DS.

- Trisomy – 95% of DS cases are of trisomy 21, where in nondisjunction the 21st chromosome has an extra, and therefore repeats it in each cell of the body
- Mosaicism – This is a rare case of 1% of the DS population, where some cells only consist of 47 chromosomes, while other cells have typical 46 chromosome arrangement
- Translocation – 4% of DS cases are of translocation, where the extra 21st chromosomes are attached to other chromosomes

2.3.1. Social characteristics of DS

The social development of individuals with DS is considerably delayed compared to a typically growing individual. Children

with DS are often seen as very sociable, affectionate, cheerful, and sunny, however there are social-emotional challenges as well. Most children and adults may develop good social skills with appropriate behaviour; however, they may experience troubles in controlling impulses, communication and relating to other children and adults and managing frustration etc.

2.3.2. Psychological characteristics of DS

As discussed in the previous section, individuals with DS have moderate to severe IQ levels. Therefore, it is noticed that DS affects the learning and psychological development of individuals. Characteristic patterns can be observed in their learning of skills compared to a typically growing individual (Harvey, 2004). Furthermore, Marcell and Armstrong (1982) states that the visual sense is stronger than auditory in attention and memory capacities of children with DS. Therefore, this suggests that the learning process of children with DS is more effective when their visual materials and environments are more supportive.

2.4. Influence of Classroom Environment on Children with DS

The learning process of children with DS cannot be expected to be as same as a typically growing child due to their different cognitive development. Consideration should be given to the fact that children with DS have difficulties related to concentration, attention and memory and have stronger visual memory than auditory memory. Therefore, Boza, Gutierres & Loro (2020) proposes four roles that architecture of inclusive education must fulfil.

2.4.1. Physical Spaces for Education

The architectural spaces are part of the education process, to stimulate the teaching/learning process of children with intellectual disabilities. It is concluded through research, that the physical environments should be open to outside and flexible, to achieve comfortable Architecture both physically and visually for optimal development of the learning process (Boza, Gutierres & Loro, 2020).

2.4.2. Perception and Sensation of Educational Environments

The learning space for children with intellectual disabilities should ensure that it caters all senses, to enhance cognitive skills providing comprehensive sensory stimulation. The built environment should aim for cognitive training, since they are at a level where they learn from the environment they interact with (Boza, Gutierres & Loro, 2020).

2.4.3. Synergy of Educational Space

Finally, they emphasize that built environment should be an active agent in learning, creating a socio-cultural environment in the classroom, specifically for children with mental disabilities. This provides chances to evoke their sense of creativity, adaptability, sense of materiality and interaction with the environment (Boza, Gutierres & Loro, 2020).

2.5. Attention Ability

The ability to choose and concentrate on a particular stimulus can be given as a general definition of Attention. This is a complex cognitive process which people use in almost all day-to-day activities, and it positions oneself towards the stimulus and create responses. Various definitions

and models have been developed over time by scientists and researchers related to attention on experimental studies. Understanding these models of attention is required in further research on architectural impacts on attention.

2.5.1. Models of Attention

Among the various accepted models of attention, the hierarchical model from Sohlberg and Mateer (2001) is considered one of the most accepted, which is developed on neuropsychology experiments. According to Sohlberg & Mateer (2001), attention model is described in five sub-components: focused attention, sustained attention, selective attention, alternating attention, and divided attention.

- Focused attention - This can be identified as the basic response to a stimulus which can be external or internal. The stimulus could be visual, auditory, tactile, or cognitive. Assessing focused attention consists of tasks which require fast processing, identification, and thorough scanning of targets.
- Sustained attention - This can be presented as a continuously maintained response over a time to a stimulus. Sohlberg and Mateer (2001) refer to this as vigilance too, and these are mostly assessed using visual or auditory continuous assessments. Computer based tasks are widely used in this area such as Test of Variables of Attention (TOVA), Conners Continuous Performance Test, and Conners and Multi-Health System Assessment (MHS).
- Selective attention - This is the ability to select and respond to a stimulus in the presence of other distractive stimuli, which can be either internal or external.
- Alternating attention - This is the ability to control the attention while switching in between different cognitive tasks.
- Divided attention - This can be presented as the ability to control attention and produce responses simultaneously to different cognitive tasks. Since this requires high working memory, assessments involving dual tasks are incorporated.

2.5.2. Attention Ability of Children with DS

Since children with DS have relatively short periods of concentration, it is very much essential to prolong that concentration time even if the duration is short, to ensure higher chances of learning. They often lose focus and do not attain the level of control. The concentration during the learning process of a child with DS can be observed by professionals and individuals working closely with them when they no longer have concentration. Concentration loss can be observed both in motion (leaving their place or fidgeting around) and even motionless (sitting on chair physically but not mentally) due to the nature of their intellectual impairment. Since it is difficult to identify a distinct marker for observation, it is suggested by Tufvesson (2007), that the 'focused sitting period' during a task which is known to them could be used as an indirect marker of the child's ability to concentrate (Tufvesson, 2007). Adapting this nature of the marker with Sohlberg and Mateer's model of attention, it can be justified that the key observation used here is the sustained attention which a child shows.

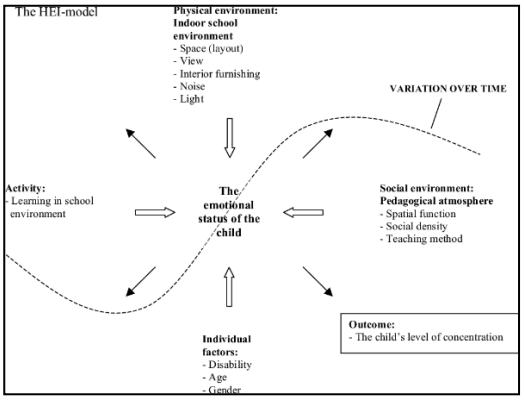
2.5.3. Sustained Attention in Children with DS: Visual vs. Auditory

According to Robbins (1998) and previous texts sustained attention requires the ability to detect unpredictable and rare

events over a prolonged period. Sustained attention stimuli can be either visual or auditory. Individuals with DS are superior in sustained attention to response task (SART) than auditory SART (Trezise et al., 2008). According to Pejovic et al. (2021), children with DS are slower in orienting their visual attention to stimuli, and distinct relationships are shown between the visual attention difficulties and poor literacy, numeracy, and social skills (Erik et al., 2016). Therefore, it is suggested that the development of physical environment factors and presentation of educational materials in visual medium may facilitate improved attention of children with DS.

2.5.4. Impact of Environmental Factors on Sustained Attention of Children with DS

Figure 1: HEI model for level of concentration of children with intellectual disability, adapted from Kuller's HEI model



Source: Tufvesson (2007)

Extracting from the Kuller's HEI model, Tufvesson (2007) has developed the HEI model for a child's level of concentration basing few case studies in the context of Sweden. The factors which influence the emotional status of the child which in turn has an effect on the level of concentration of child has been categorized as follows: Physical factors which is the indoor environment of school (Ex: space, view, interior furnishing, noise and light), the social environment which is the pedagogical atmosphere (ex: spatial function, social density and teaching method), the individual factors (ex: gender, age and disability) and finally the activity which is learning to process the level of concentration as an outcome.

2.6. A classroom for Children with DS

According to Tufvesson's (2007) conclusions on design parameters for an optimal learning environment, requirements for physical and social factors are shown in the results shown in the below table.

Table 1: Features of a classroom intended for children with DS

	Element	Positive (P)/ Negative (N)
Space	Several entrance doors	N
	Windows on several walls	N
	Several windows on one	P
	Large general classroom layout	N
View	Unavailability of view	N
	Sky view through the window	P
	View of buildings/ school yard	N
	View of greenery	**Inconsistent**
Interior furniture	Loose interior furniture, pillow seats, a computer	P
	Open shelf storage	N
Noise	Filtration of noise coming through	P
Light	Direct daylight on child's workspace	N

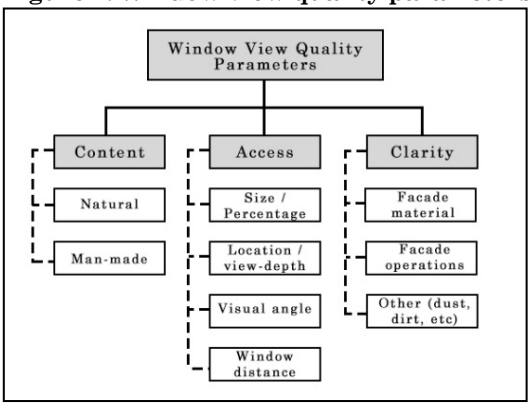
Spatial function	Small group rooms	P
	Individual seating that can be considered child's own space	P
Social density	High population density schools	N
Teaching method	One-to-one teaching	P

Source: Tufvesson (2007)

2.7. Window View

Research studies on window view quality are receiving increased attention in Architecture. It can be defined as "the quality of the visual connection to the outdoor that satisfies the building occupant" (Ko et al., 2022). As Heschong (2021) elaborates visual connections to outdoors which are related by window views seems to have positive impacts on people, including health, well-being, cognitive development, and reduced stress etc. Since these observations of window view is subjective, Ko developed three main components of the window view quality.

Figure 2: Window view quality parameters



Source: Ko et al. (2022)

2.7.1. View Content

View content emphasizes the available visual features through windows. The visual feature could be both natural and man-made features. He further elaborates on three horizontal stratifications as ground, landscape, and sky.

2.7.2. View Access

View access measures how much of the view is visible to the observer. Factors such as the size, location, visual angles, window distance etc. are discussed under this section.

2.7.3. View clarity

View clarity elaborates how clearly the observer can see the view from inside. These include the shading and glazing properties whose optical properties can affect the clarity of the view. Therefore, this framework and variables can be used in analysing the window views which are also influenced by contextual elements such as physical and social attributes.

2.8. Impact of Greenery in Window View on Attention

Kaplan (1995), in Attention Restoration Theory, describes that exposure to the natural environment can stimulate the attention capabilities of people. However, limited theoretical explanations have been published regarding greenery in this proposed domain of study. According to Hasso, there is a hidden psychological aspect of nature, where it could be very beneficial for cognition and increased levels of attention. Chawla et al. (2014), in one of their works, show the importance of green spaces for the development of children. The availability of green spaces in learning environments shows increased concentration and attention level in both typical children and even with attention difficulties, thereby reducing the participation limitations (Martensson et al., 2009). Several other studies show proof of developed sustained attention and working memory in a primary school

which has abundant green spaces (Dadvand et al., 2015).

2.9. Impact of Greenery in Window View on Sustained Visual Attention of Children with DS

According to Tufvesson (2007), the impact of several factors of view on attention is discussed. The results show regardless of the nature of the view, a window view is essential for the attention of children with DS, while the sky view brought positive results and schoolyard/built environment views brought negative results. Even though the above study has covered the area of view with respect to the concentration abilities of children with DS, the issue of greenery is unresolved, due to the inconsistency of results obtained and there is a lack of research done in this domain of concentration of children with DS. However, this research will hypothesize that the greenery effect for sustained attention is positive.

2.10. Research setting in Sri Lanka

Concepts on inclusion and inclusive architecture remains as relatively new concepts in Sri Lanka. By 2021, it is reported that the differently abled population is 1.6 million and there are no distinct statistics available on DS in Sri Lanka, due to difficulties in collection of registered data on the intellectual impairment. This can be a barrier in providing services for the population with DS at the national level. However, for the skills development of children with DS, proper education spaces are needed as discussed above. The most important aim of these spaces is to prolong the level of attention due to the lack of attention in them. Even though Tufvesson (2007) has studied the design parameters of environmental factors influencing the concentration level of children with DS, one of the four factors of the followed HEI model; the social environment is different in Sri Lanka with respect to the context of Sweden, due to it being a low- and middle-income country. The proposed research aims to build up and test the applicability of subcomponent of physical factors; greenery in view, since it shows an inconsistent of the results, hence developing the framework further to create an optimal learning environment for children with DS in Sri Lanka.

3. THEORETICAL FRAMEWORK

3.1. Research Matrix

Table 2: Research Matrix

Research question		**Data collected**	**Data collection method**	**Data collection instrument**	**Data analysis method**
		Demographic data and nature of intellectual disability and health status	Questionnaire to professionals or guardians	Custom – made questionnaire	SPSS data analysis and discussion
Preference for greenery in their window view		Comparative preference for greenery over other view factors	Picture card comparison	Multi-point graphical scale	SPSS data analysis and discussions
Sustained visual attention on varied views of greenery	VSA with low percentage of greenery / window size		Sustained Attention Response to Task (SART)	Computer based snap-game (CG) – Pressing key on non-targets and not pressing key on targets	SPSS data analysis on commissions and omissions
	VSA with high percentage of greenery / window size				
	VSA with far view greenery				
	VSA with close view of greenery				

Source: Author

4. RESEARCH METHODOLOGY

The research was designed in line with the previously completed research studies and their suggestions. The methodology was proposed to be a mixed method approach which followed both qualitative and quantitative data collection and analysis.

- A qualitative questionnaire – This was a report on their demographics filled by a parent/ guardian/ professional.
- Sustained Attention to Response Task (SART) – Generally, a computer-based task in which their commissions and omissions were recorded.

The proposed methodology did not intend to directly interact with the students, due to their nature of intellectual impairment, but through parents/ guardians/ professionals with proper consent.

4.1. Research Questions and Hypotheses

The main research question of the study was whether there is an impact of greenery in the window view on visual sustained attention of children with DS. Considering existing research findings on previously done studies, the following hypotheses were made in implementing the proposed research.

- There is an overall positive impact of greenery in the window view on VSA of children with DS.
- Far view depth of greenery in the window view have a comparatively higher positive impact on VSA.
- Higher coverage of greenery in the window view has a comparatively higher positive impact on VSA.

4.2. Research Setting

The study required a single school environment setting with the maximum no. of students for data collection. Therefore, out of the 4 schools agreed for the data collection of the research, the school with highest no. of children with DS was selected for the study.

The selected school for the study is located in Gampaha District of Western Province, Sri Lanka. This private school is run by the Sarvodaya Organization and provides education for children with intellectual disabilities such as DS, Autism, ADHD etc. The school provides services for 73 students of primary grades, out of which 23 students have DS.

Figure 3: Location of the case study with reference to Gampaha – Colombo main road

Source: Google Earth Images

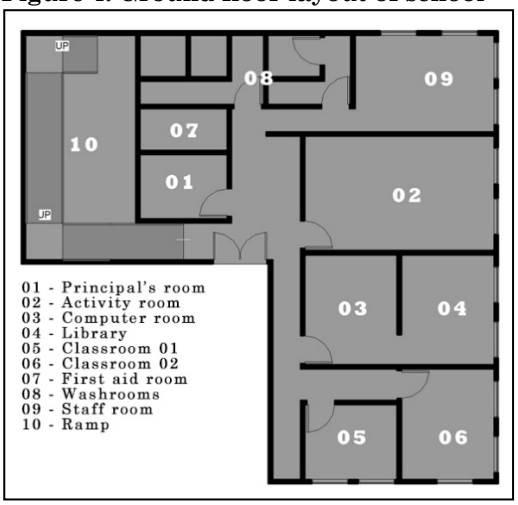
4.2.1. Selection of a classroom

The school building was a two-story building which consisted of 8 indoor classrooms, 5 utility rooms, 2 administrative offices and washrooms.

A single classroom needed to be selected for further implementation and data collection of the study. According to the school curriculum, apart from the nursery class at the ground floor in the room denoted in number 05, the children in all other classes change into different

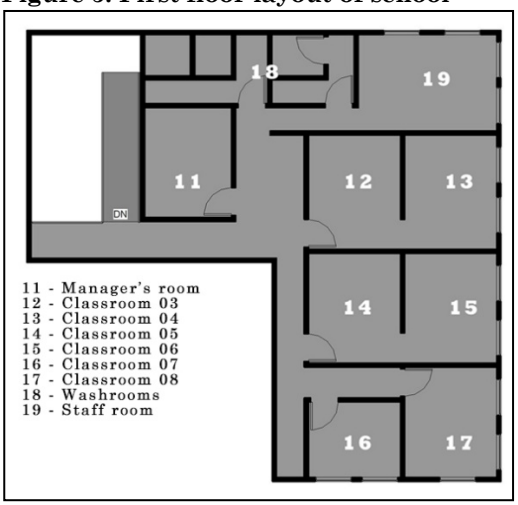
classrooms for collective activities and lessons. The classrooms' interior and layouts were identical, and classrooms 06, 13, 15 and 17 were with two windows each open to the building next to the site. Considering the demarcated nature of the classroom, classroom 8, which is denoted in number 17 was chosen for the study.

Figure 4: Ground floor layout of school



Source: Author

Figure 5: First floor layout of school



Source: Author

4.2.2. Sample selection and sample sizes

Out of the 73 students registered in the school, children with other intellectual abilities such as Autism and ADHD are excluded in this study, to maintain the consistency of the nature of the intellectual impairment. The sample selection was done by the principal of the school considering their labels of nature of nature of intellectual impairment in the register based on their medical reports. According to the register, 23 participants were eligible to participate in the study. Out of the 23 students, 4 were not eligible due to leaving the school in the past few months. Therefore, the final eligible no. of students was 19. Since the SART task needs a simple hand gesture of touching the screen, the selected samples needed to have sufficient gross and fine motor skills. It was simply screened through a simple instruction to touch the screen of the smartphone during the screening questionnaire.

4.3. Data collection

Considering the nature of the intellectual impairment, approaching the children directly was avoided and any changes to their ordinary environment were avoided, as this group of children are very sensitive to their day-to-day environment, and it could also lead to false inputs of levels of attention.

4.3.1. Selection of variables for the study

The key parameters of window view quality were carefully considered in selecting the variable parameters for the research study. According to Ko (2022), out of the three horizontal stratifications of view content, which are ground, greenery, and sky, it was observed that only the greenery and sky could be viewed from the windows of the classrooms of the

selected case study. Considering the clarity in the window view, the existing scenario of windows were selected as open, thereby the variation of façade material, façade operations, dust and degradation could be neglected or considered constant. Among the parameters of window access the size of the window, visual angle and window distance from the seat were considered as constant, therefore the only remaining parameter was the view depth. Hence, the key variable parameters considered were amount / percentage of greenery and the view depth from the seated student. The two parameters could be combined to give out four scenarios as below.

Percentage of greenery - The existing views from classrooms of the case study did not contain any greenery in the view. Therefore 0% of greenery was considered as the greenery percentage in the controlled scenario. The two variable scenarios were selected in mid-range and high-range to be evenly distributed. The low percentage of greenery was considered 40-60% of greenery of the window view size. High percentage of greenery was considered 80-100% of greenery of the window view size.

View depth - The distance between the school building window to the boundary was observed to be 6m. Since the existing condition did not contain any greenery at all in the controlled scenario, near view depth was considered 1m – 2m from the window, and far view depth was considered 5m to 6m from the window.

Table 3: Selection of parameters of greenery

	Parameter 1 – Low percentage of greenery	**Parameter 2 – High percentage of greenery**
Parameter 3 – Near view depth	Scenario 1 – Low %, near view depth	Scenario 3 – High %, near view depth
Parameter 4 – Far view depth	Scenario 2 – Low %, far view depth	Scenario 4 – High %, far view depth

Source: Author

Rough views were modelled considering the four possible scenarios and contradictions in the views were observed as shown in the below table. Therefore, the final variable parameters were narrowed down to,

- Low percentage of greenery with far view depth, &
- High percentage of greenery with near view depth

4.3.2. Data collection process

Data Collection I was the photographic study of the existing classroom environments. Both photographs and videos were collected. Measurements of the room and placements of existing design elements and furniture were recorded to create the 3D simulated environments.

Data Collection II was the screening questionnaire followed by the parental consent, which was filled in by the parents, guardians or a professional. This questionnaire was focused on the child's basic demographic profile and accessibility to technological devices and connections. Room and placements of existing design elements and furniture were recorded to create the 3D simulated environments.

Data Collection III was the results of the Sustained Attention to Response Task (SART). This computer-based task is designed in the form of a game to attract students in the process, where they will be asked to press a key in the presence of a non-target and not to press a key in the presence of a target. The task needs to be done in the existing controlled scenario and while the parameters of greenery in the window view are changed as follows.

I. Existing scenario, no greenery at all (Scenario A)

II. Lower percentage of greenery with high view depth (Scenario B)

III. Higher percentage of greenery with low view depth (Scenario C)

Data collection IV was a graphical measure of the preference of greenery for the window view by the children with DS. The students were asked to identify the picture with the view they like the most.

For the successful completion of data collection, 9 working days were utilized for the data collection process.

4.3.3. SART

Sustained Attention to Response Task (SART) is the general study to observe the sustained attention ability of a person, and it can be used for any individual regardless of their intellectual disabilities. The same study task has been done for children with DS in other literature, and therefore the same task will be used in the proposed research design with few alterations to respond to the user needs. As discussed in the literature review, children with DS are superior in visual than auditory. But considering the intellectual ability of children with DS, it was advised to alter the standard SART test which had numbers as targets and nontargets to be replaced by visuals they could easily understand. The hierarchy of visual presentation (Tutton, 2016) was used in determining the form of presentation. According to Tutton (2016), real 3D objects are the easiest form of visual communication. The list goes from real objects to writing varying from easier to harder to understand. Therefore, 2D photos of the objects were used in the SART test. Images are displayed on a white background for better contrast.

4.3.4. Experimental Setup

Considering the nature of the intellectual impairment, it was planned to avoid making any changes to their ordinary environment, as this group of children were very much sensitive to their day-to-day environment, and it could lead into false inputs of levels of attention. The existing environment was used as the controlled scenario, and the two variable parameters of window view were modelled using SketchUp while keeping all the other factors a constant. Since the process had to follow the best method of exposing to the experimental environment, realistic images were rendered using Lumion software. As a learning outcome of the pilot study, simulation animations were also rendered with videos of 5 minutes to expose the children better to the experimental environment. The SART was designed to be done through a mobile device while the simulation would be displayed on another computer screen. The simulated images of the three scenarios were as follows.

Figure 6: Scenario A – Existing view with no greenery

Source: Author

Figure 7: Scenario B – 40% to 60% greenery at far view depth

Source: Author

Figure 8: Scenario C – 80% to 100% greenery at near view depth

Source: Author

The time allocation for each test was 20 minutes including the preparation time. SART tasks were performed on each scenario with a gap of 1 day between each session to avoid unnecessary sensory overloading.

4.4. Data Presentation and Analysis

The discussion is based on the demographics, SART response comparison and the window view preferences. The research analysis used SPSS statistical software for an accurate and reliable analysis of data. The nature of the research requires a pre-intervention – postintervention analysis of the same sample. Hence, the most appropriate test was used in analysing the obtained data using SPSS software.

4.4.1. Demographic information

The following tables represent the demographic information of the participants on their age and gender.

Table 4: Demographic information of participants

		Frequency	Percentage (%)	Cumulative Percentage (%)
Age	7	1	5.3	5.3
	8	2	10.5	15.8
	9	3	15.8	31.6
	10	2	10.5	42.1
	11	3	15.8	57.9
	12	2	10.5	68.4
	13	1	5.3	73.7
	14	1	5.3	78.9
	15	1	5.3	84.2
	16	3	15.8	100.00
Gender	Female	9	47.4	47.4
	Male	10	52.6	100.0
	Total	19	100.0	

Source: Author

Table 5: Descriptive statistics of age samples

No. of samples (n)	19
Minimum age (yrs.)	7
Maximum age (yrs.)	16
Range (yrs.)	9
Mean age (yrs.)	11.42
Std. deviation	2.893

Source: Author

In the primary school where the research was conducted the students were not placed in classrooms according to their chronological age, therefore all eligible students at the school were tested in this study. Hence, the age of the population has an age range of 9 years from 7 to 16 years. The mean age of the population of the study was 11.42 years. The samples

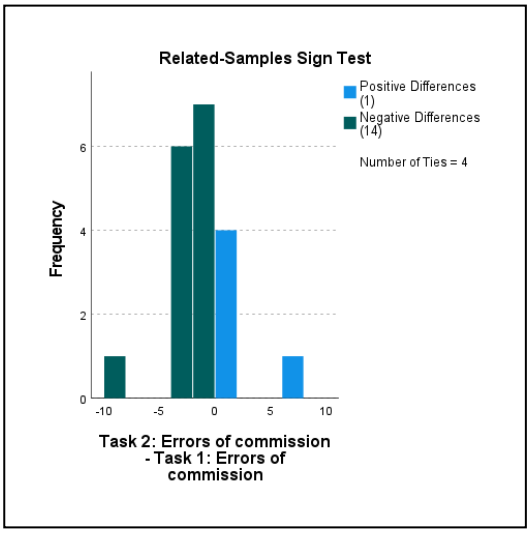
consisted of 47.4% female and 52.6% male students, where it represented almost a fair distribution in terms of the gender variation.

4.4.2. Analysis of the SART results

The impact of the greenery in the window view on visual sustained attention was measured by the number of errors of commission in SART test. A sign test was used to determine whether there is a median different between the measurements of the pairs of scenarios.

4.4.2.1 Errors of commission : Scenario A vs. Scenario B

Figure 9: Related samples sign test for Scenario A vs. Scenario B



Source: Survey Data

Table 6: Negative and positive differences of Scenario A vs. Scenario B

Negative differences[a]	14
Positive differences[b]	1
Ties[c]	4
Total	19

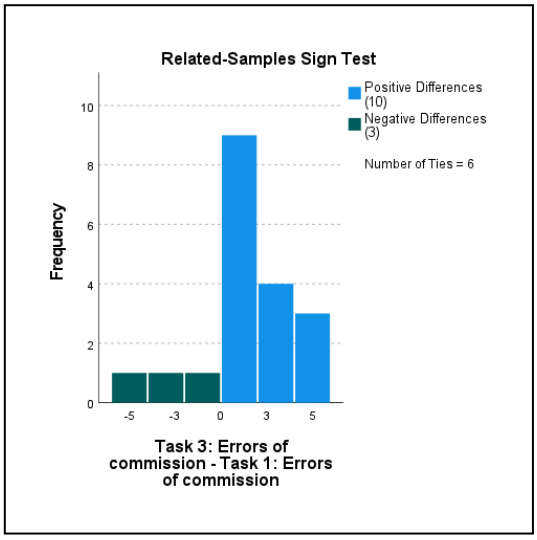
Source: Author

a. Scenario B errors < Scenario A errors
b. Scenario B errors > Scenario A errors
c. Scenario B errors = Scenario A errors

Following an exact sign test for the 15 participants (ties excluded), the view with 40%-60% greenery at far view depth showed a statistically significant median increase in VSA compared to the window view with no greenery.

4.4.2.2 Errors of commission : Scenario A vs. Scenario C

Figure 10: Related samples sign test for Scenario A vs. Scenario C



Source: Survey Data

Table 7: Negative and positive differences of Scenario A vs. Scenario C

Negative differences[a]	3
Positive differences[b]	10
Ties[c]	6
Total	19

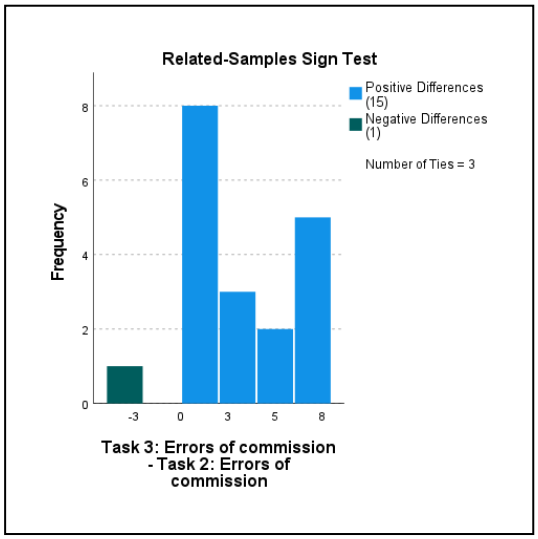
Source: Author

a. Scenario C errors < Scenario A errors
b. Scenario C errors > Scenario A errors
c. Scenario C errors = Scenario A errors

Following an exact sign test for the 13 participants (ties excluded), there was no statistically significant median increase in the VSA with the window view with no greenery compared to the window view with 80%-100% greenery at near view depth.

4.4.2.3 Errors of commission : Scenario B vs. Scenario C

Figure 11: Related samples sign test for Scenario B vs. Scenario C



Source: Survey Data

Table 8: Negative and positive differences of Scenario B vs. Scenario C

Negative differences[a]	1
Positive differences[b]	15
Ties[c]	3
Total	19

Source: Author

a. Scenario C errors < Scenario B errors
b. Scenario C errors > Scenario B errors
c. Scenario C errors = Scenario B errors

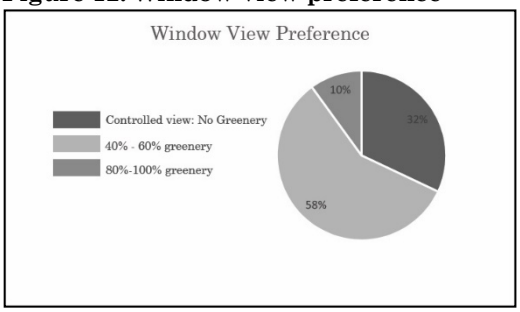
Following an exact sign test for the 16 participants (ties excluded), the view with 40%-60% greenery at far view depth showed a statistically significant median increase in VSA compared to the window view with 80%-100% greenery at near view depth.

4.4.2.4 Analysis between the test pairs

The three scenarios were compared to rearrange the order of impact of greenery in window view on VSA. The results show that there is a statistically significant positive impact of the window view at Scenario A than the other two scenarios. The results also show that the window view at Scenario A has more positive impact on VSA than at Scenario C. However, due to the insignificance of the sign test, a conclusion on the positive impact of those two window views cannot be represented.

4.4.3. Window View Preference

Figure 12: Window view preference



Source: Author

The window view preferences were collected from the 19 participants by asking them to point out the window view they like the most out of the three pictures. The results of the collected data show that 58% of participants selected the view with 40-60% greenery, while 32% participants selected the existing view with no greenery, and the remaining 10% selected the view with 80-100% greenery. Therefore, the view which the participants preferred the most is the view with 40-60% greenery, and this order of results agree with the results of the median differences and positive, negative differences. According to the results of data analysis, there is a statistically significant positive impact of the window view with 40% - 60% greenery than the other two window views. The results also show that the window view with no greenery has more positive impact than the window view with 80% - 100% greenery.

5.CONCLUSION AND RECOMMENDATIONS

According to Kaplan's (1995) restoration theory, the exposure to natural environment can stimulate the attention capabilities of people and especially availability of green spaces in learning environments show increased concentration and attention level in both typical children and children with attention difficulties. (Chaw et al., 2014). Therefore, the assumption was that the introduction of greenery in the window view of classrooms would increase the sustained attention levels of children with DS.

The findings support the assumptions partially. While a majority of the participants (58%) selected the window view with 40% - 60% greenery, the window view with 80% - 100% greenery did not show any positive impact on visual sustained attention over the window view with no greenery. Also, the increased level of greenery from 40% - 60% to 80% - 100% did not have an increased level of visual sustained attention as expected.

According to the researcher's observations, the contents of the window view should be further studied to elaborate on this. According to Tufvesson (2007), regardless of the nature of the view, a window view is essential for attention of children with DS, and the sky view through window was stated as a definite positive design parameter. Therefore, the tendency of preference for window view with no greenery over the view with 80% - 100% greenery may have been due to the sky view. However, it is significant that the addition of greenery at 40% - 60% with far view depth increased the visual sustained attention levels.
The positive impact of view with 40% - 60% greenery at far view depth over the 80% - 100% greenery with near depth, could be due to the absence of sky view despite the amount of greenery being increased. Therefore, in conclusion, a complete framework for the design parameters of the window view can be presented as follows, adding to the findings of Tufvesson (2007).

Table 9: Complete design framework derived through research findings

Factor	Element		Positive (P) / Negative (N)
Physical – Window view	Tufvesson (2007)	Unavailability of a view	N
		Full sky view through the window	P
		Full view of buildings / school yard	N
	Results from the study	Greenery at far view depth with sky view	P
		Full greenery at near view depth	N

Source: Author

This analysis could be studied furthermore accurately if a larger number of participants could be tested from a smaller range of age. Since the impact of sky view too is observed to have an additional impact on the impact of greenery on visual sustained attention, this study could be projected to a research which could compare the magnitude of impact of each view content such as sky, greenery, landscape and buildings on visual sustained attention of children with DS, and also as a comparison between typically growing children and children with DS, as a design framework for classrooms in the future context of mainstream education in Sri Lanka.

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