A Game-based Spatial Navigation Tool for Children with Visual Impairment

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Abstract

Although spatial navigation plays an important role in day to day life, there is a lack of tools, especially in the form of digital games which are able to aid visually impaired children in this aspect. The majority of tools and research developed with the purpose of conveying spatial information to the visually impaired are too complex and difficult for children as they are developed for adults. Many of these spatial navigation tools also lack portability as they are computer-based and use special equipment. This makes most of the existing tools difficult and expensive to set up for general use.

The aim of this research is to address these issues by developing a serious spatial navigation mobile game for visually impaired children which is engaging and interactive. The game is developed for use on an Android device and is portable and requires no difficult setup to use. The prototype developed is called *Hungry Cat* and allows players to take the role of a cat which has been left at home and wants to find food. Through the game, the players will be able to navigate around various levels featuring rooms of a house to find food. This game was tested with 30 visually impaired children consisting of 17 with low vision and 13 with no vision, to evaluate its success in conveying spatial information.

The game is evaluated through two tests, a food finding test and a wire net test. Food finding test is a game mode which finds out how quickly the players are able to locate a food item within the room that they have just explored. The wire net test on the other hand, allows the player demonstrate his/her spatial mental map of the explored room, by pointing out the placement and size of each item that he/she found in the room. The evaluation results from the two tests showed that the mobile game was indeed able to convey spatial information through the exploration of a virtual environment and the users can learn in a fun and interactive way.

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Declarations

“This thesis is an original work written under the guidance of my research supervisor, Dr. Lau Bee Theng and Dr. Pan Zheng. All resources used have been cited accurately according to the academic citation rules established. The content and result of this thesis have not been submitted to any other university or institute for a degree or any other qualification.”

Carmen Chai, May 2018

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Chapter 1 Introduction

Spatial navigation is an essential skill which is used in day to day life for things such as planning how to get to one's destination, manoeuvering around a complicated environment and even returning to one's car after walking about in a new place. But what is spatial navigation actually?

Wolbers and Hegarty (2010) stated that spatial navigation, being one of the most vital cognitive functions, is the capability of finding one's way in our environments and requires both perception and memory of the environment. Using multiple senses such as sight, hearing, sense of direction, and sense of location, the process of spatial navigation is where information gathered and known are combined and used while moving about in an environment over a period of time. It is common for the ability of spatial navigation to vary widely among different people. The internal representations of spatial knowledge gathered are known as cognitive maps (Cobo et al. 2017). Cognitive maps are also known as spatial mental models or spatial mental maps and these terms are used interchangeably in this study.

As mentioned earlier, spatial navigation is an ability that differs widely among different kinds of people. This includes those with visual impairments as well those with learning difficulties or learning disabilities.

There are two main categories of visual impairment considered for this study. Mandal (2012) listed three categories of visual impairment: low vision or moderate visual impairment, legal blindness as well as blindness. In this study, participants with blindness and legal blindness will be grouped together under the category of "no vision", while others with moderate visual impairment will be categorised under "low vision".

According to the Learning Disabilities Association of America (2017), learning disabilities which result in learning difficulties are processing problems that are neurologically-based. It is an umbrella term used for describing the various more specific learning disabilities such as dyslexia and dysgraphia. Learning disabilities differ from learning problems which are caused by other forms of handicaps such as visual, hearing and motor, emotional turmoil or economic, cultural or environmental disadvantage. Even though learning disabilities are not curable, they can be improved with the right support. In this study, participants with any form of learning difficulty resulting from having a learning disability will be categorised as having them.

There are several ways of conveying spatial information for the purpose of spatial navigation for the visually impaired or the blind. These include tactile maps and models that can be read through touch and also navigation aids that come in the form of GPS or obstacle detection. There are also systems developed through research that are able to convey spatial information. However, these are made for research purposes and are not available for general use. These methods will be covered in Sections 2.6 and 2.7 later.

1.1 Research Problem

The research problems (RP) of this research are:

RP1. It is common that people with sight even though being blindfolded have better spatial navigation skills than the visually impaired. Spatial navigation skills differ among those with visual experience and without visual experience. Ruotolo et al. (2017) states that spatial information is encoded differently and that early blind participants encode this information in a sequential manner while sighted people encode the information in a simultaneous manner. Late blind participants and blindfolded sighted participants also performed better due to their visual experience.

RP2. It is also common that people with better learning ability are better in spatial navigation. A study conducted by Van der Molen et al. (2009) has shown that children with mild learning disabilities were found to have performed below the standard of similar aged peers in tasks involving the short term memory and the working memory. Working memory involves the maintenance and manipulation of information including spatial information.

RP3. There are some methods of conveying spatial information to the visually impaired in the form of a virtual environment available, but they are not for children. These are discussed in Section 2.7.

RP4. Even though we are in the digital age, there is a lack of engaging and interactive tools in the form of games for the visually impaired. More specifically, there is a lack of mobile games, involving spatial memory and navigation. There is a lack of mobile based virtual environment spatial navigation games for the visually impaired, especially for children. As reviewed in Section 2.7, most research has developed systems to aid the visually impaired but the majority of them are for desktop use, are not games and are not targeted towards children.

The research problems posed resulted in the following research questions (RQ):

RQ1. Do spatial mapping skills relate to the prior spatial navigation and vision experience of the visually impaired?

RQ2. Do spatial mapping skills relate to the learning ability of the person with visual impairment?

RQ3. Does a game based spatial navigation skills learning tool help in creating spatial cognitive maps for the visually impaired?

1.2 Research Objectives

This study aims to design, develop and evaluate a mobile game prototype which allows the visually impaired children to learn spatial navigation skills in a virtual environment. The following Research Objectives have been formulated:

RO1. To identify limitations/problems in the existing virtual environment spatial navigation tools for the visually impaired.

RO2. To design and develop an enhanced audio and haptic based virtual environment spatial navigation skills learning prototype which is engaging, interactive, portable and able to track the progress of the user.

RO3. To evaluate the performance of the prototype in conveying spatial information to the visually impaired children, and determine if spatial mapping skills are affected by vision experiences or learning disabilities.

1.3 Short Description of Research Methodology

Figure 1.1 shows the proposed research methodology. Initially, a literature review is done to ensure the novelty of the prototype and to get an idea of what has already been done in the field. The prototype is then designed and developed before being tested. The test results and findings are then analysed and reported.

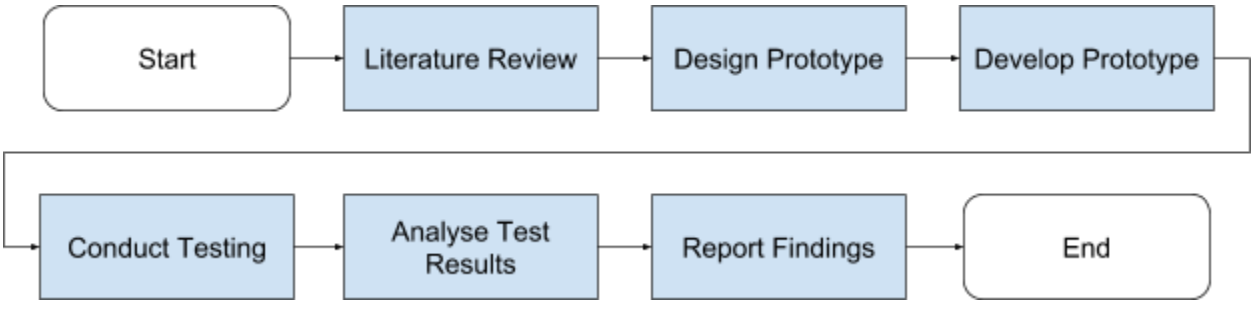

Figure 1.1 Research Methodology

Figure 1.2 illustrates how the Research Problems, Research Questions and Research Objectives of this study are connected to one another.

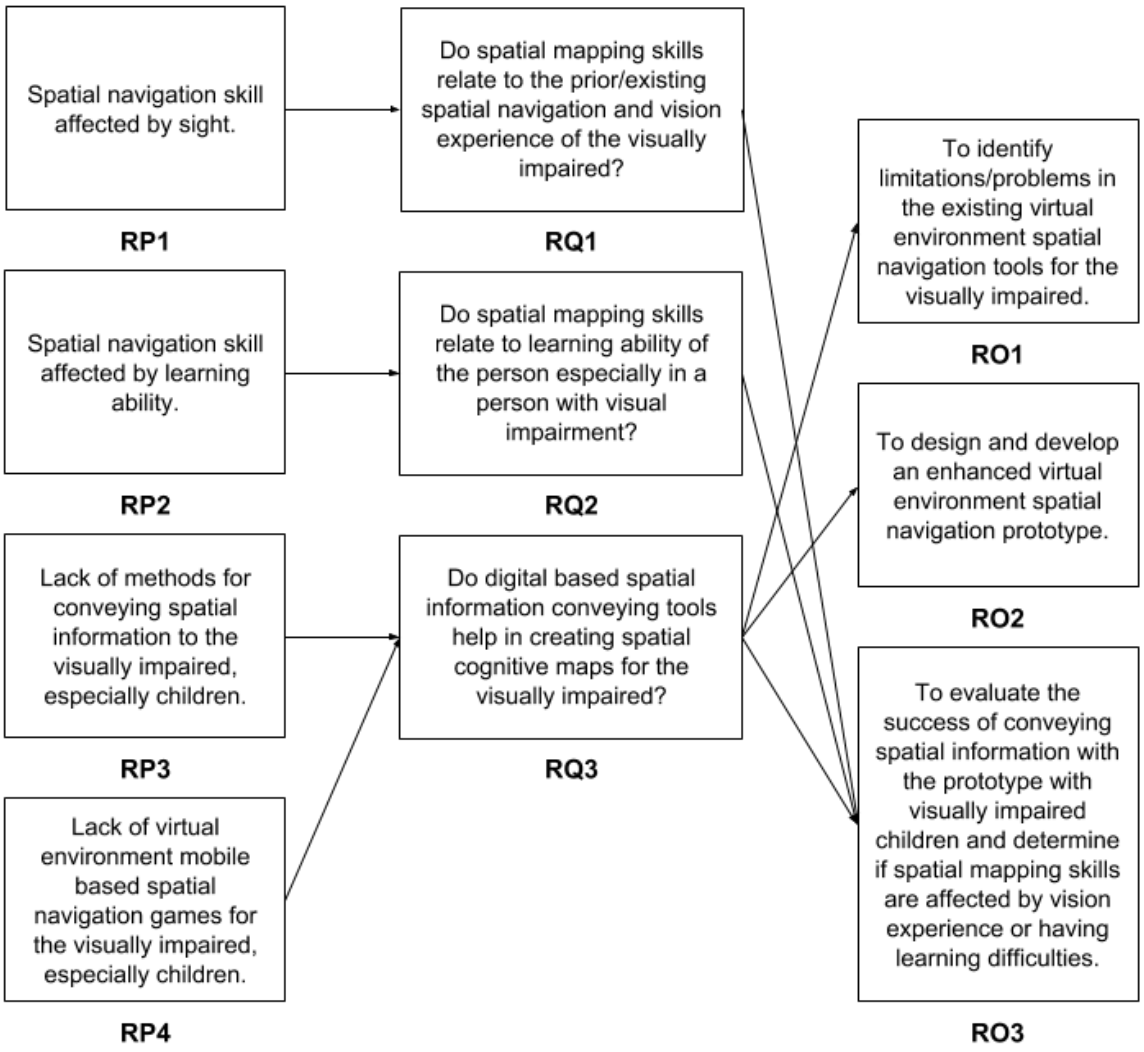

Figure 1.2 Mapping Research Problems, Research Questions and Research Objectives

1.4 Expected Contributions

There are several contributions to be expected from this study. Limitations and problems of existing spatial navigation tools are identified. An interactive and engaging game prototype that allows the visually impaired to navigate around a virtual environment to obtain spatial information is designed, developed and evaluated in this study. The prototype testing also allows deeper understanding in the difference in spatial navigation skill levels among different groups of students, such as those with low vision and no vision, and also those with and without learning difficulties. It also determines if having visual experiences such as in the case of students with low vision will result in better spatial navigation abilities, and also if having a learning difficulty will affect one's spatial navigation abilities.

1.5 Overview of the Thesis

The thesis contains five chapters as follows:

Chapter 1 Introduction

This chapter gives an overview of the research paper and includes the Research Problems, Research Questions and Research Objectives of this study.

Chapter 2 Literature Review

Chapter 2 covers the existing research that aligns with the goals of this study. It gives general information that is relevant to the study. It also states the limitations and drawbacks of each study to be improved upon in the prototype, and gains inspiration for the modelling and design of the prototype.

Chapter 3 Modelling and Prototyping

This chapter starts with the conceptual modelling of the prototype, followed by the actual design of the prototype. It breaks down and elaborates upon the different development process of the game.

Chapter 4 Evaluation

This chapter covers the testing environment and procedures. It provides the test results and analysis, and the findings and discussions drawn from it.

Chapter 5 Conclusion and Future Work

Chapter 5 gives a summary of the contribution of the study. It also covers the future improvements that can be made to it.

Chapter 2 Literature Review

This chapter covers the reviews of the existing research that are related to this study and are divided into nine sections.

Sections 2.1 until 2.5 cover general information to give better understanding of the problem space. This general information includes “Visual Impairment”, which gives an idea about what visual impairment is as well as include a summary of the World Health Organization (WHO)’s Global Data on Visual Impairments 2010. It will also include information about “Orientation & Mobility (O&M)”, what a “Spatial Mental Model” is, information about “Navigation” and how it differs for the blind and finally, “Virtual Reality” and its uses.

Section 2.6 includes methods for conveying spatial information to the visually impaired that does not involve exploring a virtual environment. Section 2.7 covers “Virtual Environment Simulation for the Visually Impaired” which will review studies that have developed and tested a virtual environment that can be explored without vision. Section 2.8 covers “Mapping Out Spatial Information for the Visually Impaired” which explores the methods used for the visually impaired to convey spatial information. The final section of this chapter is the Critical Review which shows how the literature reviews help in forming the proposed solution.

2.1 Visual Impairment

The Centers for Disease Control and Prevention (2017) defines visual impairment as having 20/40 or worse sight even with the best possible correction such as eyeglasses in the better eye. Visual impairment can range from low vision to total blindness, however “legal blindness” is categorised as having 20/200 or worse vision in the better eye, or a visual field with a diameter of under 20 degrees. This categorisation is important for determining if a visually impaired person is eligible for disability benefits from the government.

According to Duffy (2014), majority of eye care professionals describe “low vision” as a form of visual impairment that is permanently unable to be improved or corrected using glasses, contact lenses, surgery or medication that will affect the person’s ability to do everyday activities. Total blindness is defined as having a complete absence of light and form perception which is the ability to tell the difference between light and dark, and also the inability to detect change in movement and light source. Total blindness is uncommon as only 15% of individuals with visual impairment are categorized to be completely blind.

The World Health Organization (2017) states that vision function is grouped into four general categories, which is normal vision, moderate vision impairment, severe vision impairment and blindness. Moderate and severe vision impairment are grouped together under the term “low vision”. People over age 50 who are prone to chronic eye diseases and children below the age of 15 who may develop refractive errors are more at risk of becoming visually impaired. However, due to overall socio economic development, increased public awareness on how to help recover from vision impairment, conducted public health action and the increase of eye care service availability, there has been a decrease in worldwide vision impairment since the 1990s.

Major diseases that cause blindness according to the Centers for Disease Control and Prevention (2017) are as follows:

- Cataract - The clouding of the eye’s lens which blocks and changes the passing of light which is required for seeing. It can cause the individual’s vision to become dimmed or blurred due to light being unable to reach the retina, which is the layer at the back of the eye that channels images to the brain, properly.
- Glaucoma - This disease increases the pressure in the eye, which can result in damage to the optic nerve cells that carry information from the eye to the brain. In early forms of the disease the individual will first lose their peripheral vision, followed by a decrement of central vision and eventually or potentially, leading to blindness.
- Age-related Macular Degeneration - This disease comes in two forms, non-exudative (dry) and exudative (wet) and affects the part of the retina that produces clear and sharp central vision.
- Diabetic Retinopathy - Diabetes can cause deterioration of the small blood vessels in the eye’s retina to the point where they break down. This is the most common cause of blindness in working-age adults.
- Trachoma - This is an infectious eye disease. Repeated infections of this disease can cause serious scaring to the inside of the eyelid which leads to the eyelashes scratching the cornea of the eye. This can result in blindness.

2.1.1 World Health Organization Global Data on Visual Impairments 2010

In 2010, the World Health Organization (WHO) conducted a global study to gather data and information on the percentage of visual impairments among the human population (Pascolini & Mariotti 2011). The purpose of the study was to establish policies as well as priorities to assess

global eye health with the latest information on the trend and causes of visual impairment. As conducted before in the years 1995, 2002 and 2004, the systematic research and review of all available data in order to get a worldwide estimation of visual impairment for the year 2010 was carried out by the WHO Prevention of Blindness and Deafness Program. The estimates were obtained from the six WHO regions:

- African Region (Botswana, Cameroon, Eritrea, Ethiopia, Gambia, Ghana, Kenya, Mali, Nigeria, Rwanda, Uganda, United Republic Of Tanzania)
- American Region (Argentina, Brazil, Chile, Cuba, Dominican Republic, Guatemala, Mexico, Paraguay, Peru, Venezuela)
- East Mediterranean Region (Islamic Republic of Iran, Oman, Pakistan, Qatar)
- European Region (Russian Federation, Turkmenistan)
- South East Asian Region (Bangladesh, Democratic Republic of Timor-Leste, India, Indonesia, Myanmar, Nepal)
- Western Pacific Region (Cambodia, China, Papua New Guinea, Western Pacific Region Philippines, Vietnam).

Visual impairment and blindness prevalence were gathered from the 6 WHO regions for three age groups: 0 to 14 years old, 15 to 49 years old and 50 years and above. The information gathered was not categorised by gender as there were inconsistencies in the data gathered and may have resulted in more inaccuracies for the global estimate.

Table 2.1 WHO Global Estimate 2010 of the Number of People Visually Impaired by Age

Age Group	Population (millions)	Blind (millions)	Low Vision (millions)	Visually Impaired (millions)
0 - 14 years	1848.50	1.42	17.52	18.94
15 - 49 years	3548.20	5.78	74.46	80.25
50 years and older	1340.80	32.16	154.04	186.20
All ages	6737.50 [100%]	39.37 [0.58%]	246.02 [3.65%]	285.29 [4.24%]

The figures for the information gathered categorised by regions are as seen in Table 2.2. Other than the six WHO regions mentioned previously, India and China have been separated as their own region for this study.

Table 2.2 WHO Global Estimate 2010 of the Number of People Visually Impaired by Region

		Blindness	Low vision	Visual Impairment
WHO Region	**Total population in millions (percentage %)**	**Number in millions (percentage %)**	**Number in millions (percentage %)**	**Number in millions (percentage %)**
African	804.90 (11.9)	5.89 (15.0)	20.41 (8.3)	26.30 (9.2)
American	915.40 (13.6)	3.21 (8)	23.40 (9.5)	26.61 (9.3)
East Mediterranean	580.20 (8.6)	4.92 (12.5)	18.58 (7.6)	23.50 (8.2)
European	889.20 (13.2)	2.71 (7)	25.50 (10.4)	28.22 (9.9)
South East Asia (excluding India)	579.10 (8.6)	3.97 (10.1)	23.94 (9.7)	27.91 (9.8)
West Pacific (excluding China)	442.30 (6.6)	2.34 (6)	12.39 (5.0)	14.73 (5.2)
India	1181.40 (17.5)	8.08 (20.5)	54.54 (22.2)	62.62 (21.9)
China	1344.90 (20.0)	8.25 (20.9)	67.26 (27.3)	75.51 (26.5)
World	**6757.50 (100)**	**39.37 (100)**	**246.02 (100)**	**285.39 (100)**

The global estimate survey has found out that uncorrected refractive errors (43%) and cataracts (33%) are the major causes of visual impairment. Other causes of visual impairment are glaucoma (2%), age related macular degeneration (AMD) (1%), diabetic retinopathy (1%), trachoma (1%) and corneal opacities (1%). The other causes of the visual impairment (18%) were not identified.

For major causes of blindness, cataract is the cause for 51% of the population, followed by glaucoma (8%), AMD (5%), childhood blindness (4%), corneal opacities (4%), uncorrected refractive errors (3%), trachoma (3%) and diabetic retinopathy (1%). The remaining 21% causes of blindness have not been identified.

2.2 Orientation and Mobility (O&M)

In the United States, knowledge and skills that students need to acquire in order to get a high school diploma is known as the core curriculum. However, visually impaired students will need extra knowledge and skills in order to be on the same level as their sighted peers in terms of having access to the standard academic curriculum. This extra knowledge and skill is known as

the expanded core curriculum (ECC). These include skills such as reading Braille or using optical devices, interacting with others without visual feedback and also moving around an environment in a safe and efficient manner whether inside or outside. (McDonough et al. 2006)

The following skills are included in the revised ECC by Huebner et al. (2004):

- Compensatory or functional academic skills, including communication modes
- Orientation & Mobility (O&M) techniques (for safe and independent travel)
- Social interaction skills
- Independent living skills
- Recreational and leisure skills
- Career education
- Use of assistive technology (tools that enable access to the core curriculum)
- Visual efficiency skills (use of residual vision)
- Self-determination

Sapp and Hatlen (2010) have defined O&M as the efficient and methodical way that visual impaired individuals get oriented in their environment and the way they navigate through those environment in a safe, efficient, and independent manner. O&M skills taught to youths or the newly blind start off simply with the understanding of how to move their body with control and leads to other skills required to navigate through complicated environments safely, accessing transportation and also crossing streets.

As stated above, Orientation and Mobility (O&M) is one of the nine key areas of the expanded core curriculum to help an individual with visual impairment to overcome the limitations that come with being with low vision or blindness. The Encyclopedia of Special Education (2013) has given a definition of O&M as well. Orientation is the manipulation and awareness of spatial concepts, while Mobility refers to the technical skills needed for moving through a space safely. O&M is also a service provided by an O&M specialist who have been prepared to educate visually impaired students (including individuals with multiple disabilities) about O&M.

The skills taught by these specialists is one of the most popular and highly valued low vision rehabilitation item. The skills taught can begin from a young age such as encouraging a child to

roll over for their first time, to Orientation and Mobility (O&M) rehabilitation which coaches and develops special skills to low vision individuals to allow them to travel in a safe, swift and independent manner throughout their environment is one of the most popular and highly valued low vision rehabilitation items. The skills are normally instructed and practised one-on-one by a certified O&M specialist (COMS) and a visually impaired student in real places such as streets and buildings.

Although this method of training is the standard of care since WWII ended, it has limitations in how accessible and affordable it is for the visually impaired population. This is because the COMS is required to accompany the visually impaired trainee at all times during training to ensure their safety. It commonly requires a few hundred hours of instructions for the trainee to gain the skills required to navigate an unfamiliar place safely. (Bowman & Liu 2017)

2.3 Spatial Mental Model

Greca and Moreira (2000) state that the mental representation made in the human mind is an internal representation of the external world as picked up by the senses. This mental representation is known as the mental model. Although this knowledge representation is often distorted, imprecise and incomplete, it is useful as it is constructed from the subject's own perception and experience of the world around them.

One type of mental model produced is the spatial mental model. Spatial information regarding a location includes details about the environment itself, such as placement of items, buildings, their relationship between each other, as well as route information such as how to get from one place to another.

Brunyé and Holly (2008) write that spatial descriptions through language, be it through verbal or written are done in two main perspectives. They are the survey descriptions, which is akin to viewing a map, and the route descriptions, which is comparable to the perspective of navigating the environment. Piccucci et al. (2013) state that being able to perceive and remember such information about the environment in the form of abstract information such as a mental model, is important for navigation. This spatial mental model or cognitive map can be obtained through various means, such as real navigation, reading maps, verbal or written descriptions and also virtual navigation of the environment. The more experience the person has with the environment, the more accurate and detailed the spatial mental models will be.

As an environment is being navigated or a person is trying to remember an environment, information is drawn from many different sources, such as experiences within the environment, schematic knowledge of the environment, visual experience, information about the environment, verbal or written descriptions of the environment, and general knowledge about that sort of environment. All these are combined together to form a spatial mental map of the place in the person's mind. (Tversky 1992)

2.4 Navigation

Loomis et al. (2001) state that there are two distinct methods of keeping track of one's position and orientation while travelling that has been observed in humans and other species. The first method being landmark-based navigation while the second is path integration.

For landmark-based navigations, landmarks in the form of vision, audio, smell and tactile stimuli will supply the traveller with immediate sensory information about their current orientation and position. These sensory stimuli usually work together with an external map or an internal cognitive map of the location.

The path integration method on the other hand requires the traveller to rely on their sense of motion to update their position and orientation with relation to their initial location or starting point. Path integration is a reliable way of exploring past an environment where one has a map of, either internal or external and allows for sketchy landmark information to be constructed into a more understandable representation of the environment.

2.4.1 How do Blind People Navigate?

Path integration is the preferred navigational method of blind people as they have access to a lot of sensory information, which will aid with this method such as environmental sounds that give acoustic flow information, sense of heat to detect the weather or sunshine, feeling of wind movement, and even the slope of the ground surface. (Loomis et al. 2001)

Catteneo et al. (2008) state that blind individuals can compensate for their lack of vision with their enhanced hearing, touch and sense of smell to obtain information about specific places during their navigation as well. It is also known that blind individuals have developed acoustic and tactile nodes rich conceptual network. Lerens and Renier (2014) have also proven that auditory perception in early blind individuals is a lot more accurate than those in sighted individuals due to compensating for the absence of sight. Although Cappagli and Gori's (2016) study has shown that early blind children are not as accurate with auditory spatial localization, which is detecting the direction of a sound source, this difference recovers over time as they grow older.

Studies have shown that early blind or naturally blind individuals produce route-like spatial mental model to represent an environment, in contrast to the survey-like or map-like representation of sighted individuals. Noordzij et al. (2006) have conducted a study to research this fact and found that blind individuals have a preference for route-like descriptions while sighted individuals performed better with survey-like descriptions of an environment. Blind individuals also have less difficulty in estimating distance in units such as steps in comparison to using Euclidean distances. They were also found to be less accurate in estimating locations of objects in the room due to their preference for a route-like cognitive map. It is however, not out of the question for blind

individuals to generate survey-like spatial mental maps as they can read and benefit from tactile maps.

It should also be noted that individuals with low vision could perform better than early blind individuals in various spatial tasks. This might be dependent on the fact that the brain's ability to process visual information, albeit of poor quality. However, it is sufficient of a mental representation for the individuals with low vision to work with.

Due to their exploratory constraints, blind individuals are more prone to rely on their experience-based and egocentric representations of a location. This is related to the fact that blind individuals are often trained in O&M skills in relation to their own body. Routes in relation to their current position are often specified to blind individuals as they are unable to rely on visual landmarks to guide them. It can be concluded that their preference for route-like spatial mental maps and path integration method navigation is contributed by the way that blind people learn how to navigate. (Noordzig et al. 2006)

2.5 Virtual Reality and Its Uses

"Virtual reality" is defined by Merriam-Webster (2017) as an artificially generated environment, which is experienced through sensory stimuli, for example visual, audio or even tactile stimuli that is provided by a computer. One's actions can also affect to a certain extent what happens within this environment. The term "virtual reality" can also be used to refer to the technology that creates or gives access to a virtual reality environment.

Virtual reality has great potential for the improvement of O&M abilities. It has been used successfully in various rehabilitation fields such as the cognitive improvement in the elderly (Cherniack 2011), the rehabilitation of patients after getting a stroke (Merians et al. 2002)(Jack et al. 2001), and can even be used for improving sensorimotor functions in children with Down syndrome (Wuang et al. 2011). Besides the improvement of cognitive functions, VR can also be used as a form of therapy to aid in the treatment of phobias (Gregg & Tarrier 2007), to improve social anxiety or sociophobia (Hartanto et al. 2014) and also for the treatment of posttraumatic stress disorder (McLay et al. 2011).

Virtual reality has also been used successfully to teach skills that involve high risks in a safe and risk-free virtual environment such as learning to drive a truck or to fly a plane. Even highly complex

skills such as performing surgery is also able to be acquired via the usage of virtual reality through surgery simulators as discussed by Schout et al. (2010). Road safety and street crossing skills are also learnable through the usage of VR and have been used to teach road safety to children (Schwebel & McClure 2010).

With the above discussion, it is wholly possible for virtual reality to be used to help visually impaired individuals as well. This can be in the terms of O&M rehabilitation or for providing them with a safe way to obtain spatial information about an environment. Examples of how virtual reality has been used to help those who are blind or have low vision are discussed in Section 2.7.

One thing to note is virtual reality's ability to retain engagement of the user. Within a virtual environment, there is no one single path to go about interacting with the learning material. According to deFreitas and Neumann (2009), this leads to better learning due to personalised learning experiences. The numerous ways for learning will also have a greater chance of increasing engagement of the user. The experience obtained when learning within a virtual context can also be as defining as those obtained in a live context with the safety of allowing mistakes to be made.

2.6 Non VR methods of Conveying Spatial Information to the Blind

Conveying spatial information to the blind can be achieved by several means, most commonly through verbal descriptions by a sighted person. Another means would be in the form of tactile maps and models of an environment which can be read and explored with fingers. Often there are notes in Braille text printed out alongside these maps and models to give more information to the visually impaired. Wright et al. (2010) defines these models as a physical pattern of symbols which can convey the spatial relationships among the objects they are representations of based on the spatial relationship among the objects shown in the physical pattern itself.

Another way to convey spatial information to the visually impaired comes in the form of navigation aids. Technological navigation aids can also be called electronic travel aids. Some of these devices are used to determine positions (such as in the case of GPS) while others are to avoid obstacles within the environment by sensing them and informing the user how far they are from them. These navigation aids would convey the information in a non-visual way such as through haptics or vibrations and through sounds. There are also several GPS smartphone apps that have been developed for use by the blind community. (Daniel & Kalevi 2015)

Despite multiple navigation aids being designed and developed, a study done by Cuturi et al. (2016) states that these tools are not widely accepted and used by the visually impaired. This is due to the majority of these devices having complex feedback systems that are too difficult to use due to the overload to the memory, sensory and attentional capacities of the user. Gori et al. (2016) also conducted a study regarding the adaptability of these travel aids to children and it was discovered that despite the advances in technology for devices, many have low acceptability rate among adults and are also not adaptable to children. Too much attention is required to use the device and the users would have to go through long training periods before they can be used.

Papadopoulos et al. (2017) have conducted a study to determine the best way to convey spatial information to individuals with blindness by comparing three forms of navigational aids. The results of the study shows that audio-tactile maps and audio-haptic maps were a lot more effective at aiding the blind individuals than being guided through verbal descriptions. The participants of the study were better at navigating through the area and finding points of interest after they had read the audio-tactile map of the place and also were better at it after exploring the audio-haptic map of the environment compared to listening to a recorded verbal description.

Two applications, the Omero application and the AudioMetro system that have been developed by researchers to convey spatial information differently from navigation aids and tactile maps are discussed in Section 2.6.1 and Section 2.6.2. It should be noted that these systems do not involve a virtual environment which are explored in the first person's point of view. Virtual environment systems for the visually impaired are discussed in Section 2.7.

2.6.1 Omero - A Haptic/Acoustic Application to Allow Blind the Access to Spatial Information

De Felice et al. (2007) created the Omero application, which allowed the blind to interact with an audio and haptic representation of maps of indoor spaces or geographical maps. The use of a haptic device allowed the blind user to interact with the maps along with the system being able to provide auditory information via sounds and synthetic speech. The Omero application allowed the selection of objects by touch through the haptic representation and allowed the user to get related information in the form of auditory messages through a haptic device.

The haptic representation fully reflected the spatial organization and distribution of objects within the environment mapped out. The reason for this study was to analyse how a preliminary survey of the virtual map of the environment will improve the ability of the user to find suitable routes to navigate around when they are in the real environment. The Omero application has been found to be effective in helping the visually impaired users to know the environment before they actually visit it by providing them with spatial information beforehand.

2.6.2 AudioMetro - Metro Navigation for the Blind

Sánchez and Sáenz (2007) have developed a system for use with the Santiago Metro Network to aid the blind in learning how to navigate and use it for daily transport. The AudioMetro system developed is an audio-based educational software for use with desktop computers that lets blind users plan and simulate their Metro Network trips.

Users of the AudioMetro can do three things with the software. First is to register themselves, second is to prepare to travel which is selecting a starting Metro station and their destination, while the third action that can be performed is to travel, which gave the user a representation of the selected trip, during which the user can control and decide what actions and routes to take. The representation provided by the AudioMetro was based on sounds, which were used to represent an actual Metro system, having the same duration as well. A variety of sounds was in stereo to aid with the user's orientation in the environment. The system was able to guide the user regarding their decision-making and helped orient them to choose the most efficient and appropriate path to take.

This simulated trip allowed the blind user to become familiar with the trip before travelling using sound cues by learning the structure of the Metro network and obtain information regarding the different Metro lines, directions and stations.

2.7 Virtual Environment Simulation for the Visually Impaired

It is common for the visually impaired, especially those who have no vision to gain spatial information of a new environment through proximity exploration. Proximity exploration, which is the physical navigation of an environment by learning the locations of items and obstacles as they are met or run into, is normally carried out through the physical reach of the blind person's hand or via the reach of their cane. (Cobo et al. 2017)

There have been various proposals on how to aid those with poor vision to find their way around and navigate a new environment more safely such as robotic navigation, systems that include the use of Web cyber cartography, GIS and GPS to ultrasound devices to detect the existence of more distant obstacles.

Examples of such technology developed such as technological canes and robotic guides have been discussed by Cuturi et al. (2016). Overall, these devices have had low user acceptance and are not suited to be used by the general visually impaired population. This is because a large portion of the devices did not take into consideration the normal capacity of the human brain to process information. As a result, the feedback from the devices have overloaded the memory capacity, senses and attention span of the users. The majority of the devices developed for the visually impaired are targeted at visually impaired adult individuals and are not suitable for children as they convey information in a complex manner.

On the other hand, gaining spatial information or spatial knowledge about an area is not limited to only avoiding obstacles as you move around. Cobo et al. (2017) states that prior knowledge such as the spatial layout of the area and knowing your current location in the area plays an important role as well. Because of this, visiting virtual reality simulations of actual locations as well as fictitious ones to gain spatial information has been suggested. The spatial knowledge gained from exploring a rendition of a location or space allowed the users to acquire information including the locations of structures, objects and obstacles without needing to physically explore the location. Most studies that have included the development of virtual reality simulations have been done using personal computers and most studies do not include children as their test participants. These studies are explored later in this section.

2.7.1 Audio-based Environment Simulator (AbES)

After observing that the navigational difficulties faced by the blind showed that they did not have sufficient access to the relevant spatial information required to depict an environment, Connors et al. (2013) and Merabet et al. (2012) have developed the Audio-based Environment Simulator (AbES). The AbES is used to determine if a virtual environment simulator was able to enhance way finding abilities in blind individuals.

AbES allowed the user to virtually explore an actual physical location, in this case a real building layout using the context of a game. The serious video game was developed to help the blind player to acquire a detailed and reliable spatial cognitive map of the building the game level was based on. It was also created with the idea that the spatial information gathered within the game was transferable to an indoor navigation task done in the real world.

The game was played using easy keystrokes on a computer keyboard and provides spatial audio cues to the player as they explore the game level. The player's goal was to explore the level and collect the jewels planted in different rooms around the map while avoiding the monsters that are moving around. The game was played using stereo headphones and a blindfold.

The players were not informed of the purpose of the study and were not asked to remember the layout of the building during gameplay. Despite that, results of the testing of the AbES software showed that the game was indeed able to provide the blind players with an accurate spatial cognitive map of the real world location using auditory information that described the location of objects and the layout of the environment. For example, if a door is on the left side of the player, the player was able to hear a knocking sound coming from the left side of the stereo headphone. This helped to produce an immersive and interactive virtual environment to the players. According to the real world navigation tests conducted after the training on the game, the blind participants that were unfamiliar with the building have shown that they were able to navigate through it successfully after playing sessions with the game.

Merabet et al. (2012) have tested the effectiveness of the gameplay element of the software by conducting navigational tasks with two groups of blind participants. The first group were allowed to play and explore the AbES game's environment on their own. They were known as the "gamer" group. The second group, which was the "directed navigator" group, were given directions about

their navigation through the AbES software and were guided about the layout of the building through a set number of predetermined routes with the help of a sighted facilitator.

It was concluded that the “gamer” group had comparable performance during navigational tasks to the “directed navigator” group and were actually more creative about the routes they took. This was shown from their better performance in the task that required the participant to exit the building using the shortest path. The “gamer” group showed that the free exploration of the game environment provided them with a better and more flexible mental spatial map of the spatial information obtained via the gameplay. The second group that were guided showed that they were more likely to take the longest path out and demonstrated that more constrained learning methods usually fail to provide the relevant information required for conveying more detailed and useful spatial information of the location.

Connors et al. (2014) have also tested the AbES video game with a sample of blind adolescents, aged 16-17. It has been concluded that the system was able to transfer spatial information to these younger participants which allowed them to successfully navigate a real world building which was represented within the game.

2.7.2 Audio Haptic Maze (AHM)

In a study done by Sánchez (2012), a computer video game that used audio and haptic cues was developed with the purpose of improving the Orientation and Mobility (O&M) of blind students. The study was conducted with totally blind students of age range 10-15 years. The video game developed for the study is called the Audio Haptic Maze (AHM) and was inspired by the design of AbES discussed earlier.

In the video game, the player needed to escape from the maze to complete the level. They could do so by finding keys that correspond to the doors in the maze. These keys could be found in jewellery boxes located throughout the corridors and rooms within the maze, they can also contain treasure. The player needed to pick up and try the keys at the door for the correct ones in order to escape the maze. To increase the entertainment value of the game, a scoring system was added which the players can increase by finding treasure and by taking less time to exit the maze.

The game had three interfaces, the graphic interface, the audio interface and the haptic interface. Although the graphic interface was of no use to the blind player, it was necessary to provide information to the developer as it showed the location of the user while playing the game.

The audio interface was for the blind player and used spatial sounds to produce the ambience in the game environment. Stereo sounds, which are used to increase player's engagement with the game, have been provided using stereo earphones. Sound cues are also added to other forms of interactions such as with the items like the doors, jewellery boxes and keys, and with movement like walking steps and when bumping into objects. Verbal audio was also added to the game to provide information to the user where required.

The haptic interface was also implemented for the blind players. This was achieved with the use of a haptic device (Novint Falcon), which was able to provide haptic feedback to the player, such as providing force feedback to the front when they move forward, vibrations to the left when they turn left and allowing the user to differentiate different items in the game level. For example, touching a wall with the 3D cursor gave a different object texture than when the user touched a door.

The use of both audio and haptic feedback allowed the player to spatially map out the game's virtual environment in their mind. It also let the player have a better idea of the orientation, shapes and distances of items on the game level when moving around the stage. The information provided allowed the players to make wise decisions about what direction to move towards to get from location A to location B. The results of the evaluation also showed that through playing AHM, the development of O&M skills of the students were improved.

2.7.3 BlindAid

The desktop personal computer virtual environment system developed by Schloerb et al. (2010) called BlindAid is another example of how virtual environment systems can help the blind learn more about new environments independently without physically being at the location. The system provided both three-dimensional spatial audio and used a Phantom haptic interface to provide the user with haptic feedback as well. It was able to record the user's actions within the virtual environment and gave a visual display of it so that researchers and O&M instructors were able to review it later.

As with the Audio Haptic Maze discussed earlier, the BlindAid system had 3 interfaces as well. The graphic interface was for the use of the researchers, developers and the O&M instructors and had been sized to have the same aspect ratio as the usable workspace provided by the Phantom haptic device.

The audio interface featured 3D sounds, which emulated the person standing within the virtual environment by providing the direction and distance of sounds. There were three audio display modes implemented with BlindAid. The first mode expected the user to be facing forward by default and provides the stereo audio to match. The second mode, also in stereo audio, allowed the “rotating” of the avatar’s head through the rotation of the Phantom haptic device stylus, which let the user turn the avatar’s head side to side as in the real world to aid with sound localization. The third mode presented the sounds in mono format but still scaled the volume of the audio to match the distance.

The types of audio included in the system were contact sounds, background sounds and landmark sounds. Contact sounds were sounds heard when the avatar interacts with an object, including the short verbal description of the object the user can bring up by pressing a button on the keyboard, for example “elevator”. Background sounds were used to give user ambient sounds specific to areas within the virtual environment, which allowed them to know what region they are at. Lastly, the landmark sounds were used to mark important places as audio beacons and were located at predefined and fixed locations on the virtual map. Up to three of the landmark sounds were defined by the developers while the other six landmarks were allowed to be placed by the users during their explorations.

The haptic interface utilized the Phantom haptic device with a stylus attached, which let the blind user interact with a scale-model of the selected virtual environment by letting them move the avatar within the environment and gave forced feedback to the user that emulated the ones obtainable when using a white cane. It also provided feedback on the texture of the item.

The results of the system being tested with four blind subjects showed that the BlindAid helped them to learn about new locations and that the subjects were also able to pick up on how to use the system with relative ease. The testing also showed that spatial information obtained via virtual environments were able to transfer to navigation in real places as well.

Lahav et al. (2012) have used the BlindAid in a case study to determine if the virtual environment provided by the BlindAid was able to help improve the O&M abilities of newly blinded people. In this case study, one newly blind person's O&M improvement based on the system's usage has been monitored. The study included mostly locations the newly blind participant was familiar with and a few unfamiliar locations. The real locations were mapped out into a virtual environment for the participant to explore safely via the system.

The study showed that the virtual environment simulation let the participant practice and learn for hours on how to navigate around different spaces while doing it from a safe and relaxed environment. The results from the research indicated that the use of the virtual environment for training had improved the participant's O&M abilities by improving their confidence and sense of control when exploring the real space. Along with that, their spatial learning experience, orientation problems and exploration strategies used have improved as well.

Even though this research was focused on only one participant, it demonstrated that a virtual environment system is able to enhance O&M skills of a newly blind user by letting them explore the real location and learning to strategize their navigation skills better with each use. Virtual environments as an exploration tool were also beneficial in the sense that they have no limits to the size and shape of the real environment that can be included or mapped out for exploration.

2.7.4 Auditory-based Architectural Exploration

Picinali et al. (2014) conducted a study where two kinds of methods for gaining spatial information via auditory exploration were compared. The two types were through navigation in the real environment and navigation through an audio only virtual environment. The study put a great emphasis on the participants being able to comprehend the space architecturally rather than the sounds within the space.

The two spaces chosen for the study were two corridor areas in the laboratory building, which was simple enough for the study but complex enough to provide an assortment of auditory and locational landmarks such as having side branches, stairwells and sound sources, which are static.

In order to provide more cues to the participants of the study to detect during the testing, extra simulated sound sources were added to the environment such as the sounds of someone typing

on a computer and the sound of the toilet flushing. These were added to the exploration of the real environment as well through audio loops being played from loudspeakers placed at the area.

Previous methods of listening to recordings of spatial audio of the real environment have been shown to be ineffective, therefore, for this study; an interactive 3D virtual acoustic model was used instead. The participants using headphones with a head tracking orientation sensor attached, and a joystick explored the virtual simulation of the corridors. To minimize the difference between the real world exploration and the virtual one, the simulation was adjusted in order to have the same acoustical parameters as the real location. A simple model was developed as well in order for the participants to familiarize themselves with the interface and how the acoustic model would be interacted with.

Through observations of real world navigation of the blind, it has been noted that self-produced noises like footsteps and finger snapping were used to locate objects such as a wall or door based on the acoustic reflections made from it. Therefore, the acoustic model also included the simulation of a finger snapping function in order to reproduce the function. The joystick allowed the participant to move forward and backward in the virtual corridor and changed speed according to how much forward pressure the participants has applied to the joystick. The finger snapping function was accessible when pressing the joystick button.

The study showed that an interactive audio-based virtual simulation of a physical location as developed in the study is realistic and detailed enough to offer suitable spatial knowledge of the architecture to improve the understanding of the space in the participants. Participants in both groups, the real life navigation and the virtual navigation group were able to produce consistent and meaningful depictions of their spatial cognitive map of the corridors via LEGO bricks and have defined the spacing and distance of what can be found in the environment well.

2.7.5 Acoustic Virtual Reality based O&M Training

Seki and Sato (2011) developed a training system to aid blind people to recognize their environment without having to train in a real environment. This was achieved through training of the “auditory orientation” skill, which involves “sound localization” which is the ability to recognize the location of a sound, and “obstacle perception” which is the ability to sense objects that do not produce sounds such as walls through sound reflection or insulation. Because training this O&M ability is normally done in a real environment and may be stressful and occasionally dangerous for beginners especially where real vehicles are involved, this system has been developed to reduce the risk and stress from the training by allowing the trainees to train in a virtual environment instead.

The auditory orientation training system provided a virtual environment based on head-related transfer function (HRTF) simulation for the training of O&M and allowed the trainee to explore the virtual training environment in safety. The trainee was still able to listen to sounds including vehicles, ambient noises and even sound reflection and insulation from the environment through headphones and a head-tracking device. 3D sound localization was achieved through HRTF. The system was able to produce 10 3D sound signals at the same time and these were mixed by the mixer and given to the trainee through headphones. The position sensors attached to the trainee’s head and knee measured the position and directions of them. This allowed the virtual environment to match with the trainee’s facing direction and know at what pace the trainee was “walking” in the virtual environment while actually stepping in place. There was also a visual display on the computer monitor so that the O&M instructor would be able to monitor the trainee’s performance during the virtual environment training.

The virtual training environment developed had four different types of components, which were sound source, wall, road and landmark. Sound sources were objects within the virtual environment that create sound such as vehicles, shops, pedestrians. These sounds were able to move in a constant direction at constant speed, which was well suited for simulating a moving vehicle on a straight road. Another form of sound source in the virtual training environment were background noises, which could be sounds of streets, crowds, festivals and more. Walls were objects that could reflect and insulate sounds, which were important for obstacle perception. Roads were objects that include roads, streets and paths; it helped with the design of the virtual training environment and has a start point, end point and width. Lastly, landmarks were used to

represent items like trees and telephone poles and was mainly just for the design of the virtual training environment.

The participants of the training were blindfolded sighted people which emulated being novice blind people. They were divided into 3 groups, which is the no training group, the virtual training group using the system and the real training group that is trained in the real environment. The efficiency of the system was evaluated with the trainee's performances before and after the training was conducted. Technical and anxiety evaluation results, which were questionnaires, filled in by the participants before and after the training sessions showed improvement in both the virtual training group and the real training group in both evaluations. The participants were also measured for walk locus and walk stress before and after the training. Results of the training showed that the virtual training provided better training in walking while listening to environmental sounds in comparison to real training. The virtual training was also as effective at reducing stress while navigating, improving walking techniques and improving walk anxiety as much as the real training is able to.

2.7.6 Virtual Reality Street Safety Training

In order to see if virtual reality based street safety training for the visually impaired was feasible; Bowman and Liu (2017) have conducted a study to compare both virtual street training and real street training. The task chosen for the study was being able to decide when it was safe to cross a signal controlled street, as it required the collection of real time information from the environment via visual and auditory skills. The participants chosen were from the low vision category who have difficulty and uneasiness crossing the streets on their own. They were then randomly divided into two training groups, the virtual street training group and the real street training group.

The road safety skill of the participants were assessed pre-training and post-training to gauge if either or both kinds of training helped. The participant was brought to a real street corner by a certified orientation and mobility specialist (COMS) and was asked to face away from the perpendicular street. The participant was then guided to face the crosswalk of the perpendicular street and asked to say, "GO" when they thought was the safest time to cross the road during the DON'T WALK phase of the pedestrian crossing signal. This test was conducted before the training and after the training.

The real street training was conducted at real street intersections and was overseen by a COMS. The virtual streets were simulated to mirror real time street intersections. Instead of being shown to the participant via a single monitor or through a VR headset, the scenario was displayed through 3 projected screens. This allowed the COMS to communicate directly to the participant and minimize the risk of the participant getting cyber sickness. The simulator was able to continuously generate and display dynamic content at the street intersections with high-levelled artificial intelligence (AI). There were pedestrians and cars that obeyed traffic laws as well as proper traffic and pedestrian control signal cycles. The O&M skill to be taught in this training is known as the near lane parallel traffic surge (NLPTS) skill.

The result of the research showed that the street crossing skills obtained via VR training were transferable to the real streets as well. It demonstrated that the low vision participants who were not able to see the pedestrian signs and signals were able to get better at timing their street crossing in real streets with the O&M skill learnt from the virtual streets, which was comparable to the benefit of training on the real street.

2.8 Spatial Cognitive Information Mapping

There are various methods used for the visually impaired to map out the spatial cognitive information they have gained. Spatial cognitive information include things such as paths and routes, and environmental information such as placement of items and size of space. The methods for mapping these out range from simply drawing it out for simple spatial information such as short routes to reconstructing a map of the location they have explored using LEGOs. These methods are discussed in this section.

2.8.1 Block Reconstruction

In the study by Picinali et al. (2014) discussed in Section 2.7.4 earlier, 3D auditory models were made to compare the effectiveness of both physical navigation and virtual navigation of two corridors in a laboratory building. To gauge how much spatial information has been obtained by the participants, they were asked to reconstruct their spatial cognitive maps of the corridors using LEGO construction blocks and mat as accurately as possible.

Everything the participants could understand about the environment and its settings were asked to be specified by the participants through the block reconstruction. This included if they have detected doors and if they were open or closed, changes in floor surface, changes in textures, changes in the height of the ceiling, if there was an open space or if it was just the corridor at that part. Noises heard during the navigational exploration of the environment were also asked to be marked down and described. Special textured LEGO blocks were provided to allow indication of any characteristics of the environment that the participant found interesting. After marking the section with the special block, the participant were asked to describe it verbally and these were noted down on a drawing of the reconstructed map by the experimenter on site.

Prior to asking the participants to perform the block reconstruction of their mental spatial map of the environment they have just explored, they were queried about their previous experiences with LEGO to gauge if they would have problems using them. None of the participants indicated that they had any problems with using LEGO to create objects. The fact that the participants were also familiar with tactile representation techniques like embossed subway maps was also noted.

Overall, participants were able to adeptly construct the spatial map of the corridor using the LEGO bricks.

2.8.2 Stuart Tactile Maps

Stuart (1995) developed a non-visual test used to gauge the ability of learning spatial information of a person. Due to its non-visual nature, it is suitable for testing with visually impaired individuals. The test is called Stuart Tactile Maps (STM) and it will reveal how many times someone needs to practice a route in order to get it correct.

Even though the STM test is not available commercially, it is possible to make them oneself. As long as the lines for the mapping are clearly differentiated from the background when traced with one finger, and that there is no break in the lines around corners, and that the placement of the lines and angles are following the original measurements of the original STM, they will be good enough for use for the STM test. It is also important that the maps produced do not contain any distracting features such as blobs of glue, or wrinkling of the background item in order to prevent distractions for the participants.

The STM test has three sets of maps. Set A is the main set of maps. Set B is used to retest a participant after they have done Set A in order to prevent them from having an inaccurate test result due to their memory of doing Set A. It should be noted that Set A and Set B have the same level of complexity. Set C on the other hand is the easiest and is used to show if the participant is able to remember basic directions. Set C is only required if the participant has a score of 0 when doing Set A or Set B as it implies a lack of spatial memory.

The test was conducted in a non-visual way and participants were required to be blindfolded throughout the test. The test was also conducted using only one hand, two-handed explorations were not allowed for the test. The facilitator also guided the exploration of the map from start point to the endpoint in order to standardise the task. After three guided exposures, the participant was immediately asked to draw the route they have just traced onto a piece of paper.

This test showed that drawing a path on a piece of paper is also a valid way of allowing a blind individual to convey spatial information. However, it needs to be noted that the spatial information conveyed in this task is simply a route with no other spatial information such as placement of objects and size of location.

2.9 Serious Games

According to Karagiorgas and Niemann (2017), serious games have been created for education by providing a platform for making boring tasks a bit more engaging by presenting these tasks as a game. Such games have been created for use for activities such as practice, training and providing solutions and are used in various fields such defence, healthcare, research, production, and learning about cultural heritage.

An example of a serious game would be the Virtual Factory (Treviño-Guzmán & Pomales-García 2014). It is created to provide the players more information about the Industrial Engineering (IE) field within a manufacturing environment. This serious game was tested with pre-college and freshman students and results showed that the participants had become more motivated to pursue the IE field after playing the game. It also increased their understanding regarding how IE is used in a manufacturing environment. The results from interviews with participants conducted before and after the game testing proved that the participants were able to gain knowledge from playing the game.

Serious games have been developed to aid children as well, such as for children with Attention Deficit Hyperactivity Disorder (Bul et al. 2018) and also for children with speech disorders and hearing problems (Nasiri et al. 2017). These kind of games are used to allow children to be able to learn on their own and due to it being a game will motivate the children to participate more. The teacher, therapist or specialist will not have to be there to guide the children as in normal teaching sessions, thus saving time and manpower. Serious games can also allow progress of students to be assessed after they have played the game.

2.10 Critical Review

From the reviews above, to the best of our knowledge, it can be seen that the majority of the discussed studies, although including virtual reality environments in their research, have been designed to be computer-based and require special equipment to be set up in order for the participants to use it. This equipment included orientation and movement sensors and haptic devices. This fact and the lack of portability of the setups make it difficult to reproduce the setup and make it infeasible for general use.

Additionally, most of the studies were conducted with adult participants and did not consider children with low vision or blind children in their experiments. This was also reflected in the

navigation aids produced in the market or through studies as they have made it difficult for the younger generation to use and comprehend. Environments tested out in current studies were complex, consisting of larger locations spanning multiple rooms or sections. The systems, not made with children in mind, had also included rather complex controls that required high levels of cognition and attention spans, which would be difficult to meet for younger children.

In addition, majority of the systems created in the reviewed studies were only in the form of a navigation, exploration or simulation tool. The formal tone set by it being a system with the lack of interesting elements may bore the children, resulting in a lack of motivation to participate and explore the virtual environment generated. By making it a serious game, it will help to boost the motivation of children to participate.

Therefore in this research, to address the issues stated above, a prototype of mobile game based spatial navigation learning tool was developed for children. This prototype serious game is built in the commonly used Android platform and can be played on any Android device with built-in mobile sensors, accelerometer and magnetometer, which removes the need for a complicated setup. The game is also simple, having rooms in a house as levels for the children to explore with intuitive and simple gameplay controls. It is anticipated that the children will be able to explore the environment in the form of a game, thus they will be encouraged and motivated to participate.

Chapter 3 Modelling and Prototyping

In order to resolve the problems discussed in Section 2.10, a game based solution to assist children with visual impairment to learn spatial navigation is proposed. This chapter consists of multiple parts and begins with the discussion of the proposed solution and goes through the overall conceptual architecture of the prototype game. The scope and limitations as well as the prototype's functional and quality requirements are also discussed in this chapter. The design and development process of the game modules, game levels and other user interfaces are illustrated, and the game play scenarios are depicted using flowcharts. The development tools used and the system requirements of the game are also provided in the chapter. Finally, the implementation of the interfaces, and game module are described at the end of the chapter.

3.1 Proposed Solution

Based on the reviewed virtual environment systems and games for the blind, it can be seen that although they are effective in conveying spatial information, the majority of them were desktop computer based and required special equipment such as orientation and movement sensors or haptic devices to be set up in order for the participant to explore the virtual environment.

The studies also showed that audio cues are useful in conveying information to the blind in a non-visual way. Several of these studies also added an extra layer to the virtual environment by including haptic cues as they can enrich the environment the participant is exploring. Haptic cues can substitute for visuals and are sometimes more efficient in conveying information such as textures and collisions than visuals are. With both audio and haptic cues added to the environment, it has made the virtual environment more immersive and interesting to explore.

In this study, a virtual environment serious game prototype called *Hungry Cat* is developed for use on Android devices such as tablets. This reduces the need for setups and allows the virtual environment to be explored anywhere. The prototype also includes haptic cues and audio cues to create a more immersive environment to play in. With the availability of mobile sensors such as the accelerometer and magnetometer, it is possible to make a non-visual game which is playable through movement and is able to sense the direction of the user in real time.

The controls are simple and intuitive to allow the participants to be able pick up on how to play the game easily. The gameplay includes bumping into objects and gaining information from the

tile directly in front of where the user is facing to mimic the proximity exploration of blind individuals.

Rather than exploration of a large virtual environment spanning several rooms or being located outdoors, the game is scaled down to a simpler environment. The player takes the role of a cat looking for food and explores rooms with furniture within a house. The reason for this is that the test targets are children ranging from age 7-17 years.

The game is made in 2D mode and allows movement in forward, backward, left and right directions with no capabilities for diagonal movement. This again simplifies the gameplay as well as the layout of the room to aid with remembering the spatial information such as the whereabouts and size of the items within it.

3.2 Overall Conceptual Architecture

The *Hungry Cat* prototype is a 2D mobile serious game designed for visually impaired children, which allows them to gain spatial information about a virtual environment by controlling an avatar which is a cat. The game, set in the perspective of the Cat avatar looking for food allows players to move through the rooms in a house through simple controls and physical movement, which are detected via the accelerometer and magnetometer of the mobile device.

The game environment is made up of a 2-dimensional area consisting of tiles where players can choose to move forward, backward, left or right within it to discover the objects in the room. Objects and obstacles will be identified when bumped into or interacted with by the player or can be heard through the audio and haptic feedback the environment provides. There are also objects within the environment that the player may interact with, such as to climb up and down them. There will also be a food object available for the food finding mode gameplay. Sound sources will also be heard when players get closer to them and provides an audio landmark to the player.

The time taken for the player to complete the level as well as actions taken such as number of steps, number of turns and number of interactions with the environment will also be recorded and saved to the device as a text file for analysis purposes. Figure 3.1 summarizes the conceptual architecture described.

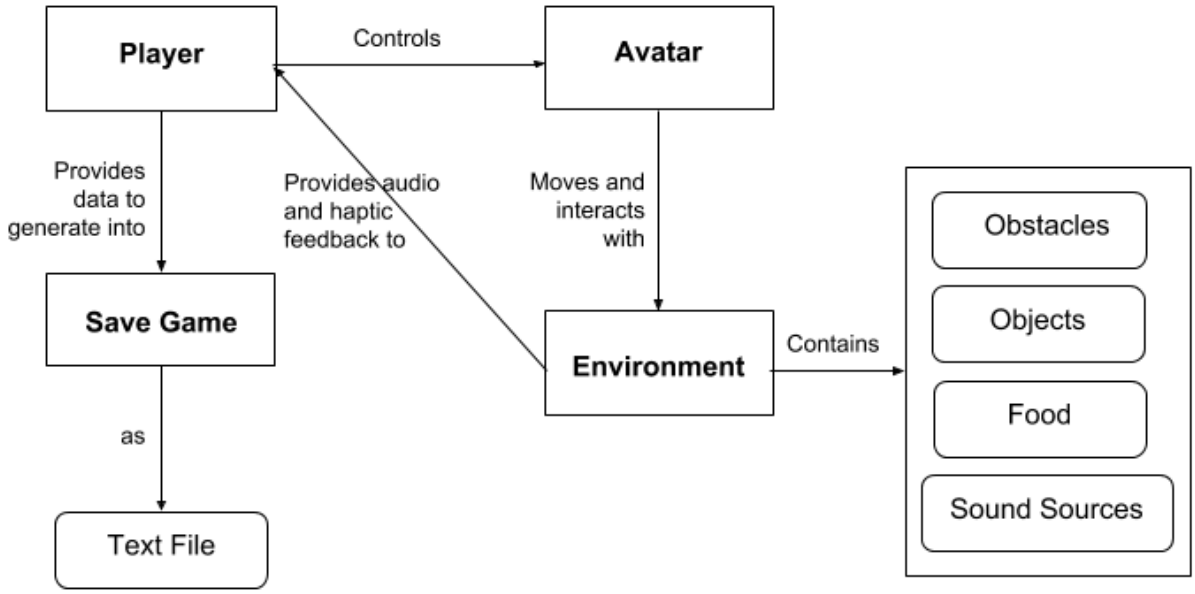

Figure 3.1 Conceptual Model of *Hungry Cat*

3.3 Scope and Limitations

The mobile game developed for the purpose of this study is targeted to visually impaired children ranging from ages 7 to 17. In order to make it understandable and playable for children, especially the younger ones, the game is required to be simple. Therefore, the original concept of letting the player explore a more complex environment, which was an entire house, is changed into multiple individual rooms. This allows for the younger children and those that have learning difficulties to participate better in the study.

Additionally, the mobile game developed is only done for the Android platform and not exported to other mobile platforms. The essence of the proposed solution is to find out whether the mobile game concept is applicable to spatial navigation work for the children with visual impairment, regardless of the mobile platform.

3.4 Prototype Design Requirements

This section covers the functional requirements as well as quality requirements of the prototype.

3.4.1 Functional Requirements

The prototype is required to be able to perform the following functions:

- Allow the selection of game level and game mode

  The prototype should be able to allow the correct game level and game mode to be selected by the facilitator of the game testing according to what is required at the time. There will be the tutorial room and 6 other rooms to select from ranging from small and easy rooms to larger and more complex rooms with more furniture. The two modes that can be chosen from are the exploration mode and the food finding mode.

- Generate game level

  After a room and game mode are selected, the prototype should be able to generate the map of the room for the player to explore. The gameplay of the room depends on the game mode chosen. Exploration mode lets the player explore freely within a time limit of 5 minutes while in food finding mode, the player will have 5 minutes to locate the food in that room.

- Detect player's controls

  The game should be able to detect what action the player wants to perform. Some controls require the use of mobile sensors such as the accelerometer and magnetometer so it is important that the game prototype be installed onto devices equipped with such sensors. The game should be able to respond when the player chooses to move forward or change their direction as well as when they choose to interact with environmental objects and when they press a control in order to obtain more information.

- Provide appropriate feedback

  As the player explores the game level, they may interact with objects by checking the tile in front of them or by accidentally bumping into them. The game will be required to give the correct feedback in the form of audio, be it speech or sounds, as well as in the form of haptic feedbacks, such as in the case of bumping into items.

  The game will also provide audio and haptic feedback whenever the player takes a step to let the visually impaired players know how many steps they have taken so far. The game will also

inform the players via speech of actions taken as well as inform them of events such as when they have found the food.

- Save player gameplay data

  For the purpose of research analysis, the player's name will have to be registered and selected before playing the game. The gameplay data of each player will be recorded and stored individually into text files for each room and game mode played. This gameplay data includes time taken, steps taken, turns taken, bumps made, tile checks made, information checks made as well as penalties incurred.

3.4.2 Quality Requirements

The prototype is also required to fulfil the following quality requirements:

- Usability

  Since this game is designed for children, it should be easy to control and simple to understand for them. With the target age being as young as 7 years old, the language used in the speech for the game needs to be simple while the game controls should be easy enough for younger children to still be able to play and enjoy the game.
- Reliability

  The game should function as intended and be able to generate the room levels and save the player's game play data into a save file.

3.5 Designs and Development

This section shows the designs and development of the game in terms of game modules, game levels and other user interfaces.

3.5.1 Game Modules Designs and Development

The prototype game *Hungry Cat* utilizes the Model View Controller (MVC) design pattern as depicted in Figure 3.2 below. The MVC design consists of three kinds of objects, which are the View objects, the Controller objects, and the Model objects.

View objects are objects that are shown to the user and consist of the User Interface (UI). View objects also communicate user actions such as interactions, for example a button push, with the View and Controller objects. Controller objects are objects that receive the user actions and update Model objects. They also receive updates from Model objects and reflect the changes to the View objects. Lastly, the Model objects signal changes that happen within them to the Controller objects. These changes include updates within Model objects or creations of new Model objects.

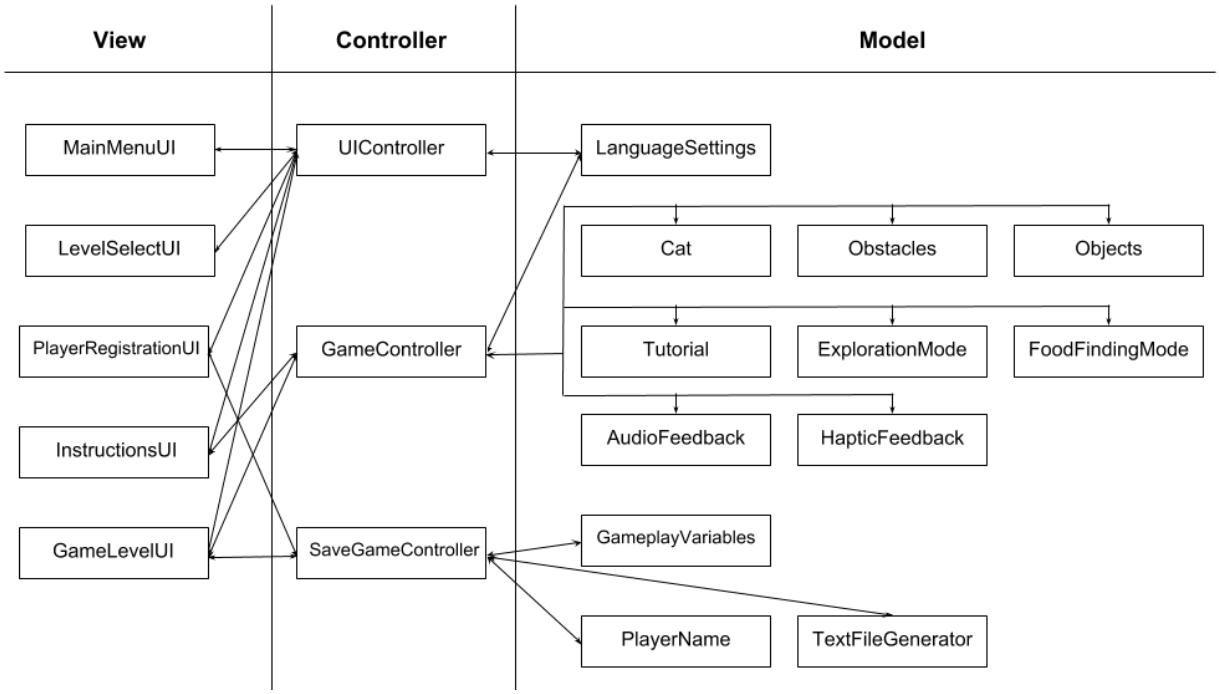

Figure 3.2 Model View Controller design of *Hungry Cat*

View Objects

The View Objects listed are MainMenuUI, LevelSelectUI, PlayerRegistrationUI, InstructionsUI, and GameLevelUI. The first three of these UI are interactive through touch and provide graphics for the ease of use by the game testing facilitator. In the current version of the game prototype, these three UI are not accessible by the participants.

MainMenuUI helps to navigate to other menus such as the LevelSelectUI, the PlayerRegistrationUI and the InstructionsUI. There is also an option to set the language settings of the game through this menu. The LevelSelectUI enables the user to start a game level in the game mode of their choice. PlayerRegistrationUI is for registering the player name to more easily identify the text file generated by the player's gameplay.

InstructionsUI is interactive for the visually impaired due to the fact that it provides audio feedback in the form of pre-generated Text to Speech (TTS) files. The same goes for the GameLevelUI which is interactive by the visually impaired through the device's touchscreen, the accelerometer and the magnetometer of the device. Both the InstructionsUI and GameLevelUI contain graphical interfaces for the use of the testing facilitator so that they may observe the progress of the player. However, for the purpose of providing equal footing for all participants, either having low vision or being blind, a blind mode has been implemented for all the Game Levels to cover the graphical map display from being viewed.

Controller Objects

There are three Controller Objects in this game: the UIController, the GameController and the SaveGameController.

The UIController aids the navigation in between the multiple UIs by receiving touch input from the user through the pressing of buttons displayed. It also receives keyboard input for the PlayerRegistrationUI and updates the LanguageSettings Model Object regarding the preferred language selected when they toggle the language selected in the Settings Popup.

The GameController allows the player to play the game. It detects input from the user by checking the values obtained from the accelerometer and magnetometer of the device. The accelerometer detects if the device is tilted forward which signifies that the user wishes to move forward. The magnetometer detects the facing direction of the user and tells the Model Object, which is the "Cat" avatar, which direction to look towards.

Another user input detected by this controller is the touch input, allowing the user to perform checks for item data and obtain information about their current location. The GameController updates the Cat Model Object's location and interaction with the environment such as with Obstacle and Object. When interaction with the environment occurs, the GameController updates the GameLevelUI View Object to provide the player with audio and haptic feedback. The different play modes such as the tutorial, the exploration mode and the food finding mode also affect the GameLevelUI through the GameController.

The third Controller Object is the SaveGameController. It detects user's actions within the GameLevelUI and updates the GameplayVariables Model Object with the information. After the player finishes a game level, it generates a text file and names it according to the registered player's name, the current game level, the game mode selected and the current date.

Model Objects

There are multiple Model Objects in the game prototype:

- LanguageSettings

  Stores the preferred language setting selected. The prototype game's generated speech is available in both English and *Bahasa Melayu*.
- Cat

  Is the representation of the player in the environment, or the avatar. The player explores the room through the Cat and can control it to move around the room and interact with the objects within it.
- Obstacles

  Obstacles in this game are objects the player cannot walk through and stand for the boundaries of the room, such as the wall and the doorway. For the simplicity of the game, the players are not able to pass through the doors in the room. The doorway where the Cat begins the game is used as the starting location for the Cat avatar.

- Objects

  Contains item data and allow for the triggering of AudioFeedback and HapticFeedback depending on how the player interacts with them. A check of the tile in front of the player gives AudioFeedback in the form of speech informing the player what is in front. On the other hand, bumping into the object also gives the player a speech sentence describing the item they bumped into as well as HapticFeedback in the form of the device vibrating.
- Tutorial

  Provides support for the tutorial room by monitoring the player's actions and telling them what the next step is. It gives instructions to the players on how to control the Cat and how to go about exploring the environment as well as how to find food in the food finding mode.
- ExplorationMode

  Allows the game level to be played in exploration mode. In this mode, the player can freely explore the room in the given time limit of 5 minutes. After 5 minutes, the game ends and the gameplay save text is generated.
- FoodFindingMode

  Allows the game level to be played in food finding mode. In this mode, instructions to find the food are given initially and may be accessed by the player through the information check. The food item is also present on the map in food finding mode. Like the exploration mode, food finding mode has a limit of 5 minutes for the players to locate the food. The gameplay save text is generated after the 5 minutes are up or when the user finds the food.
- AudioFeedback

  Provides the device with auditory feedback to give to the user. Sound effects from objects are in stereo format, while other sounds such as speech and ambient music are in mono format. Different objects in the room emit different sounds if it can make sounds. For example, a table does not have any sounds but the clock on the wall emits a ticking sound. The loudness of object sounds also depends on the player's distance from them. Being closer to the sound source makes it louder. The facing direction also affects how loud it is. Facing away makes it softer while facing towards it makes it louder. Another example is if the item is on the player's left side, the sound it emits are louder in their left ear and softer in their right ear. This is to help with the player's orientation of the room.
- HapticFeedback

  Causes the device to vibrate for a certain duration depending on the event that occurs. Taking steps on a hard surface causes a longer and harder vibration than taking steps on a carpeted floor. Bumping into different objects also causes different intensity of vibrations to be given.

- GameplayVariables
  Stores current game play variables to be saved into a text file later. Variables include time taken, steps taken, number of turns made, number of bumps into objects, number of tile checks performed, number of information checks performed and number of penalties incurred.
- PlayerName
  Stores list of player names registered to the device and keeps it as a .txt file so that the same player names may be chosen again later.
- TextFileGenerator
  Generates a text file with .txt extension for the player's gameplay variables of the game level. It gets player's name from PlayerName object and the variables to write into the text file from GameplayVariables.

3.5.2 Level Designs and Development

This section covers design and development elements of the game levels. These include the general room level layouts, the game levels, the controls, the different game modes, the audio and haptic feedback and finally the sprite images used for the game.

Room Level Layouts

The general room layout is as shown in Figure 3.3 below. It depicts the UI elements as well as game environment features that are available in all rooms: with the exception of the Food object and the Interactive object.

As seen in Figure 3.3, there are several user interface elements. Two of them are interactive. The Back Button is for going back to the main menu. This is for exiting the level easily. The Blind Mode Button which is hidden from view, is used to toggle on and off between the blind mode as shown in Figure 3.4. It should be noted that the blind mode shown in the screenshot above is the newer edition. Section 3.10 will discuss the need for changing the blind mode to this design. The blind mode is on by default to avoid the advantage of using residual vision to view the map. The button for toggling the blind mode is to enable the facilitator of the test to quickly determine how the user is doing if assistance is required during game play.

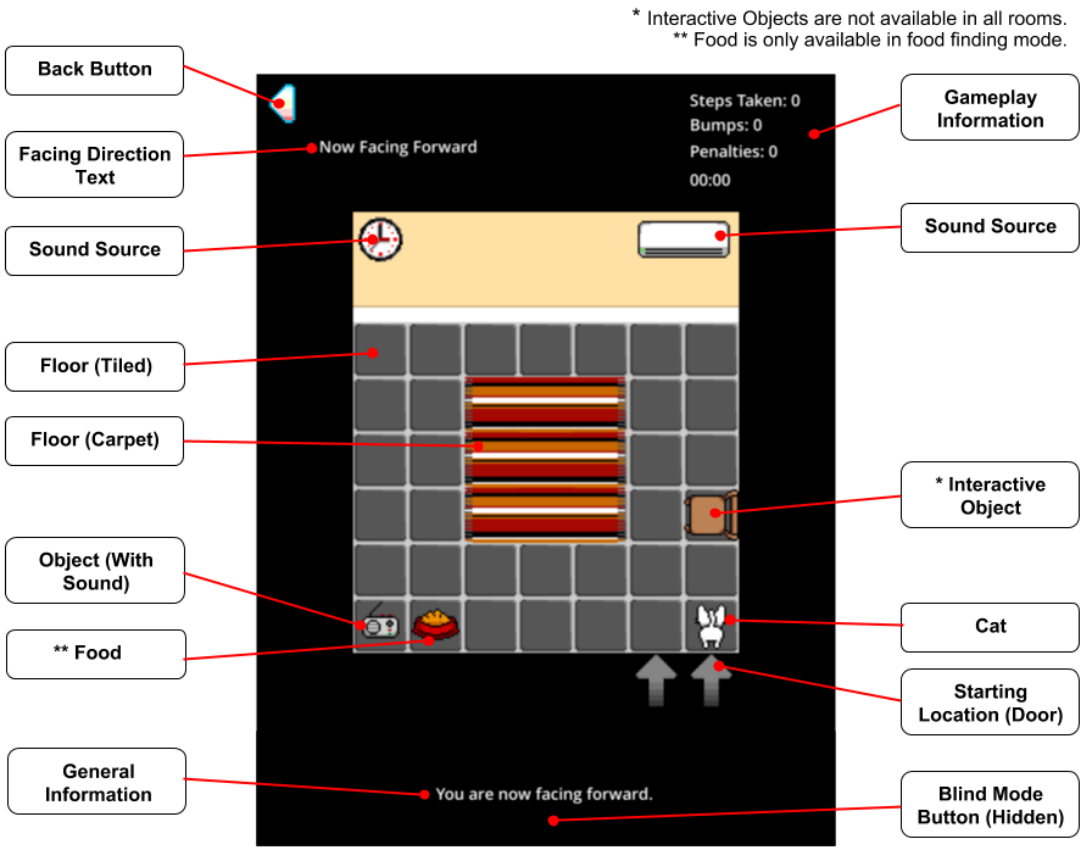

Figure 3.3 Screenshot Showing General Room Layout

Other UI elements are for information purposes to inform about the facing direction of the user, general information such as what objects they have bumped into and game play information like the time left, steps taken, bumps made and penalties that occurred.

All room levels are surrounded by a black background, representing the walls. The player may not leave the area bordered by the walls and bumping against the walls and doors will result in auditory and vibrational feedback from the game. The doorway is shown by the two arrows pointing upwards and is the starting location of the player when they begin the game level: the Cat will always begin on the right hand tile of the doorway.

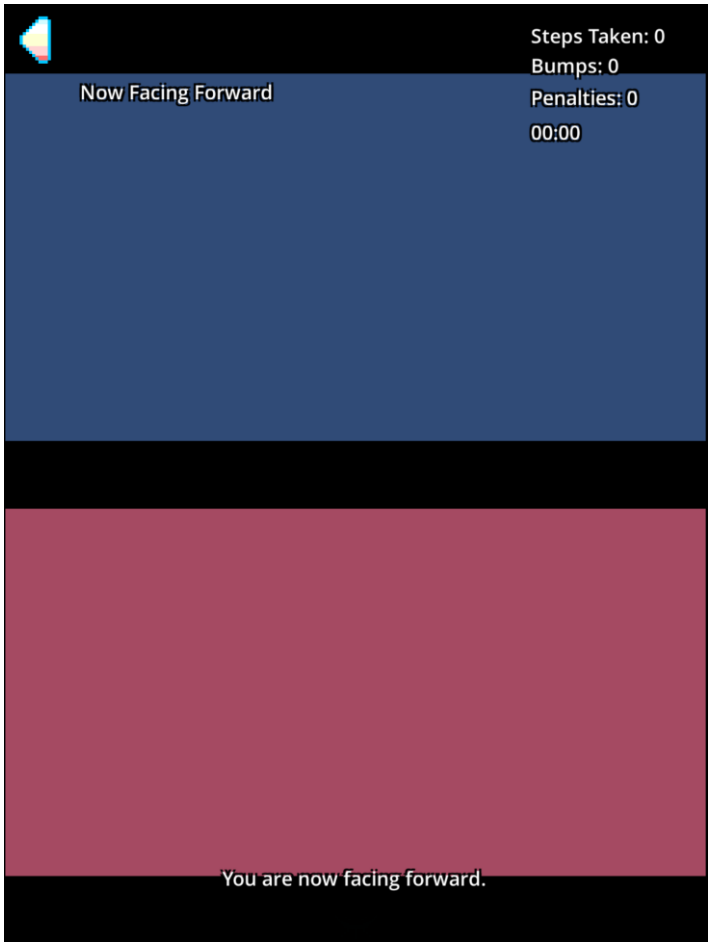

Figure 3.4 Screenshot Showing Blind Mode Activated

All rooms will have floor tiles and can come in a few variations, some rooms may have tiled floors, some rooms may have wooden floors, and some rooms may contain carpets. Different variations of floors will provide different auditory and haptic feedback when the Cat steps on them.

Each room will have at least one sound source to help players orient themselves. These are normally against the walls of the room and are not objects you can bump into. There are also objects that give off sounds such as the radio in Figure 3.3 above. However, not all objects will have a sound effect attached to it such as for cabinets and potted plants.

The more difficult rooms will have interactive objects, which are climbable to reach a higher location. This is because food items located in the harder rooms are usually placed on an elevated surface and requires certain knowledge of the room to be able to locate it. Without any objects, it

is possible for the food to be found simply by walking around in the room at random. While on an elevated surface, the player will have to perform a tile check to trigger an action to climb down. Trying to walk off a high surface will result in a penalty.

Game Levels

There are six game levels that will be used for the evaluation of the prototype. Before playing the six levels, there will be a tutorial level which will be used to build familiarity of the gameplay controls of the player. Table 3.1 will summarize the tutorial room and the 6 rooms.

Table 3.1 General Information of Room Levels

Level	Room Name	Size	Food	Has Interactive Objects	Number of Objects (excludes wall objects)	Number of Sound Sources (includes wall objects)
0	Tutorial Room	7 x 6	Bowl of Cat food	Yes	2	3
1	Hallway	8 x 2	Bowl of Cat food	No	2	1
2	Laundry Room	6 x 4	Bowl of Water	No	3	2
3	Study Room	5 x 6	Sandwich	Yes	5	2
4	Bedroom	7 x 6	Pizza Slice	Yes	4	3
5	Kitchen	8 x 6	Fish	Yes	8	3
6	Living Room	8 x 10	Chicken Drumstick	Yes	7	3

- Level 0: Tutorial Room

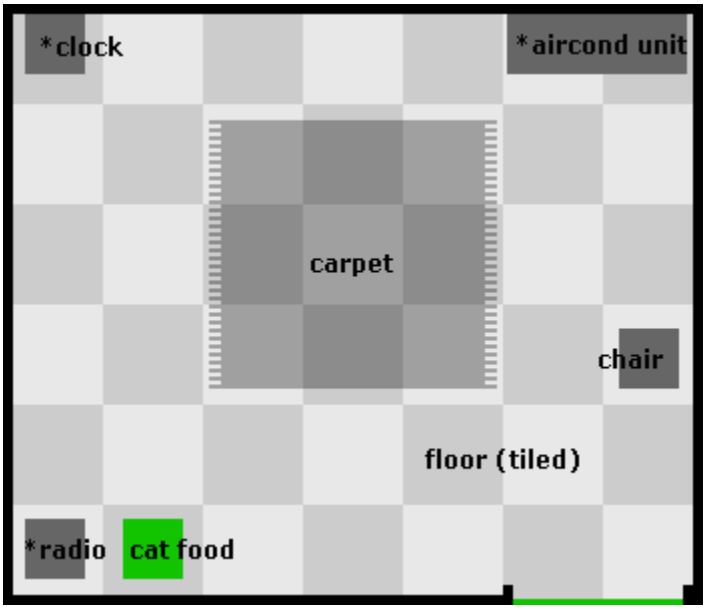

Figure 3.5 Level 0 - Tutorial Room Frame

As mentioned, the purpose of the tutorial room level is to help players get used to the controls of the game. The sound sources are marked with an asterisk (*).The tutorial room contains three sound sources, one at different corners of the room to show the user that being at different parts of the room results in different volumes for the different sound source. It also has one interactive object to allow the user to learn how to locate and interact with an object.

- Exploration Mode:

  The tutorial begins with introducing the players to the basic controls. Firstly, they are asked to move forward by tilting the device forward. After this is complete, they are asked to turn to face the right, back, left and front. They are then asked to perform both a tile check and an information check. After doing so, they are then given information of the location of the chair, which is the interactive object and where to find it. When they have successfully located the chair, the game tells the player how to interact with it and to choose to climb up the chair. Once they have done so, they are asked to climb down the chair. The players are then given some time to continue exploring the room to become more familiar with the controls.

- Food Finding Mode:

  The tutorial begins in the same room, except for one difference: the addition of a Food item for the Cat to find. The tutorial starts with the game giving players directions to the food. The game lets the player know that they may get the information again at any time by doing an information check. Once the player locates the food, they have completed the tutorial.

- Levels 1 - 6: Hallway, Laundry Room, Study Room, Bedroom, Kitchen and Living Room

  Rooms for Levels 1 to 6 are played after the tutorial room. There will be an increase in difficulty from the first room to the last, this is done so by increasing the size of the room thus increasing the area the player can explore within the same 5 minute duration. There are more and more objects and sound sources in the room as the difficulty increases as well. Additionally, from Level 3 (Study Room) onward, interactive objects will be added to the rooms.

  - Exploration Mode:

    Gameplay for exploration mode is the same across the 6 rooms. The player is given 5 minutes to freely explore the room. At the end of the 5 minutes, exploration mode ends and they can begin the food finding mode.

  - Food Finding Mode:

    As with the exploration mode, there is no difference in furniture placement in food finding mode for the 6 rooms. The player is given instructions to the food at the beginning of the level and are given 5 minutes to locate it. The game ends once it is located or the time is up.

In order to draft out the layout of each room, the frames of each room and what it contains is drawn out. As mentioned previously, the sound sources are marked with an asterisk (*). Objects are depicted as grey rectangles while the food which is only present in food finding mode is shown with a green square. Figure 3.6 to Figure 3.11 show the room frames for the individual levels:

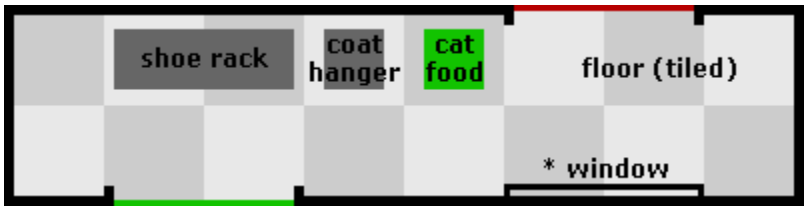

Figure 3.6 Level 1 - Hallway Frame

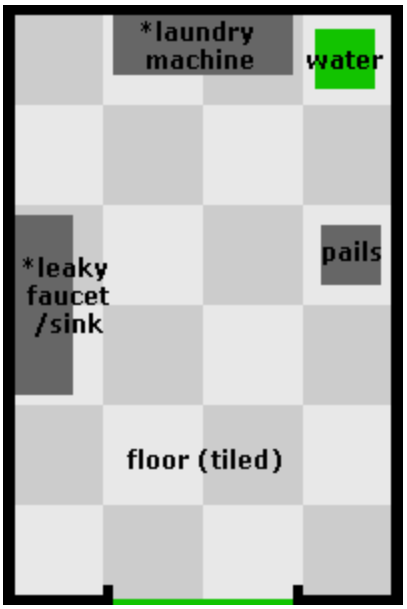

Figure 3.7 Level 2 - Laundry Room Frame

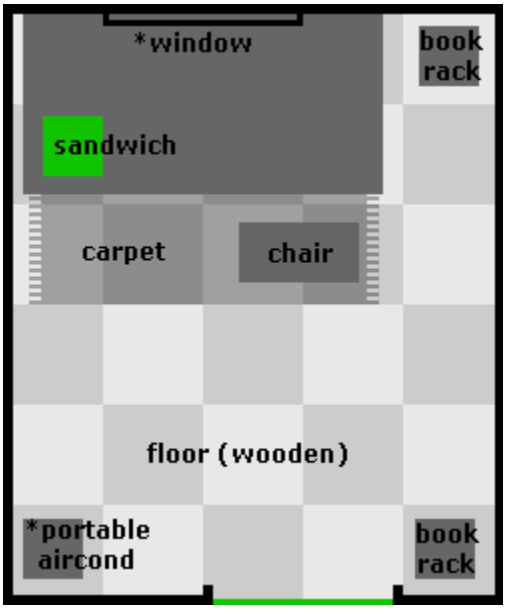

Figure 3.8 Level 3 - Study Room Frame

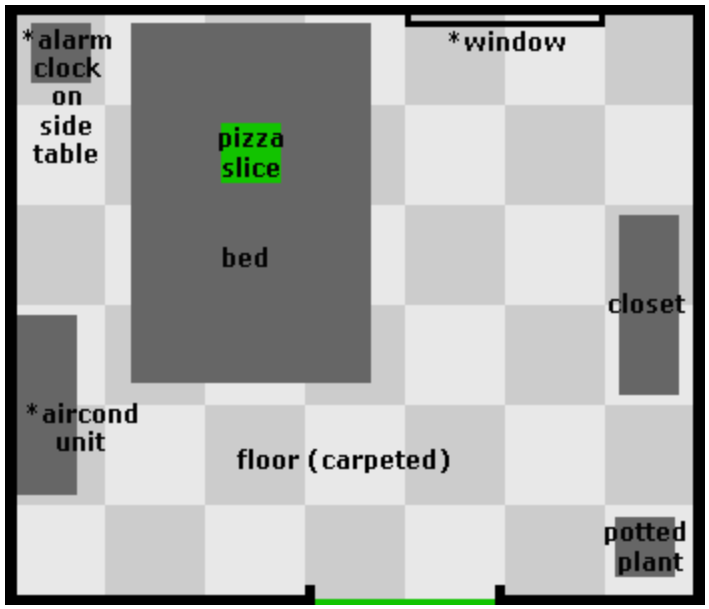

Figure 3.9 Level 4 - Bedroom Frame

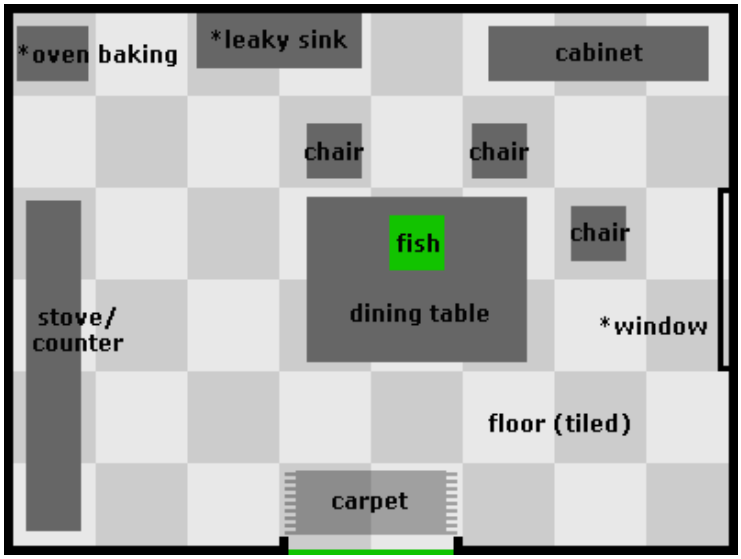

Figure 3.10 Level 5 - Kitchen Frame

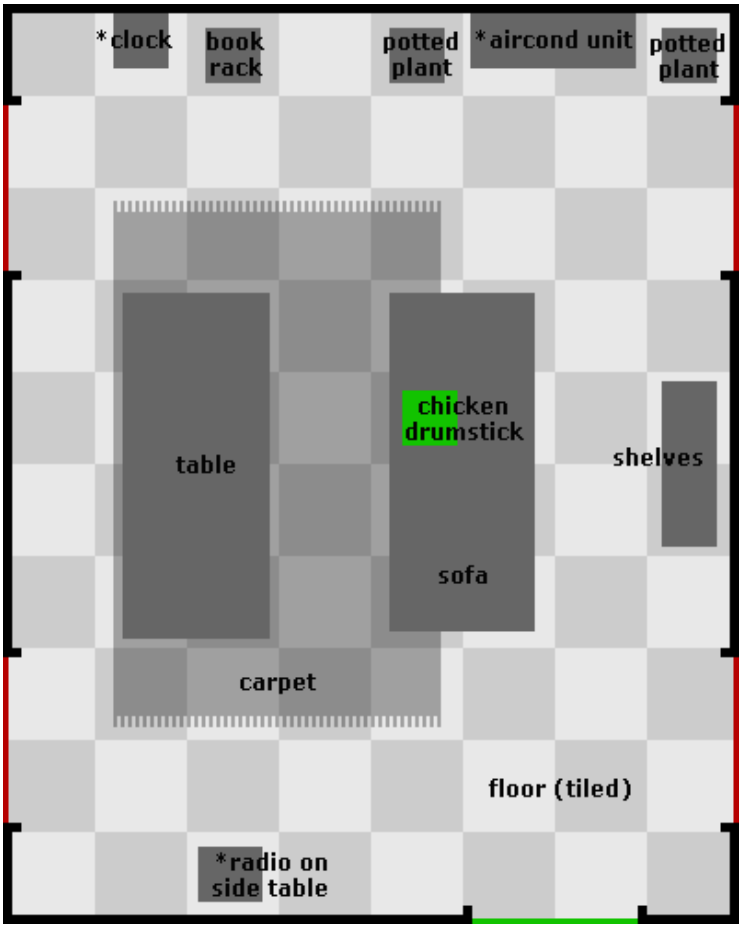

Figure 3.11 Level 6 - Living Room Frame

Controls

There are multiple controls in this game as follows:

- Move Forward

  The player can move forward by tilting the device forward. This movement is detected by the accelerometer. The Cat continues to move forward by one step every second the device is held that way. They can stop moving forward when they stop tilting the device forward.

- Change Cat's Direction

  The players can change the cat's direction by physically moving themselves in real life. The device's magnetometer detects the change in their facing direction and move the Cat's facing direction as well.

- Check Tile in Front

  The player can check the tile in front for item information or to initiate an interaction with an object in front by tapping the top half of the device's screen. This informs the player what

object or obstacle is in front of them. If it is an interactive object like a climbable chair, the action prompt is brought up.

- Check for Location Information

  The player can get information from the game by tapping the bottom half of the device's screen. The game informs the user of their current location, and if in food finding mode, provides the user with the initial directions and their current distance from the food.

- Dismiss Location Information

  As the location information given may be long and the player may no longer want to listen to it anymore after getting the information they want, they can dismiss it anytime by tapping the top half of the screen.

- Choose Action

  When interacting with an object that has an action, two options are given for the player to choose. Depending on their choice of action, the player will have to tap either the top half or the bottom half of the screen to trigger it.

Game Modes

There are two game play modes in this game:

- Exploration Mode

  This mode begins with informing the player what room they are playing in and when they can start playing. The 5 minute timer begins as soon as the sentence is ended. The player is allowed to move freely around the room to gain spatial information of the location. After the five minutes are up, players are no longer be able to continue exploring the room.

- Food Finding Mode

  This mode is played after the exploration mode of the same room as players can use the spatial information they have gained from exploring to better locate the food. This mode begins with informing the player how many tiles away and in what direction away the food is from the player. The 5 minute timer starts as soon as the sentence is ended. The player can access this information again by tapping the information check. The information check additionally tells the user how close they are to the food as they change their location in the room. The level is completed after the 5 minute duration is up or the player locates the food successfully.

Audio and Haptic Feedback

As the player interacts with the virtual environment in the game, they receive audio and haptic feedback from interaction with it.

- Audio Feedback

  There are a few types of audio feedback given by the game. The first one is in the form of computer-generated speech which provides the user with easy to understand descriptions and instructions. This sound is mono and can be listened to equally in both ears. The second one is sound effects, which are sounds from items that are considered sound sources, for example the dripping sound from a sink and the ticking sound from a clock. These sounds are in stereo as they are based on the distance the user is from the items as well as their facing direction orientation. There are also sound effects for the steps as players take them. This is to let the user know how many steps they are taking so far. The last kind of sound is the background music, which is just ambient music for the game menus to set the mood for the game.

- Haptic Feedback

  Haptic feedback by the game is simple as it is just the vibration from the device. This vibration is played by the device when triggered by events such as being played in time with the player's steps when they move forward. It is also triggered when the player bumps into objects. Depending on the hardness of the floor surface and the item they bump into, the intensity of the vibration varies. Hard objects will trigger a longer vibration than softer or lighter ones.

Sprites

To build the game levels, sprites, which are pictures used in the game need to be drawn. To maintain a simple design for the game, all the sprites are drawn using pixels. The same sprites can be reused for multiple levels of the game.

Here are some examples of the sprites developed for the game prototype:

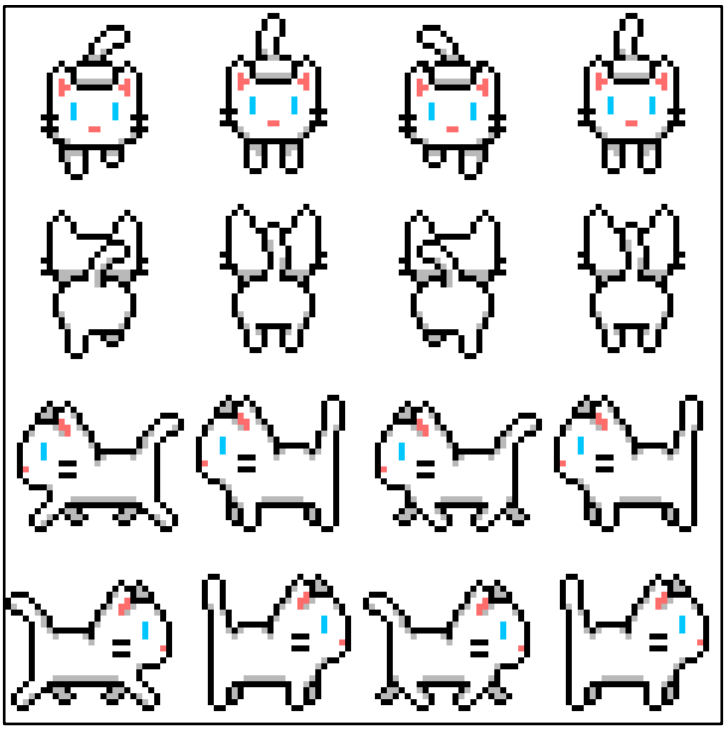

Figure 3.12 Cat Sprite Sheet

The Cat is the avatar the players play as in *Hungry Cat*. Its sprite sheet shows its animation movement when it is facing backward, facing forward, facing left and facing right. When put in the game, the Cat is animated and will face in the same direction as the player's current direction.

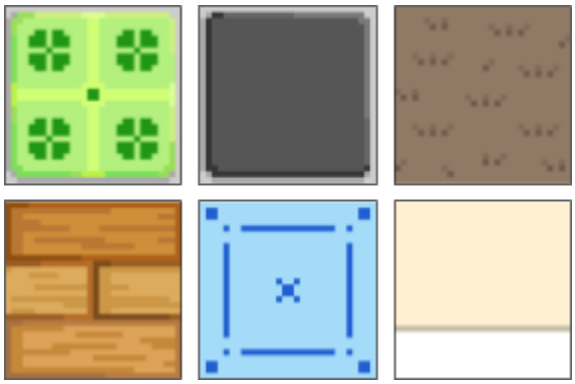

Figure 3.13 Examples of Tile Sprites

Tile sprites are sprites that can be drawn once and reused repeatedly in the levels. These kind of sprites are normally used for the walls and floor of the room.

Figure 3.14 Examples of Furniture Sprites

Furniture sprites are images of items that are in the room. Even though this is a serious game for the visually impaired, the presence of images in the game eases the development and testing process of the game. It also helps the facilitator of the test to know where exactly the user is during game play when they require assistance by turning off the blind mode.

Figure 3.15 Examples of Food Sprites

Besides the sprites shown above, another item, which requires sprites for the game, is the Food item. Although it only makes an appearance in the food finding mode of the game, sprites are required for easier identification of the item when glancing at the screen.

3.5.3 Additional User Interface Screen Designs and Development

Besides the game play levels which have been discussed in the previous section, this section covers the other user interface screens for this game. Wireframes of each UI screen are shown here to depict the design. Currently majority of these screens are only navigable by sighted individuals. The term “Player” in this section refers to the person who is going to play the game, while the term “user” refers to the person who will interact with the user interface.

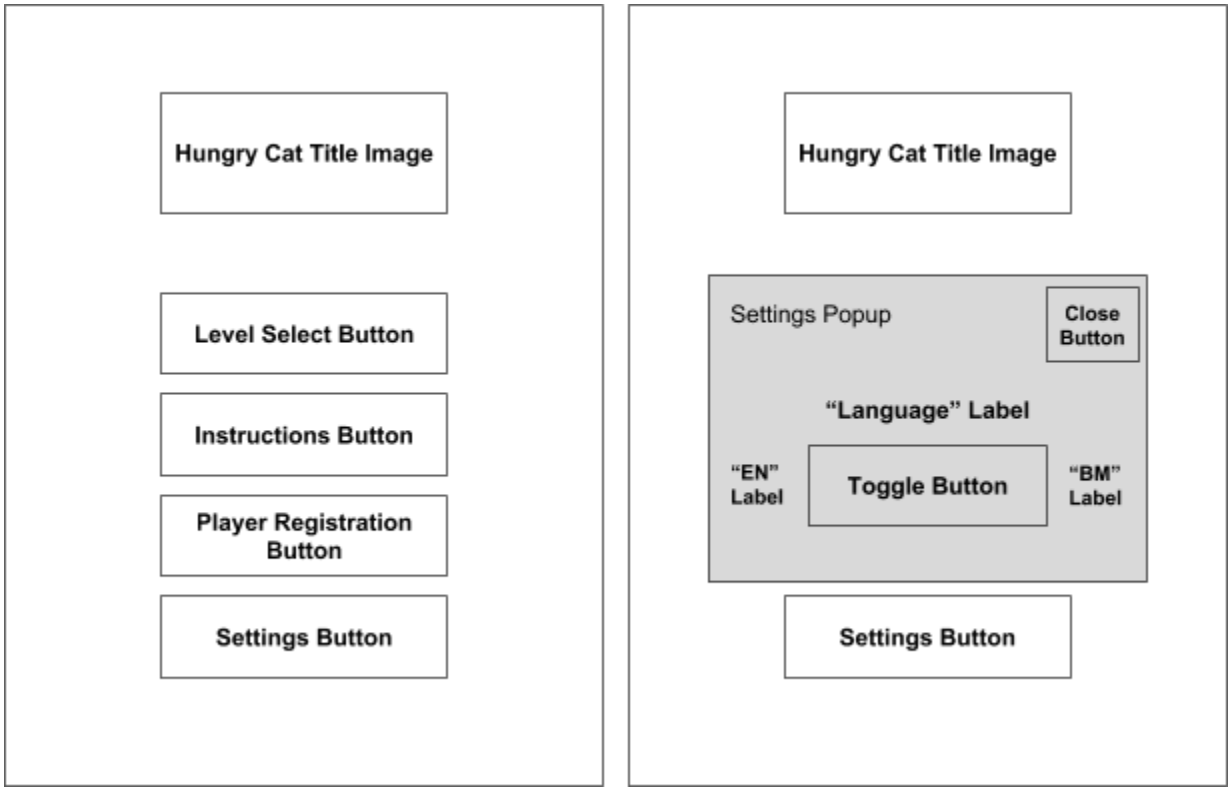

Figure 3.16 (a) Wireframe of MainMenuUI, (b) with Settings Popup

The MainMenuUI is the first screen of the game, this screen leads to all other screen and is primarily used for navigation between them. The Level Select Button brings the user to the LevelSelectUI, the Instructions Button brings the user to the InstructionsUI, and the Player Registration Button brings the user to the PlayerRegistrationUI. The Settings Button brings up the Settings Popup menu where the user can change their language preference by pressing the Toggle Button. Players can choose between English and *Bahasa Melayu*. Language preference affects language used by the speech in game. The Settings Popup can be dismissed by tapping on the Close Button. The Settings Popup has only been implemented after the prototype testing discussed in Section 3.10 deems the need to have a second language for the game.

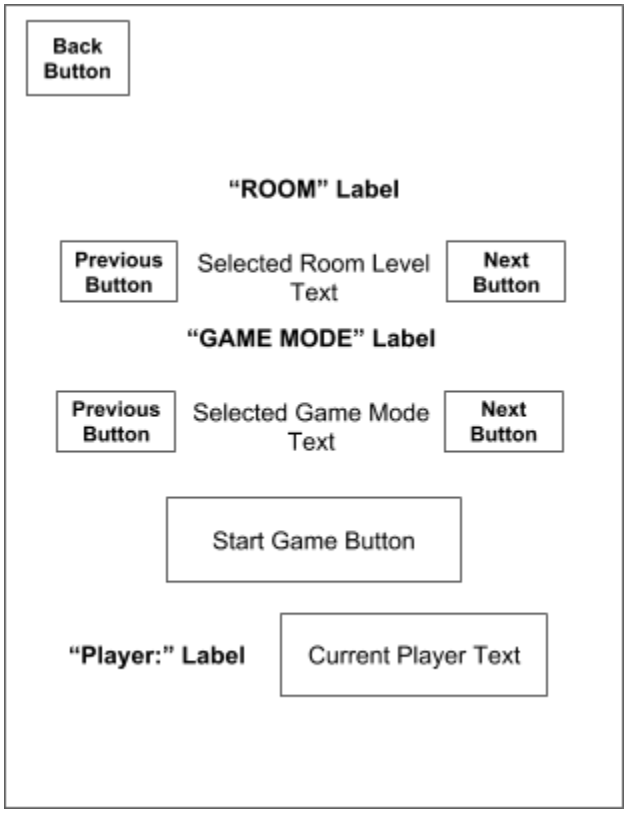

Figure 3.17 Wireframe of LevelSelectUI

The LevelSelectUI can be accessed from the MainMenuUI. The user can go back to the MainMenuUI using the Back Button at the top left corner. While on this screen, the user can choose the room and game mode they want by tapping the respective Previous and Next buttons. The Texts are updated according to the change in selection. After selecting the room and game mode they want, the game level can be started by pressing on the Start Game Button.

The current Player's name is displayed near the bottom of the screen. This is an indication for the facilitator of the test to know if they have already set the name of the player for the purpose of the save game files. If no Player is chosen, it displays "Default".

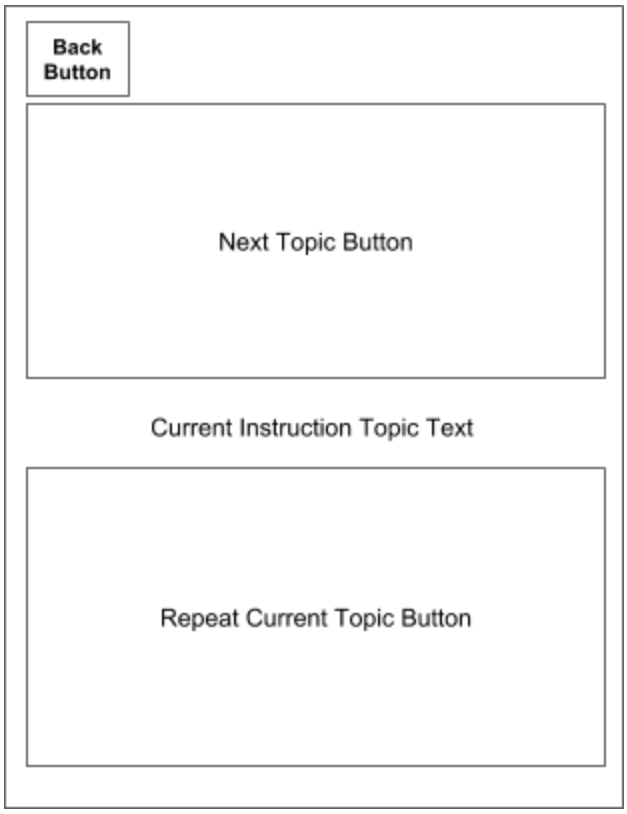

Figure 3.18 Wireframe of InstructionsUI

The InstructionsUI can also be accessed from the MainMenuUI. This screen gives the user information regarding how to play the game in verbal format. It is to be noted that this is not the tutorial level and is intended to give a brief to the players before they begin the tutorial room. To make it easier for the visually impaired children to run through the instructions at their own pace, the buttons for “Next Topic” and “Repeat Topic” are placed at the top and bottom of the screen respectively. Like the LevelSelectUI screen, there is also a Back Button at the very top left corner of the screen to allow the user to return to the main menu.

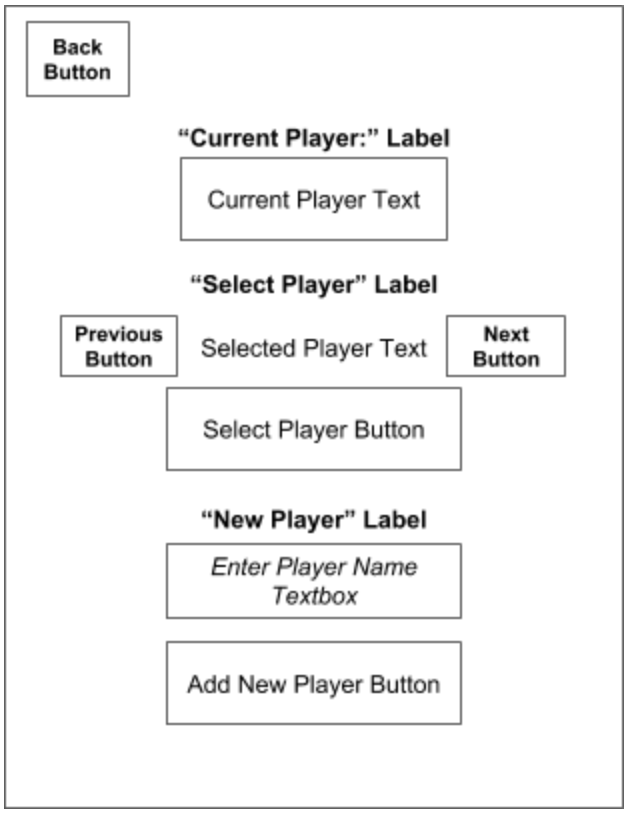

Figure 3.19 Wireframe of PlayerRegistrationUI

From the MainMenuUI, the PlayerRegistrationUI can be accessed. As with other screens that can be accessed from the main menu, there is a Back Button at the top left corner of the screen to allow the user to return to the main menu easily. In this menu, the user may register the player's name for the naming of the save game files. The Current Player chosen is displayed, if no player is chosen for the testing session yet, the word "Default" is displayed.

If a Player has already been registered previously, their name can be selected again by pressing the Previous or Next button to locate the name of the player. Once the name they chose is displayed, the user needs to press the Select Player Button in order to set the player as Current Player. The Current Player Text is updated accordingly.

If the Player is new, their name may be added to the list by entering the name in the Enter Player Name Textbox and pressing the Add New Player Button. This adds the new player to the list of names. The user may now select the player from the Select Player options.

3.6 Game Play Scenarios

There are two game modes: exploration mode and food finding mode. The logic flow for these two modes are depicted as flowcharts. Other scenario flows that occur within them such as saving the gameplay data and player controlled actions like moving forward, changing facing direction, performing a tile check and performing and information check are also included in this section.

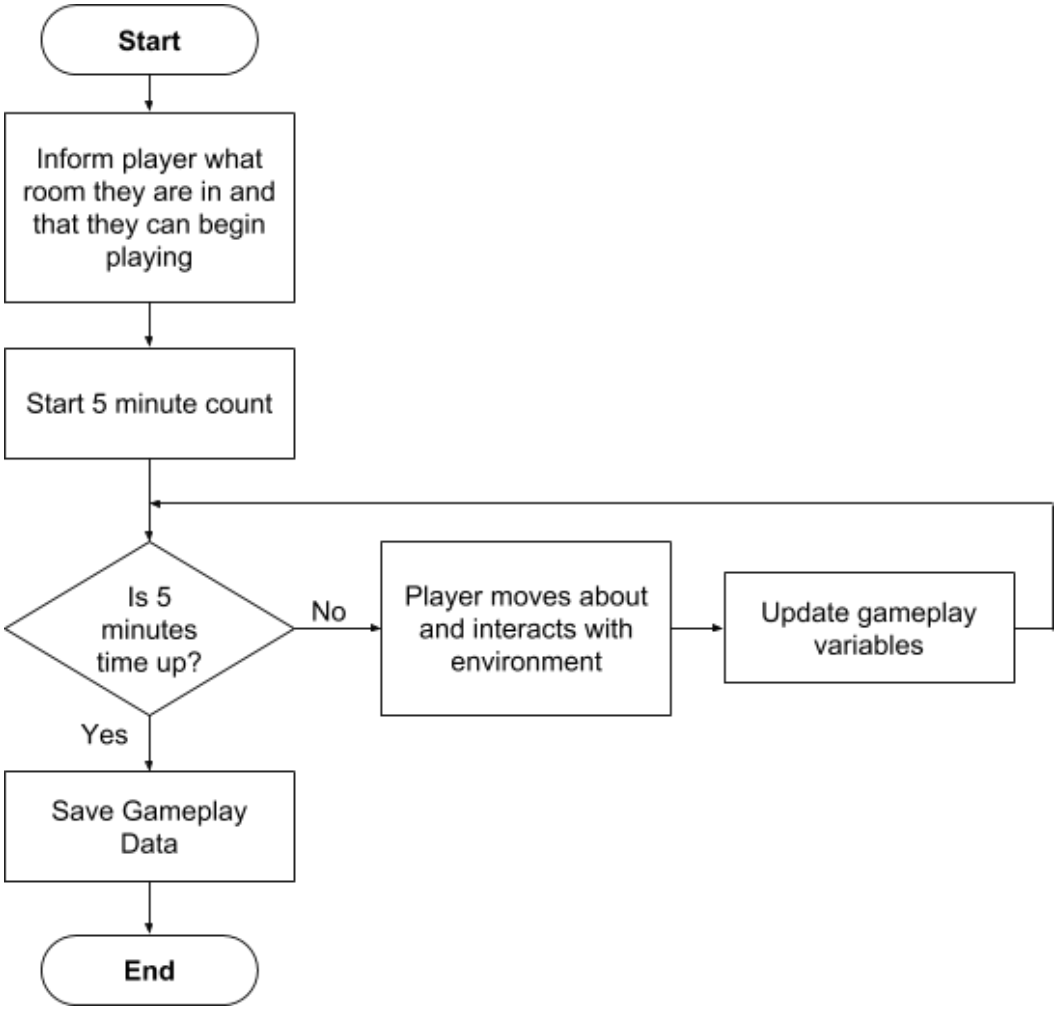

Figure 3.20 Flowchart for Exploration Mode

Figure 3.20 shows how exploration mode is carried out. The game ends when the time is up. An exception to this flow would be if the user decides that they are finished exploring early then the game ends at that point. After the 5 minute count is initialized, the player is free to move about and interact with the environment. The actions taken are counted and updated to the gameplay variables for analysis. When the 5 minutes is up, the gameplay data is saved and the level is ended.

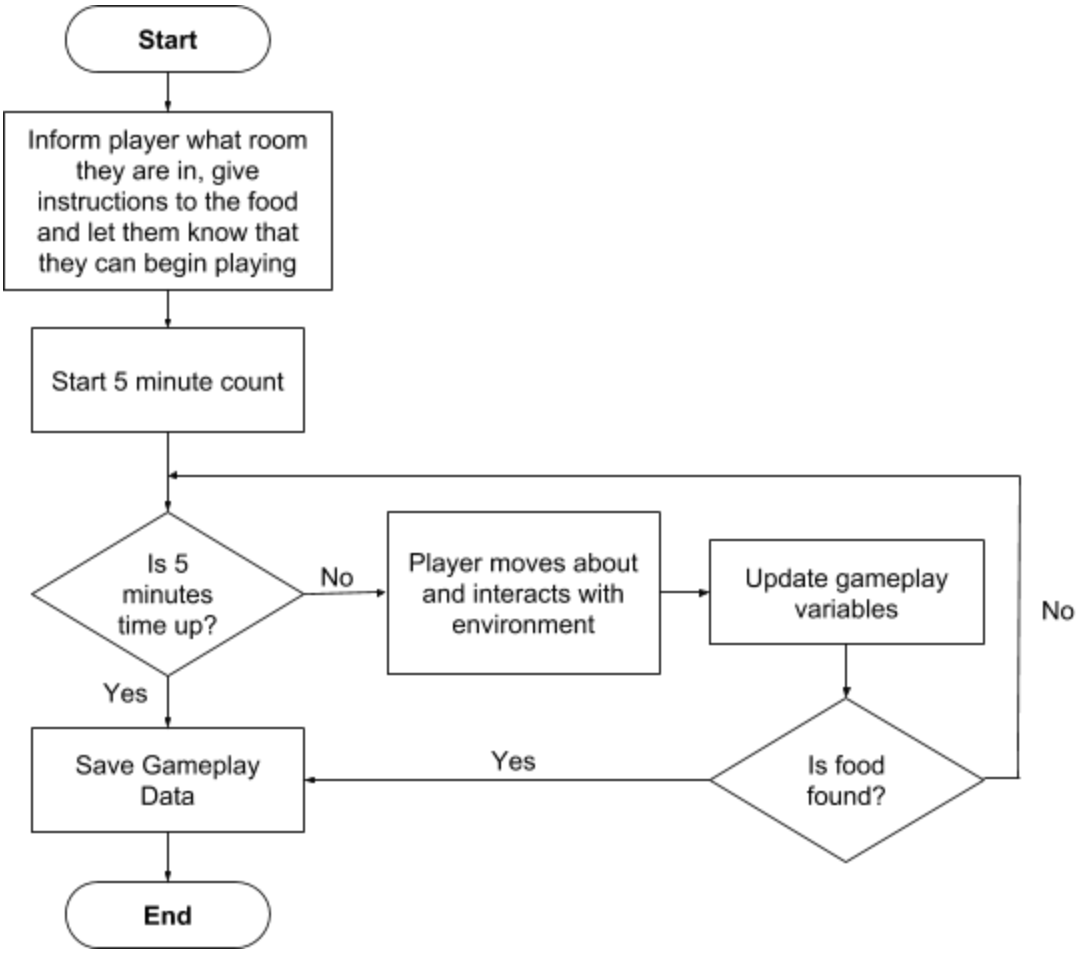

Figure 3.21 Flowchart for Food Finding Mode

Figure 3.21 shows how food finding mode is carried out. It is similar to exploration mode however there is an additional end game condition of finding the food. The player beats the level if they find the food within 5 minutes time, or else the game will end after the 5 minutes is up.

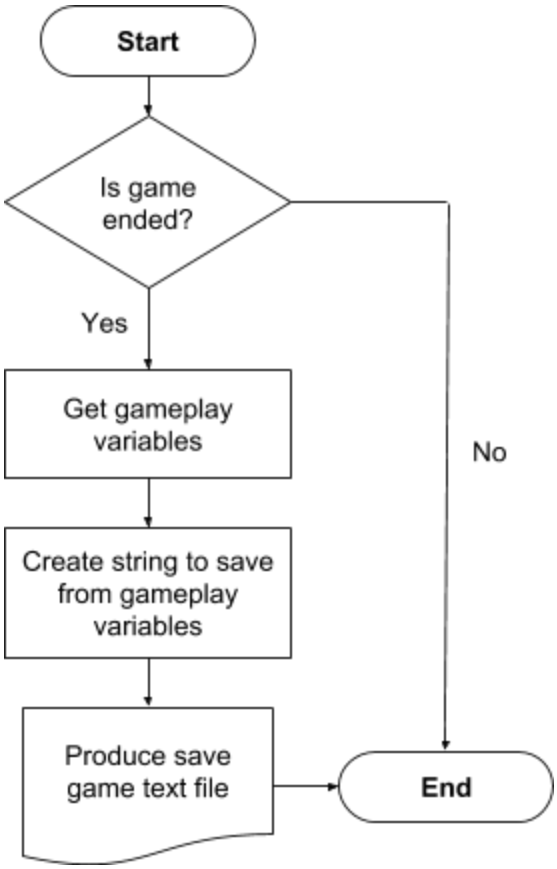

Figure 3.22 Flowchart for Saving Gameplay Data

When a game is ended, be it through timeout, player wanting to stop exploration mode earlier or through the discovery of the food object, a save game text file is produced as shown in Figure 3.22. This text file contains the gameplay variables of the player's attempt and is used for analysis.

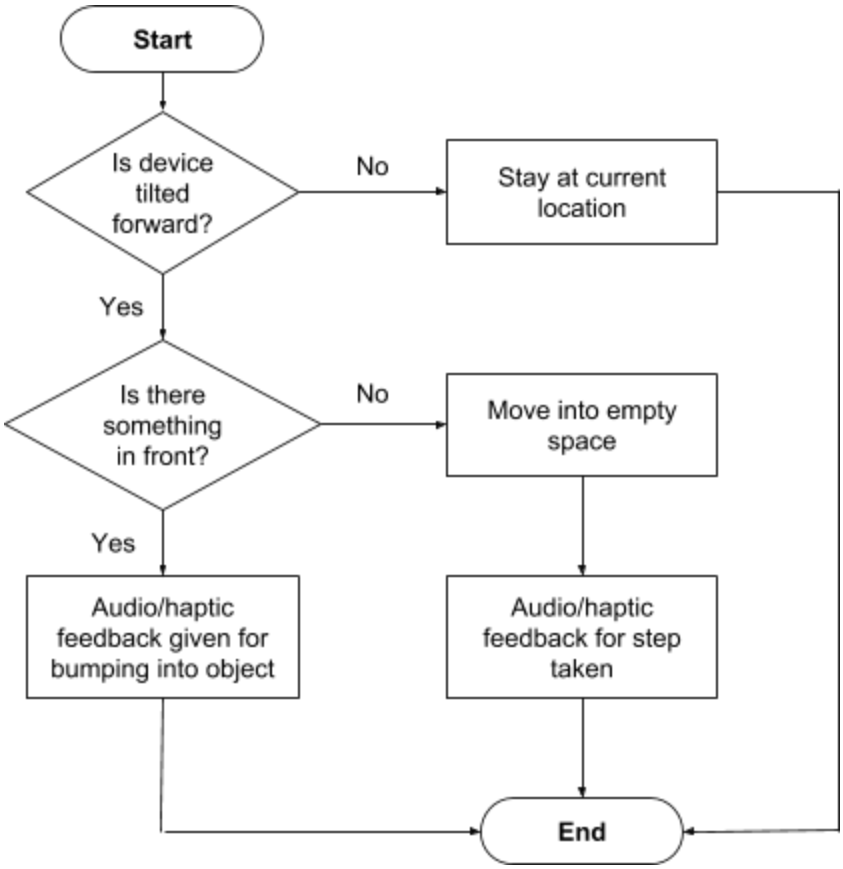

Figure 3.23 Flowchart for Moving Forward

Players can move forward when they tilt the device forward as shown in Figure 3.23. This tilting forward action is detected by the mobile sensor, the accelerometer. If the device is not tilted forward, the Cat avatar does not move forward. When it is tilted forward, there is a check to see if the tile in front is occupied. If there is nothing in front, the Cat moves into the empty space. However, if there is something, the Cat bumps into the object. Audio and haptic feedback are given in both cases to alert players of what has happened.

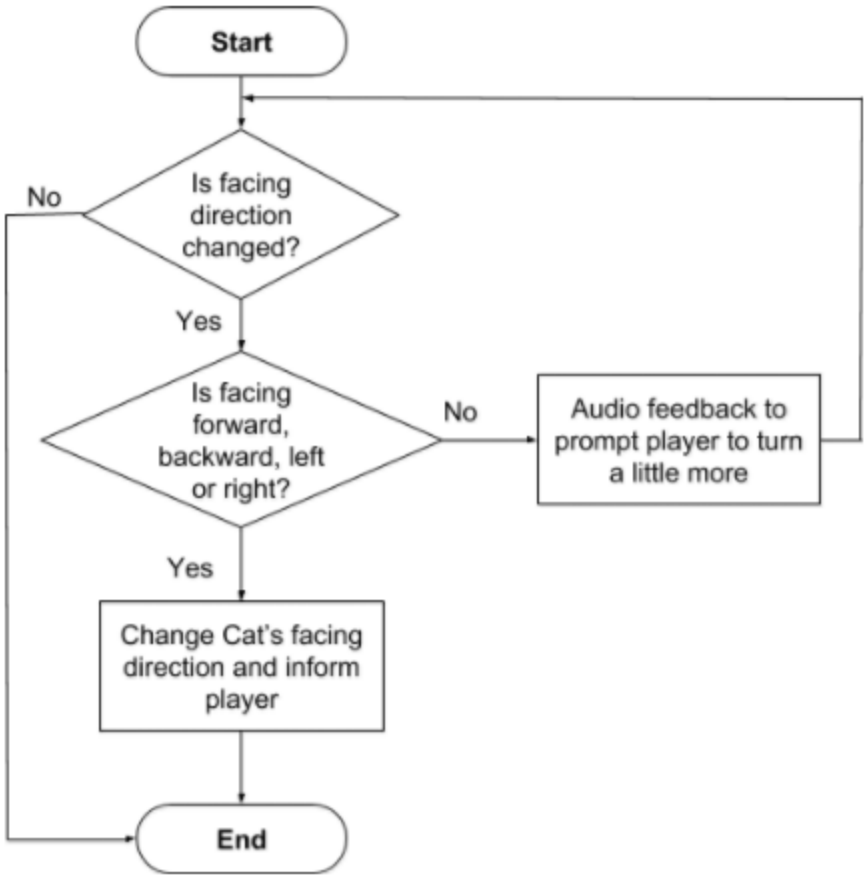

Figure 3.24 Flowchart for Changing Facing Direction

Players can change the facing direction of the Cat avatar by changing their facing direction physically while holding the device as illustrated in Figure 3.24. The mobile sensor, magnetometer inside the device gets the player's initial direction upon starting the game level and sets it as a "forward" direction. It also detects the change in facing direction of the player and informs the game. The game then checks to see if the facing direction is either forward, backward, left or right. Although the changing of direction need not be 100% accurate to the 90-degree angles, it is still rather strict and if the player is not within the acceptable range, audio feedback is used to prompt the player to turn a little more. When the player has changed their facing direction to within the acceptable boundary, the Cat's facing direction changes and the player is informed of the current facing direction.

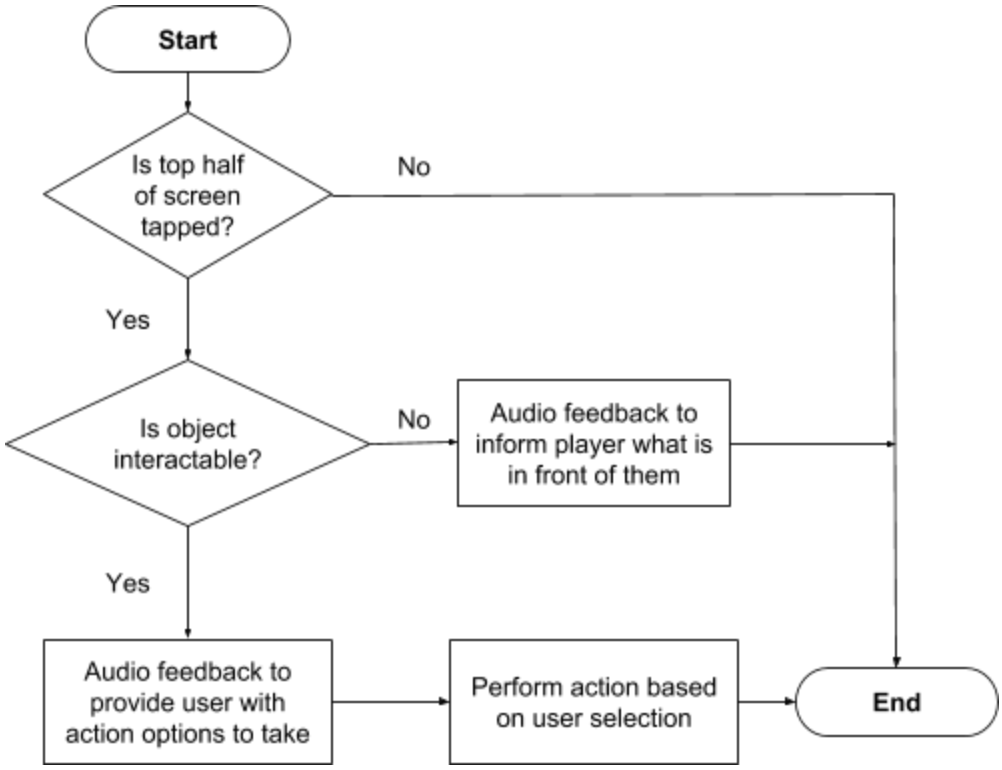

Figure 3.25 Flowchart for Performing a Tile Check

As can be seen from Figure 3.25, players can perform a check to know what is in front of them by tapping the top half of the device screen. When they do so, the game informs them what the tile in front is. If the object in front is interactive, the user is prompted to choose an action. They can then tap the top half of the screen or the bottom half of the screen depending on their choice to execute the action.

3.7 Development Tools

The development of *Hungry Cat* required several resources. The main thing being a game engine, which has enabled the game to be developed. The others are resources in the form of art, sounds and text to speech (TTS). This section covers the development tools that have been used to assist in the prototype making progress.

The game engine chosen for this study is the *Unity 5* game engine. The coding language used by this engine is C#. Although primarily used for 3D visuals and for the development of computer games, *Unity 5* also supports mobile game development in 2D graphics.

For the graphics used in the game, *Adobe Photoshop* was used for the creation of the sprites and user interface items such as the menu buttons.

There are two languages used in this game, therefore two versions of the speech were required to be generated. *TTSReader* was used for the purpose of the English speech, while *nusuara* has been used for generating the *Bahasa Melayu* speech.

Audacity has been used for the editing of the audio for the game, which includes the sound effects and the generated speech. This software has been used to adjust the volume of the audio, crop out unnecessary bits and also to combine different pieces of audio together.

3.8 System Requirements

The prototype game is developed for the Android platform and requires a minimum API level 14, which is Android 4.0 “Ice Cream Sandwich”. The game app developed relies on the mobile sensors: accelerometer and magnetometer. Therefore, a touch screen mobile phone or tablet equipped with both the accelerometer and magnetometer is required. It is also recommended that the device has enough RAM and free memory to play the game smoothly.

3.9 Design Implementation

Based on the design presented in Section 3.5, a prototype game has been developed. This section discusses the implementation of the user interface, the gameplay and the save game module.

3.9.1 Interface Design Implementation

The user interfaces in *Hungry Cat* are kept simple and easy to understand. Figure 3.26 shows the linking between the screens (other than game levels) in the game. The Main Menu links to Level Select Screen, the Instructions Screen and the Player Registration Screen. All three of these screens link back to the Main Menu. The Main Menu can also open up a Settings Popup through the Settings Button.

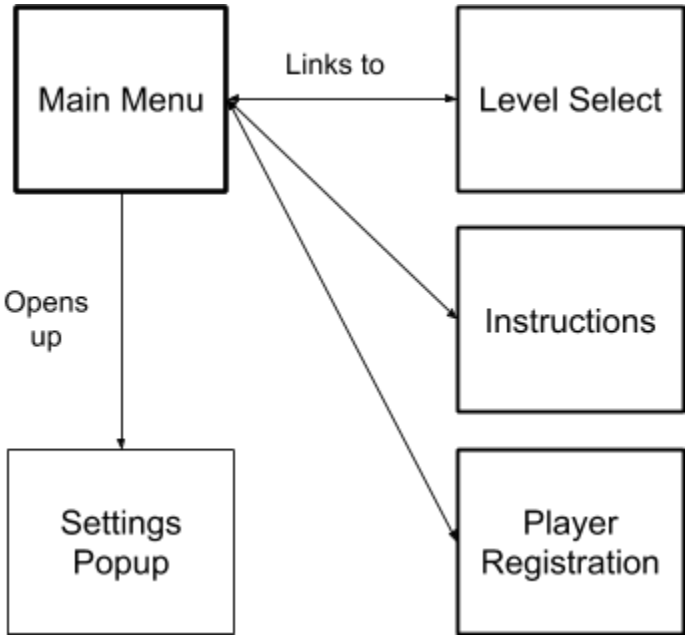

Figure 3.26 How the Different User Interfaces Link

To match with the pixel art used for the sprites in the game, the user interface elements such as buttons are also done in that art style. As the graphic elements for the game do not hold high importance in attracting the player's attention, the design was kept simplistic. The same background picture and colour scheme are reused for all screens to keep the design consistent. All the screens shown in the figures below have been constructed in Unity 5. Graphical images of the UI have been done using Adobe Photoshop and added into the project. Figure 3.27 to Figure 3.30 show the user interface for screens that are not the game play.

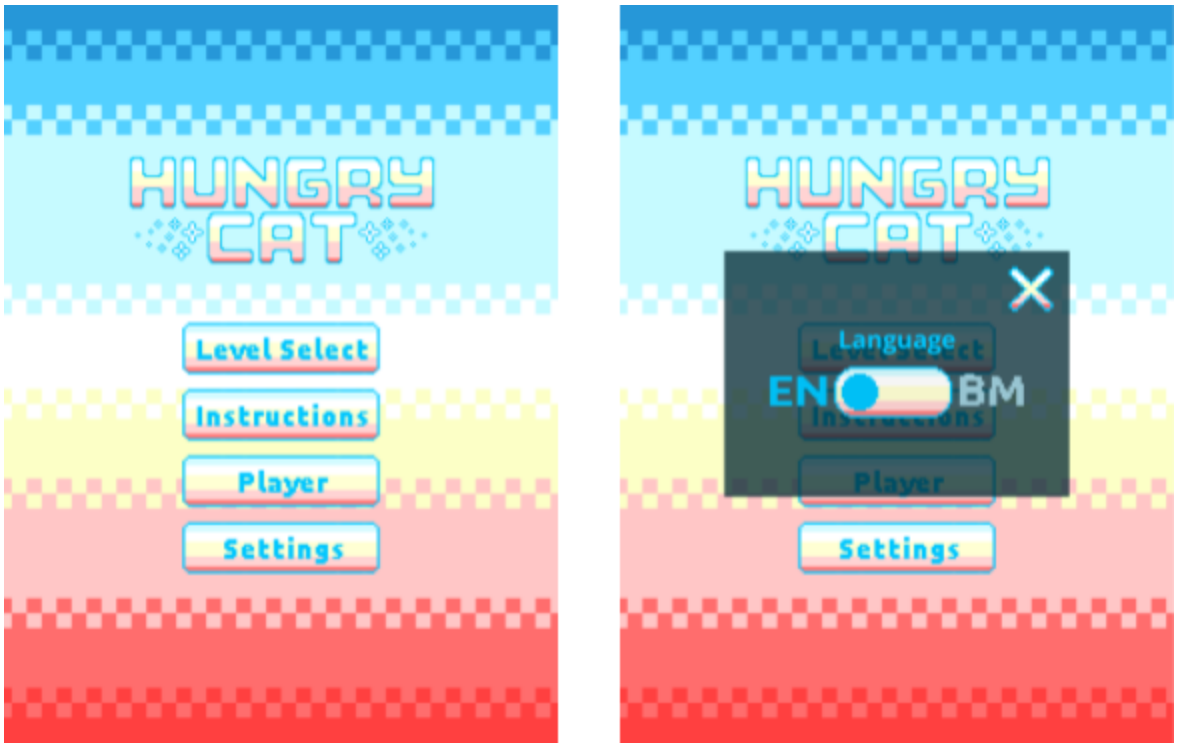

Figure 3.27 (a) Screenshot of Main Menu, (b) with Settings Popup

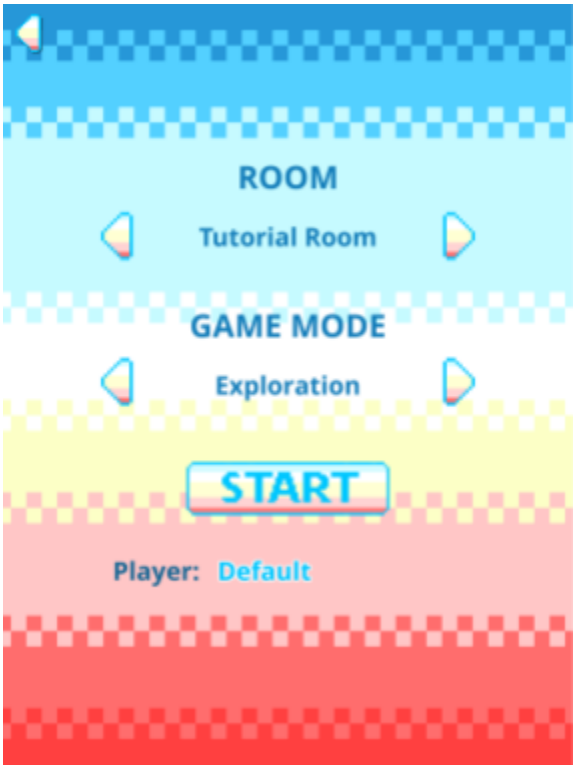

Figure 3.28 Screenshot of Level Select Screen

Figure 3.29 Screenshot of Instructions Screen

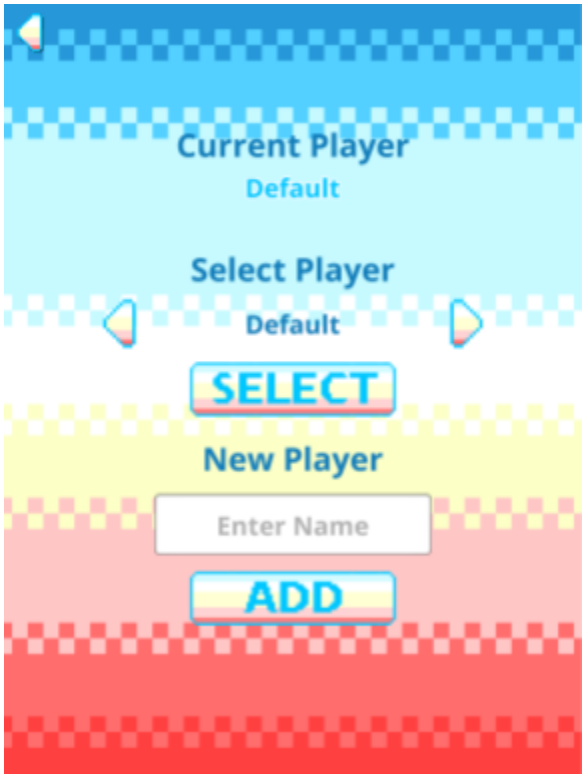

Figure 3.30 Screenshot of Player Registration Screen

3.9.2 Gameplay Design Implementation

The gameplay screens include multiple elements such as the game controller, the Cat avatar, model objects for items in the game, images for the graphical interface and audio for feedback to the players.

Cat Avatar and Game Controller

The Cat character, which appears in all the rooms, is the avatar the player controls. The Cat character explores and interacts with the room on the player's behalf. However, to do so, several things need to be added to it.

A collision box is first defined for the Cat. The collision box is how the Cat senses its surroundings. When a collision box of the Cat touches or overlaps with another collision box (such as that of an item in the room), it determines what the item is by getting information stored in the item. The information obtained affects how the Cat interacts with the item.

The Cat also needs to be able to receive the player's controls. Therefore, the Game Controller receives the controls by the players such as tilting of the device, changing of facing direction and tapping on the screen. The controller then informs the Cat Avatar what action to take. For example, if the direction is changed successfully, the Cat avatar changes its facing direction as well by changing what image sprite it should be displaying.

The Cat Avatar also provides some audio and haptic feedback to the players. The main example being when the player moves it forward. Every step the Cat takes results in the sound of one step and one instance of vibration. With this, the player is able to know how many steps they have taken. The Cat also meows differently depending on if the player has chosen to perform a Tile Check or an Information Check. The changing of direction of the Cat also triggers some audio feedback. The game informs the player of their new facing direction. For example, the game says, "Facing Left" if the player has changed their facing direction to the left.

Obstacles and Objects

All room items are structured individually and are added to each room's scene during the construction of each room during development. Each item contains some data in order to make the Cat's interaction with it accurate. These data include its name, which is used to identify the sounds that are played when the Cat collides or bumps into it. Certain items such as the floor tiles are not considered as obstacles, the variable of whether the item has a blocking type collision box or not determines how the Cat interacts with it. The Cat walks across a tiled floor but stops moving forward if there is a bookshelf in front.

The data also includes what level of elevation the item is. This is mainly for display purposes. If the Cat character is standing on a lower elevation than the item, the item appears on top of it, example: if the Cat is under a table. When the Cat is under furniture, the game informs the player that they are under it. This is to emulate a human's ability to know that they are under something in the real world.

It is also important for the Cat to be on the same elevation as an item before it can interact with it, such as when the Food is on the table. If the Cat is not on the same elevation as the Food and is on the floor instead, the Cat is not able to bump into or perform a tile check on the Food item.

Another variable the item holds is if it is an interactive item or not. Interactive items prompt the user to choose an action after they perform a tile check on it while non-interactive items only provide the user with a sentence to inform what the item is.

There are also some items that are also sound sources that emit a stereo sound effect. Examples are the air conditioner, the dripping sink and the radio. This is to help players become more immersed in the game.

Food Object

The Food is a special kind of item that appears only in the food finding level. Examples of Food that can be found within the various levels of the game are a bowl of cat food, fish and a slice of pizza. It is a sound source and all foods play the same upbeat piece of music on loop. Although it was initially decided that different foods will have different music to represent it, to keep the game simple it has been then changed to be the same sound for consistency. The playing of music is to emulate the smell of the food within the game, as the sense of smell is not conveyable through a mobile device. The sound gets louder as the player gets closer to the food as a clue to its location as well.

Tile Check Scenarios

Whenever the Game Controller receives a tap on the top half of the device's screen, it carries out a tile check to check what the item in front of the Cat is. When an item is identified, audio feedback in the form of speech is given to the player.

With non-interactive objects, examples of speech are:

- For shoe rack item:

"There is a shoe rack in front of you."

- For a floor that is tiled with no item on top of it:

"The floor in front is tiled."

It should be noted that although the item, for example, the shoe rack, is located on top of a tiled floor, the tile check only identifies the item or object itself.

With interactive objects, examples of narration will be:

- For chair item, when facing the side or front of the chair:

"There is a chair in front of you, would you like to climb onto the chair?"
"Tap the top of the screen to climb up."
"Tap the bottom of the screen to stay where you are."
[Game waits for player's response answer.]

Scenario 1:

[Player presses top half of screen.]
"You have climbed onto the chair."
[Cat moves up onto the chair. Cat's elevation is changed to be above the chair and now appears on top of the chair.]

Scenario 2:

[Player presses bottom half of screen.]
"You have chosen to stay where you are."
[Cat does not move up the chair and maintains current position.]

- For chair item, when facing the back of the chair where they are not able to climb up:

"There is a chair in front of you. You can't climb up from this side as the back of the chair is in the way."

<u>Information Check Scenarios</u>

Whenever the Game Controller receives a tap on the bottom half of the device's screen, it carries out an information check. This information check is different between the exploration mode and food finding mode of the game as the second mode includes the initial directions to the food and the current distance away from the food.

- For exploration mode:
  - In hallway, standing on a tiled floor:
    "Current location: You are standing on a tiled floor in the hallway, facing right."
    "Be careful of bumping into walls and furniture"

- For food finding mode:
  - In hallway, standing on a tiled floor:
    “Current location: You are standing on a tiled floor in the hallway, facing right.”
    “Directions to food: the cat food is two steps to the right and one step forward from the starting position. It is also directly to the right of the coat hanger.”
    “Distance away: The food is one step to the right of and one step to the front of you.”
    “Be careful of bumping into walls and furniture”

As seen in the example above, the information check can be quite lengthy. Therefore, the player is able to cancel it at any time by tapping the top half of the device’s screen.

<u>When the Game Begins</u>

For both game modes, before the player is officially allowed to begin playing, a sentence is played to help them be aware that the level has begun. Upon finishing the sentence, the controls are enabled and the player may begin playing freely. For the exploration mode, the player is told what room they are playing in. For the food finding mode, which is played right after the exploration mode, the player is not informed what room they are in again and instead the player is encouraged to listen to the directions to the food before the game play begins.

- For exploration mode:
  - In hallway:
    “In the hallway.”
    “You may start playing now.”

- For food finding mode:
  - In hallway:
    “Please listen to the directions to the food before playing. Listen carefully.”
    “Directions to food: the cat food is two steps to the right and one step forward from the starting position. It is also directly to the right of the coat hanger.”
    “You may start playing now.”

When the Game Ends

The gameplay ends several ways. The following shows the several scenarios of how the game may end, excluding the scenario where the player chooses to end the game early and stop their exploration of the room when playing on the exploration mode.

- For exploration and food finding mode:
  - When the player has played for 5 minutes and times out
    "You have explored the room for 5 minutes."

- For food finding mode:
  - When player has found the food by bumping into it:
    "Oh, it's food. Yay!"
    "Hooray, you have completed the level."

  - When player has found the food by making a tile check while facing it:
    "There is a bowl of cat food in front of you."
    "Hooray, you have completed the level."

Penalty Count

There is only one way to incur a penalty in this game, and that is to try and walk off a high location. The game will not be over when they player tries to do so as the game says the following sentence while adding on to the penalty number count.

"You have almost walked off a high place. Be careful."

A penalty is being incurred for this scenario, as it is dangerous to move about without considering what is in front of oneself, especially when on a higher or elevated ground.

Shared User Interface

All room levels share the same basic user interface but differ in the structure and content of the room itself. Every game level has a Back button at the top left to go back to the main menu and also have the blind mode overlap the image of the room by default. The blind mode toggle button is in the same part of the screen for each room.

Several game variables are also displayed at the top right corner of the screen. These game variables are the number of steps taken, the number of bumps made, the number of penalties incurred and the amount of time that has passed. There is also a display at the top right corner for the current facing direction of the player. This information and other information such as what object the player has just bumped into are displayed at the bottom of the screen.

These variables are not hidden as it does not affect the gameplay even if the player has residual vision but can greatly help the facilitator of the test know the progress of the player without needing to turn off the blind mode. The stereo headphones the players will be wearing will prevent gaining of knowledge of what is going on through audio feedback; therefore, the visual feedback is necessary.

Screenshots

Below are figures containing the screenshots of each room for both the exploration mode and the food finding mode, starting from the tutorial room. They show the final layout of the rooms that have been built based on the designs in Section 3.5.2.

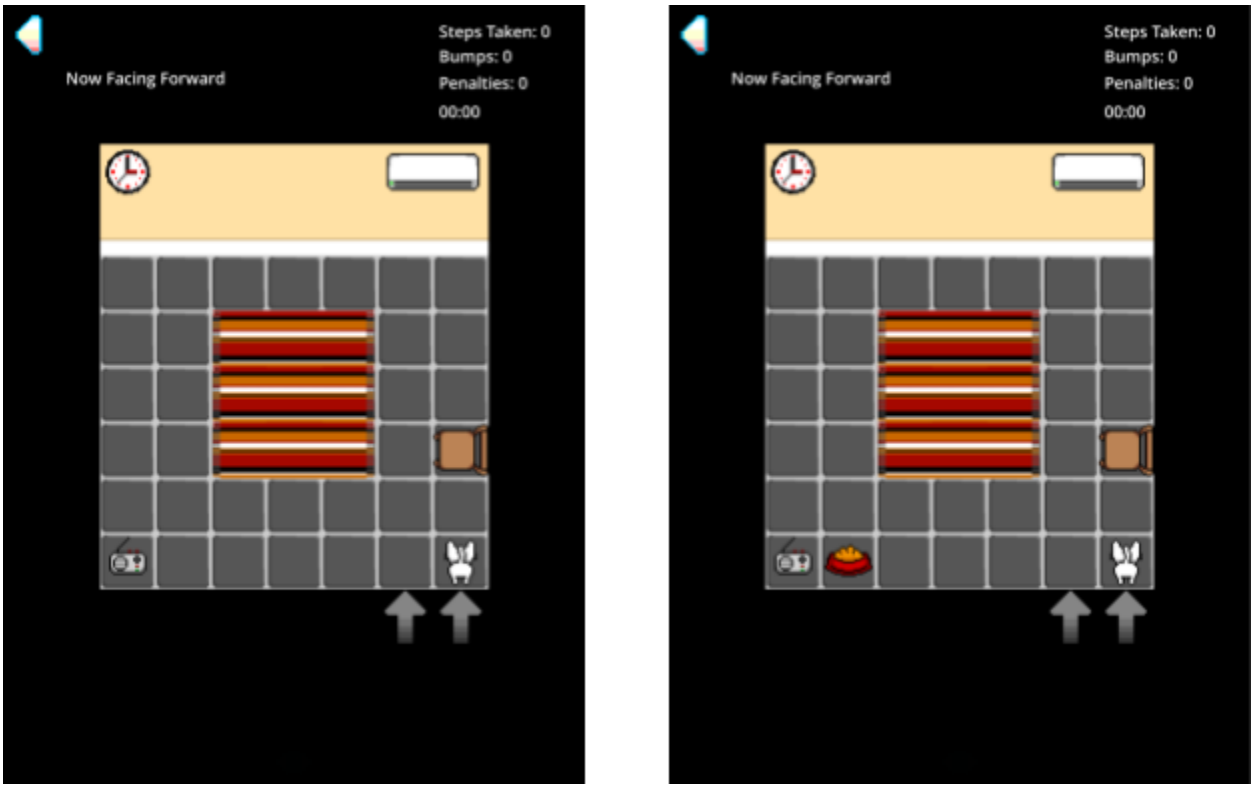

Figure 3.31 Tutorial Room: (a) in Exploration Mode (b) in Food Finding Mode

The *Tutorial Room* has 42 tiles in total (7x6 tiles). The food item in the food finding mode is a bowl of cat food. The directions to food: “The cat food is five steps to the left of the starting position and directly to the right of the radio playing music.”

It is easiest to find the food in the tutorial level as the player need only change their facing direction once. This is to give the player confidence in tackling the actual game play levels.

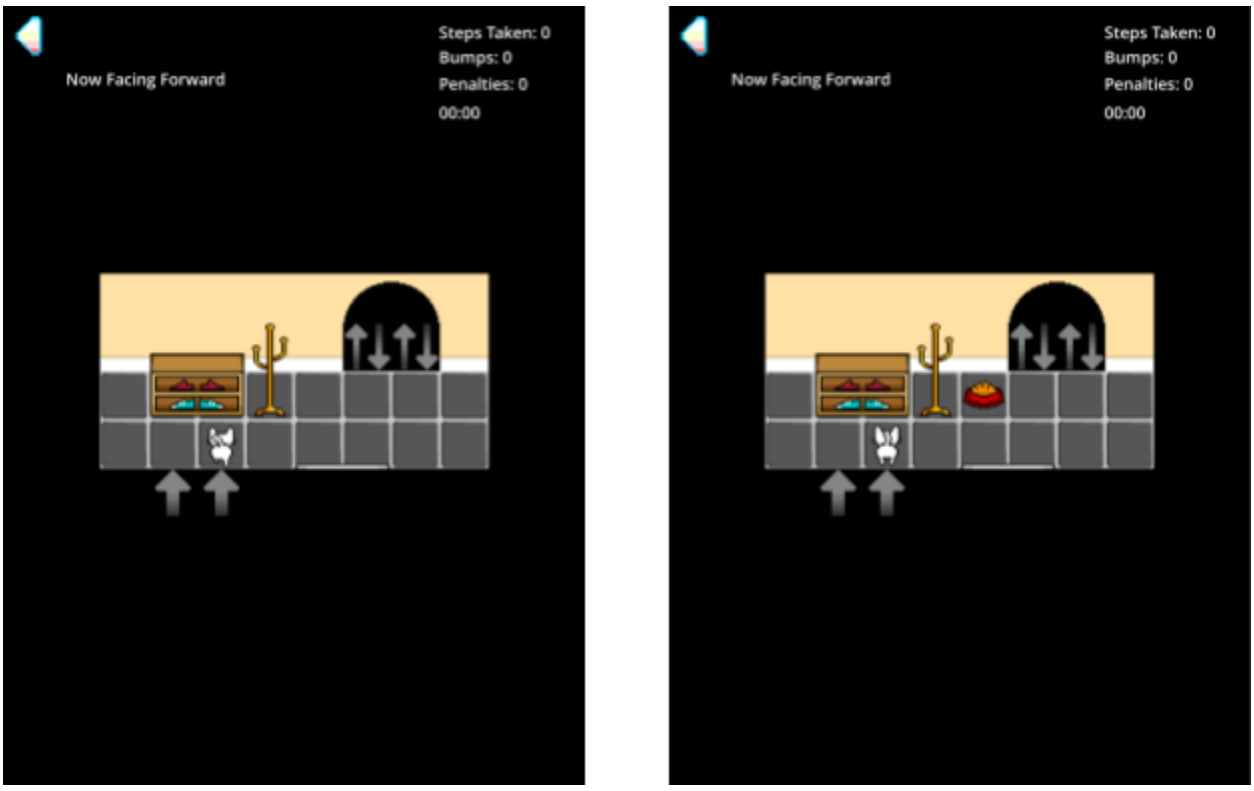

Figure 3.32 Hallway: (a) in Exploration Mode (b) in Food Finding Mode

The *Hallway* has 16 tiles in total i.e. 8x2 tiles. The food item in the food finding mode is a bowl of cat food. The directions to food: “The cat food is two steps to the right and one step forward from the starting position. It is also directly to the right of the coat hanger.”

This is the easiest level as the food is easy to find due to the small total area and the fact that there are no obstacles on the path stated when directions to the food are given.

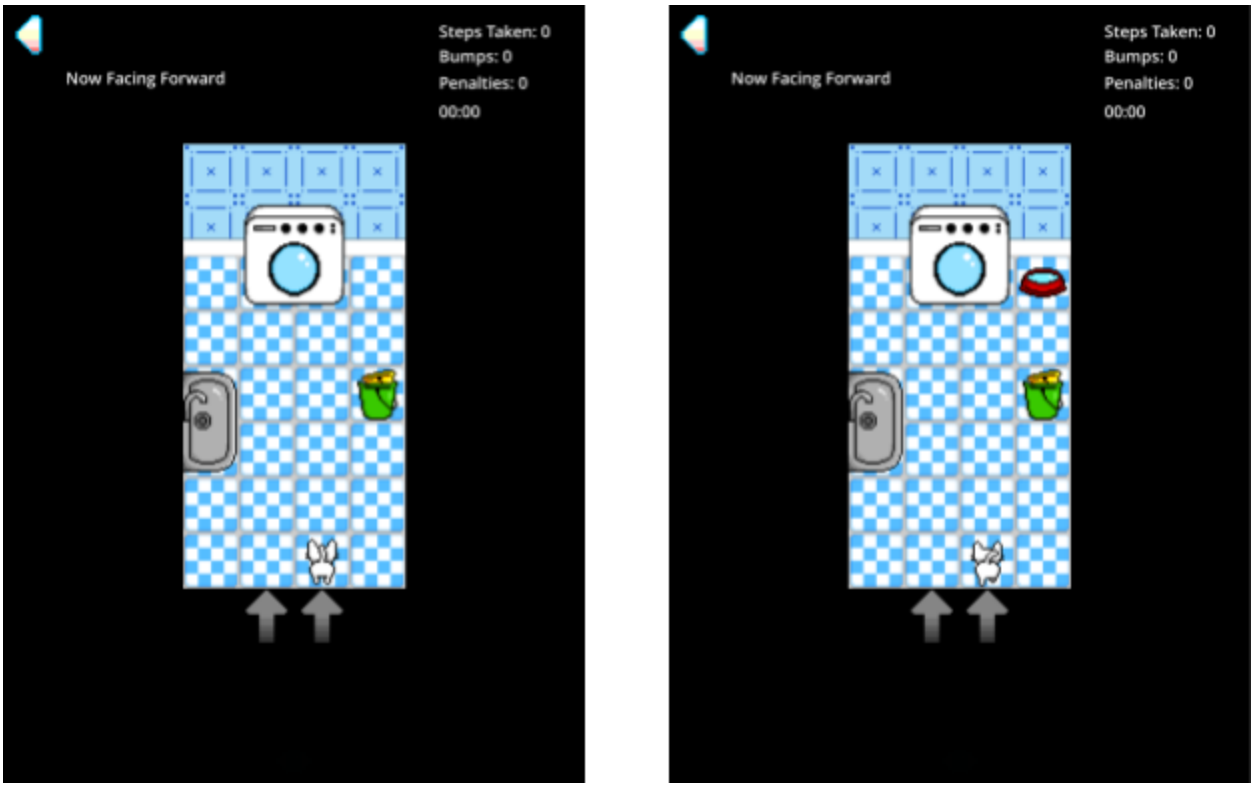

Figure 3.33 Laundry Room: (a) in Exploration Mode (b) in Food Finding Mode

The *Laundry Room* has 24 tiles in total (4x6 tiles). The food item in the food finding mode is a bowl of water. The directions to food: “The bowl of water is one step to the right and five steps forward from the starting position. It is also directly to the right of the laundry machine. Be careful of objects that might be in the way.”

The addition of the extra line to the instructions are due to the fact that the food item is no longer navigable directly through the instructions given as there is an object in the way. The player will have to manoeuver past the pail or the laundry machine to be able to get to the food.

Figure 3.34 Study Room: (a) in Exploration Mode (b) in Food Finding Mode

The *Study Room* has 30 tiles in total (5x6 tiles). The food item in the food finding mode is a sandwich. The directions to food: “The sandwich is three steps to the left and four steps forward from the starting position. It is on the table. You will have to climb up the chair first to climb up to the table.”

This is the first stage where the player is required to have a better knowledge of the room to attain the food. As stated in the instructions, they will have to climb up the chair first to get onto the table where the food is. The successful interaction with the objects to get onto elevated ground to obtain the food demonstrates how clearly the player knows the room.

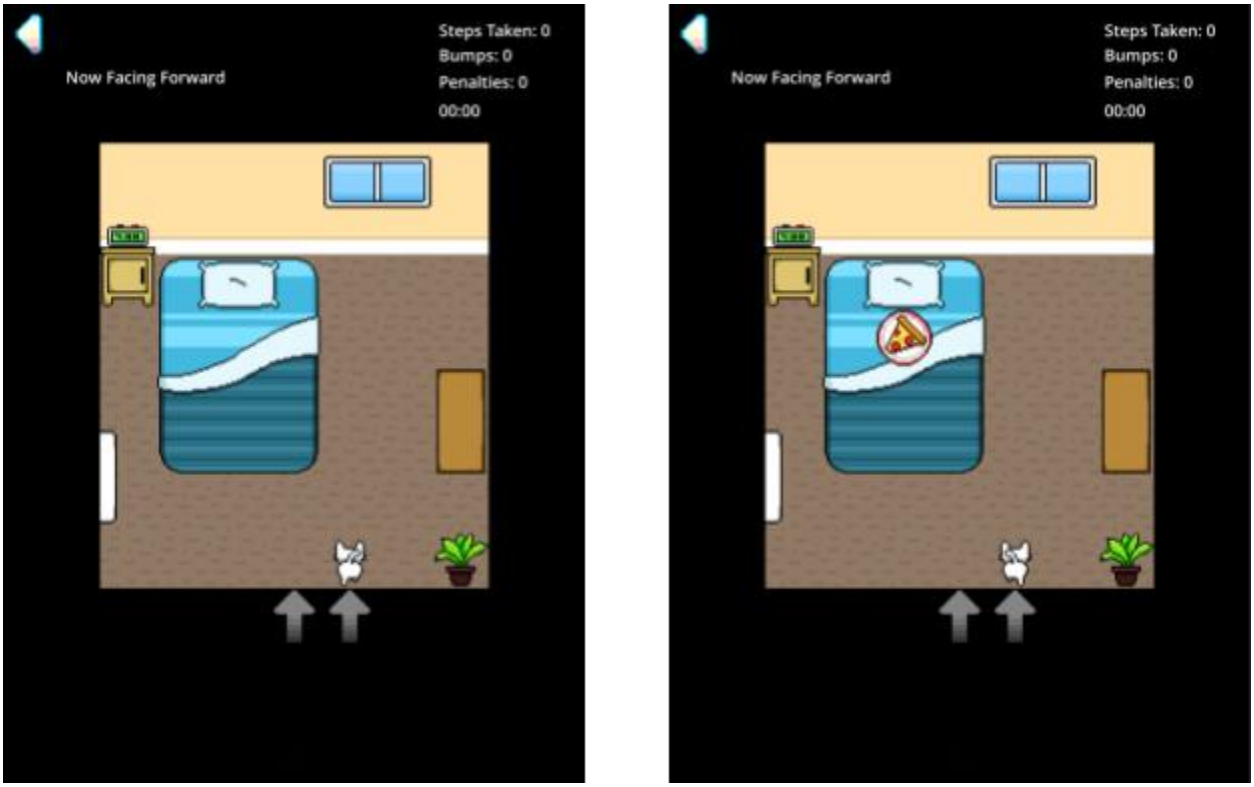

Figure 3.35 Bedroom: (a) in Exploration Mode (b) in Food Finding Mode

The *Bedroom* has 35 tiles in total (7x6 tiles). The food item in the food finding mode is a slice of pizza. The directions to food: “The pizza is two steps to the left and four steps forward from the starting position. It is on the bed. You will have to climb onto the bed to reach it.”

This level is considered easier than the Study Room level. This is because the food is only elevated once. The player need only climb up one piece of furniture to be on the same elevation level as it is. This room serves as a break in case the player gets demotivated from the difficulty of the previous level.

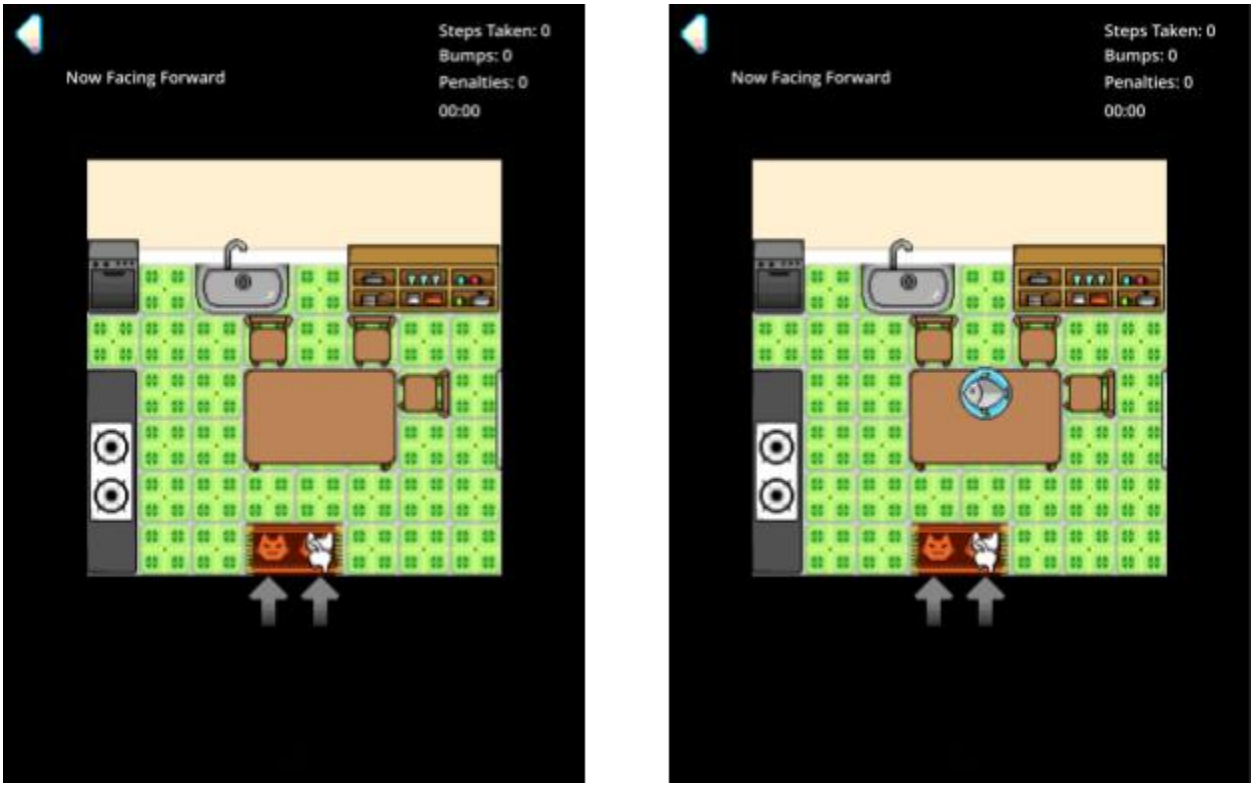

Figure 3.36 Kitchen: (a) in Exploration Mode (b) in Food Finding Mode

The *Kitchen* has 48 tiles in total (8x6 tiles). The food item in the food finding mode is a fish. The directions to food: “The fish is three steps forward from the starting position. It is on the table. You will have to climb up a chair first to climb up onto the table.”

This is the second level that requires the player to climb up two times in order to reach the food. However, the kitchen has three chairs in which the player may locate to climb up to the table. This game level is still a challenge as the size of the kitchen causes the player to require more time to successfully locate a chair to climb up from.

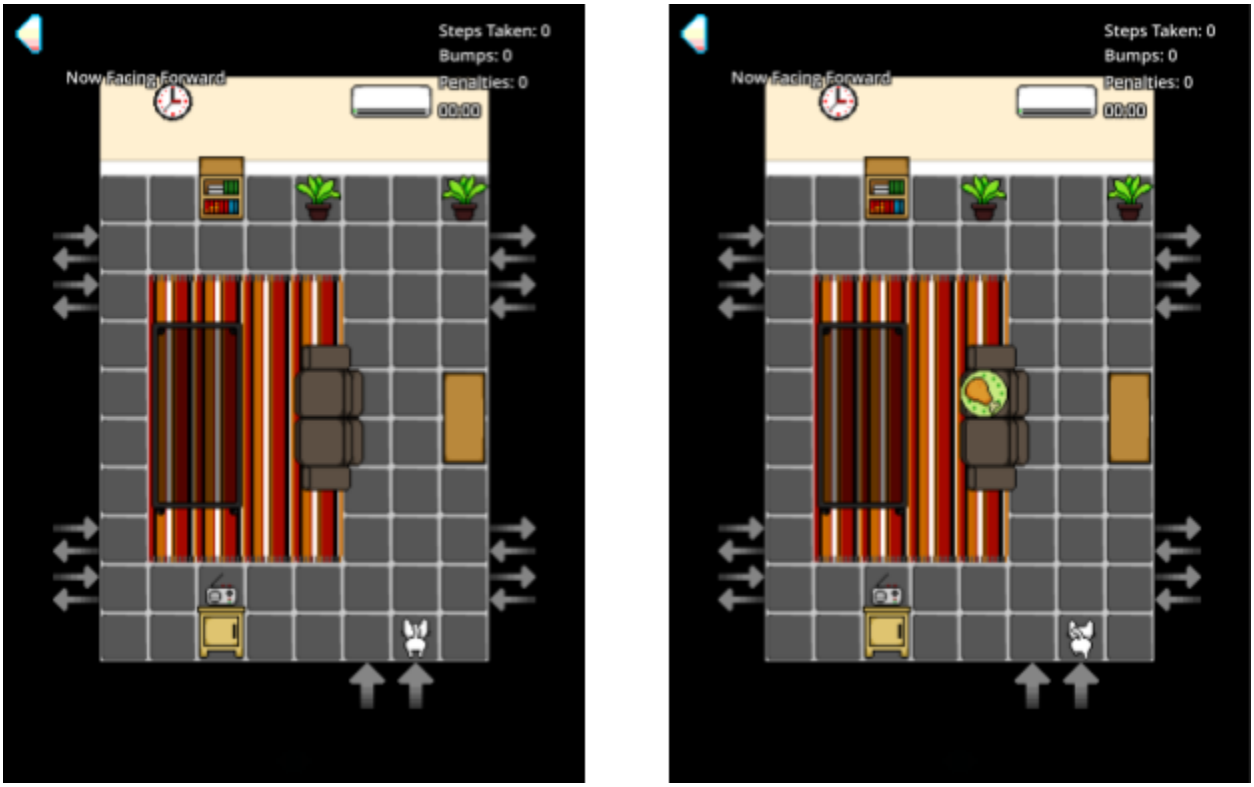

Figure 3.37 Living Room: (a) in Exploration Mode (b) in Food Finding Mode

The *Living Room* has 80 tiles in total (8x10 tiles). The food item in the food finding mode is a chicken drumstick. The directions to food: “The chicken drumstick is two steps to the left and five steps forward from the starting position. It is on the sofa. You will have to climb up onto the sofa to reach it.”

The final room of the game levels, the living room is very large and tests the ability of the players to remember the furniture placement within it. In terms of finding the food, the player may face a challenge of locating the front of the sofa to climb up for the food. They are not allowed to climb up from the side of the sofa or from the back of the sofa. They are also not able to climb up onto the part of the sofa where the food is at and are met with the audio feedback speech “There is a sofa in front of you. You can’t climb up from here as there is something on the sofa.” Although several doorways can be seen to the left and right of the room, the doors are all locked and only serve as landmarks for the player.

3.9.3 Save Game Design Implementation

In order for the gameplay of the player to be recorded clearly and successfully, there are several requirements. Firstly, the player's name has to be set and selected in the player registration screen. The second requirement is for the save game function to be triggered when the game level ends, be it through timeout, exiting the game through the back button or through the discovery of food.

For easier identification, the text file generated after each game ends is named using the combination of [player's name] + "_" + [yyyymmdd] + "_" + [room level] + "_" + [game mode]. Thus, for a player named John who played on 1st January 2018 the hallway room in food finding mode, it will generate the text file name: *John_20180101_hallway_food.* An example of the text generated via the save game for the food finding mode is as shown below:

```
Time Taken: 28 seconds / 00:28
Steps Taken: 7
Turns Made: 4
Times Tile Checked: 1
Times Information Checked: 0
Bumps into Obstacles: 1
Penalties Incurred: 0
```

Figure 3.38 Save Game Example

The save game example in Figure 3.38 above shows that the player has taken 28 seconds to discover the food. They did this within taking 7 steps, and making 4 turns. They have performed 1 tile check, 0 information checks, bumped into obstacles or objects 1 time and incurred 0 penalties during the game play.

3.10 Prototype Testing and Changes Made

As the game prototype was being developed, it was tested for feedback among sighted peers. From the early testing results, several adjustments and enhancements have been suggested and made to the game before being used for testing with the visually impaired children.

- Text to Speech Changes

  Initially, the speech for the game was only in English. However, due to English not being the native language or national language in Malaysia, *Bahasa Melayu* speech was added to the game as well. With this, a language setting popup menu was included in the main menu to set the participants' preferred language before they begin playing. The addition of *Bahasa Melayu* speech is useful as it provides participants with options to choose a language they best understand.

  Another feedback obtained regarding the language of the game is that the English speech generated at that point in time was too fast and sometimes required quite a lot of attention and repetition to understand it. The speech was slowed down a little to be more easily understandable.

- Food Location Information Change

  In the food finding mode, the player can obtain information of how close they are to the food from their current location by bringing up the information check. They can do this by tapping the bottom half of the screen. Originally, the sentence structure used for this information was done by comparing the player's location to that of the food. For example: "You are 5 steps to the left of the Food". This proved to be disorienting to the early testers as in their minds, it sounded like the Food object was 5 steps to their left. The sentence structure was then changed to compare the food location is to that of the player, with the new sentence structure being "The Food is 5 steps to the right of you." It is more easily understood where the food currently is using that sentence structure.

- Information of Interactive Object Change

  Climbable or interactive objects were tricky to implement in the game. This is because logically, the Cat should not be able to climb up a chair or sofa from the back of the chair. They have to be facing the front or side of the chair to climb up it. The Sofa Object is a little different from the chair object as it should disallow climbing up from the sides as well.

Initially, it was not considered that it would not be obvious to the player that they will not be able to climb up from certain directions of the furniture object. However, after some more testing and feedback from early testers, it was decided that the fact that the player will not be able to climb up from certain directions should be made clear. Due to this, when performing a tile check on the tile from behind a chair for example, the speech feedback given would have to inform you that you are facing the back of the chair and additionally inform you that you are not allowed to climb up from that direction.

- Blind Mode Change

  In the original version of the blind mode, the screen was completely black and the blind mode button was visible. This required to be changed as testers that were able to see the blind mode button were tempted to press it. Being able to see the map of the room will be a completely unfair advantage, even for those with low vision. Therefore, the blind mode has been changed so that the blind mode button was not visible.

  It was also later improved upon by having the screen show the top half of the screen in red and the bottom half of the screen in blue. This quickened the understanding process of the sighted or low vision players on where is acceptable to tap when they want to tap either the top half or the bottom half of the screen. Fully blind players are not affected by this change.

3.11 Summary

Development of *Hungry Cat* mobile game prototype was carried out using several tools. It was implemented using *Unity 5* and the resources for the game were created or generated using *Adobe Photoshop*, *TTSReader*, *nusuara* and *Audacity*. The game is developed for Android devices and require the device to be equipped with the mobile sensors: accelerometer and magnetometer for the controls of the game.

This mobile game, which is intended for visually impaired children, allows them to obtain spatial information of fictional rooms through the exploration of the virtual environment generated. The players can take the role of a Cat in the game. The game includes a tutorial room and six different game levels, which can be played in two different game modes: the exploration mode and the food finding mode.

After the ending of each game play level by each participant of the study, a save game text file is generated to provide a means of extra analysis of the results obtained from the testing. The gameplay variables provided through the text file include the time taken by the player, the number of steps taken, the number of turns made, the number of bumps against obstacles or objects, the number of tile checks they have performed, the number of information checks they have called and the number of penalties incurred during gameplay.

In addition to the game play, there are several other user interface screens in this game such as the main menu, the level select screen, the instructions screen and the player registration screen. There is also a settings popup accessible through the main menu for changing the player's preferred language, which affects the speech feedback given by the game during gameplay.

The prototype developed was tested before being used with the visually impaired children. Through the tests, several changes have been suggested, most importantly the addition of the *Bahasa Melayu* language to the game and the way some of the speech feedback given in the game described certain events.

Chapter 4 Testing and Evaluation

This chapter presents the testing and evaluation of *Hungry Cat*, and elaborates the test environment, test participants, the food finding test and wire net test, procedures of how the tests are conducted and the test sessions. This chapter also shows the results of both the food finding test and the wire net test followed by additional notes regarding the tests. The chapter is concluded with a discussion on how well the prototype has achieved its aim and a chapter summary.

4.1 Purpose

The purpose for conducting the tests is to determine if the game prototype proposed and developed in this research is able to help the children with visual impairment learn spatial information of rooms. The game is expected to be able to do so by allowing the participants to experience exploring a room digitally and gather spatial information regarding the content of the room. This is because the game requires the use of one's use of spatial navigation skills to explore the virtual rooms, such as facing direction awareness, knowing where one's location is within an area, how to get from one place to another based on spatial knowledge and familiarity of the place. There were two tests conducted for this research to verify the effectiveness of *Hungry Cat*: The food finding test and the wire net test. The tests are elaborated further in Section 4.4.

4.2 Test Environment

The tests for this study were carried out at a local government boarding school for the blind. The tests were conducted after school hours in an unused classroom in order to prevent affecting the participants' studies. The tests were conducted with two participants at a time. Due to the use of stereo headphones during game play, the participants were not affected by each other. The facilitator of the tests was in the room with the participants in order to provide aid whenever required during the game play. They were also there to watch out for when the participants were finished exploring the room and were ready to be tested on their spatial knowledge by playing the food finding level and performing the wire net test.

Before the tests were conducted, an invitation letter was sent to the school management to obtain their permission to carry out testing the game with the students of the school. The tests were conducted with the permission of the school among 30 students age from 7 to 17 years old.

4.3 Test Participants

The target of this study is to develop a serious game prototype for the visually impaired, especially the younger generation. The study was therefore conducted with the cooperation of a government boarding school for the blind.

4.3.1 Participant Requirement

There were several requirements the participant must meet before he/she could take part in the testing of *Hungry Cat*:

1. Is between ages 7 to 17
2. Is blind or has low vision
3. Is able to understand English or *Bahasa Melayu* and follow basic instructions
4. Is able to communicate in either English or *Bahasa Melayu* to convey the placement of items in the wire net test
5. Is able to cooperate and complete the designated games in the testing

4.3.2 Participant Overview

30 students with visual impairments ranging from age of 7 to 17 years old participated in this study. 9 of them are primary school students while the other 21 of them are secondary school students. The reason for the uneven numbers above was due to the lack of qualifying participants, as there were students with multiple disorders (including learning difficulties) that hindered them from being able to participate properly in the research. 7 out of 30 of the participants had minor learning difficulties, they were able to communicate their thoughts briefly. There were 17 participants with low vision and 13 participants with no vision.

For anonymity, participants were labelled and referred as “Participant #” in this study. There were 3 extra participants who were not able to complete all the games, thus their results were not included in the research. Table 4.1 shows a summary of the 30 participants.

Table 4.1 Participant Overview

Age Group	No.	Student	No Vision/Low Vision	Learning Difficulty
Primary School	1	Participant 1	Low Vision	✓
	2	Participant 2	Low Vision	
	3	Participant 3	Low Vision	
	4	Participant 4	No Vision	
	5	Participant 5	No Vision	
	6	Participant 6	Low Vision	
	7	Participant 7	No Vision	✓
	8	Participant 8	Low Vision	
	9	Participant 9	Low Vision	✓
Secondary School	10	Participant 10	Low Vision	
	11	Participant 11	Low Vision	
	12	Participant 12	Low Vision	
	13	Participant 13	Low Vision	
	14	Participant 14	No Vision	
	15	Participant 15	Low Vision	
	16	Participant 16	Low Vision	
	17	Participant 17	Low Vision	
	18	Participant 18	No Vision	
	19	Participant 19	No Vision	
	20	Participant 20	No Vision	✓
	21	Participant 21	Low Vision	
	22	Participant 22	No Vision	
	23	Participant 23	No Vision	✓
	24	Participant 24	No Vision	
	25	Participant 25	No Vision	✓
	26	Participant 26	No Vision	
	27	Participant 27	Low Vision	
	28	Participant 28	Low Vision	
	29	Participant 29	No Vision	✓
	30	Participant 30	Low Vision	

4.4 Tests

There were two tests conducted in this study to evaluate the effectiveness of exploring the virtual rooms in order to gain spatial information:

- The first test being the food finding test, which is a game mode in *Hungry Cat* to be played after the participant has explored the room.
- The second test is the wire net test, which is a test to show how much of the room the participant remembers.

4.4.1 Food Finding Test

The food finding test was carried out immediately after the participant has played the exploration mode of the room selected within the game. In the food finding test, the participants were given directions to the food located in the room they have just explored. If the participants were familiar with the layout of the room, it would help greatly in locating the food.

While playing the food finding mode, the participants had 5 minutes to locate the food and were able to get more clues as to where the food is by getting information from the information check. The information check allowed the participants to see how many tiles or steps away the food is from them. The food was also a sound source and played a song, which got louder when you got closer to it to emulate the presence of smell in reality. If the participant was unable to locate the food within the 5 minutes given, they were not given another chance to play it again.

The time taken for the player to locate the food was saved, along with other save game variables such as steps taken, turns made, number of bumps into objects, number of tile checks performed, number of information checks performed and number of penalties incurred. These variables were used for analysis of the test data obtained.

After the food finding test was completed, the participants were asked to do the wire net test.

4.4.2 Wire Net Test

To evaluate the effectiveness of the game prototype, a non-visual test was developed which allowed the blind participants to point out the location of the items in the room. The test was done using a metal wire net, which has square holes in it to represent the individual tiles of the room. A mounting board frame that was cut out in the dimensions of the room was placed on top of the wire net. Figure 4.1 shows the wire net used, along with a piece of mounting board that has yet to be cut into a frame of the room.

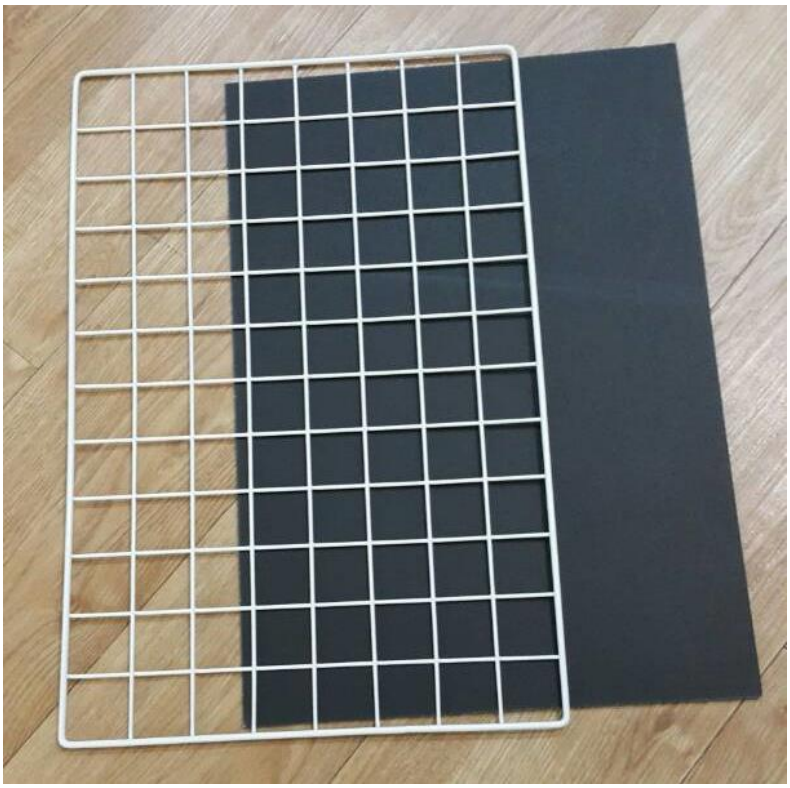

Figure 4.1 Wire Net and Mounting Board

Before the wire net test begins, the initial location and direction of the participant's avatar was indicated using a bottle cap. It was explained to the participant that the mounting board frame represents the walls of the room and that the bottle cap stands for the initial or starting location of the Cat avatar. The participant was then given some time to feel the wire net and mounting board frame for themselves. Some of the participants were guided to feel the boundaries of the room, as they required extra explanation due to having learning difficulties. The wire net and mounting frame for each room are shown in Figure 4.2 below.

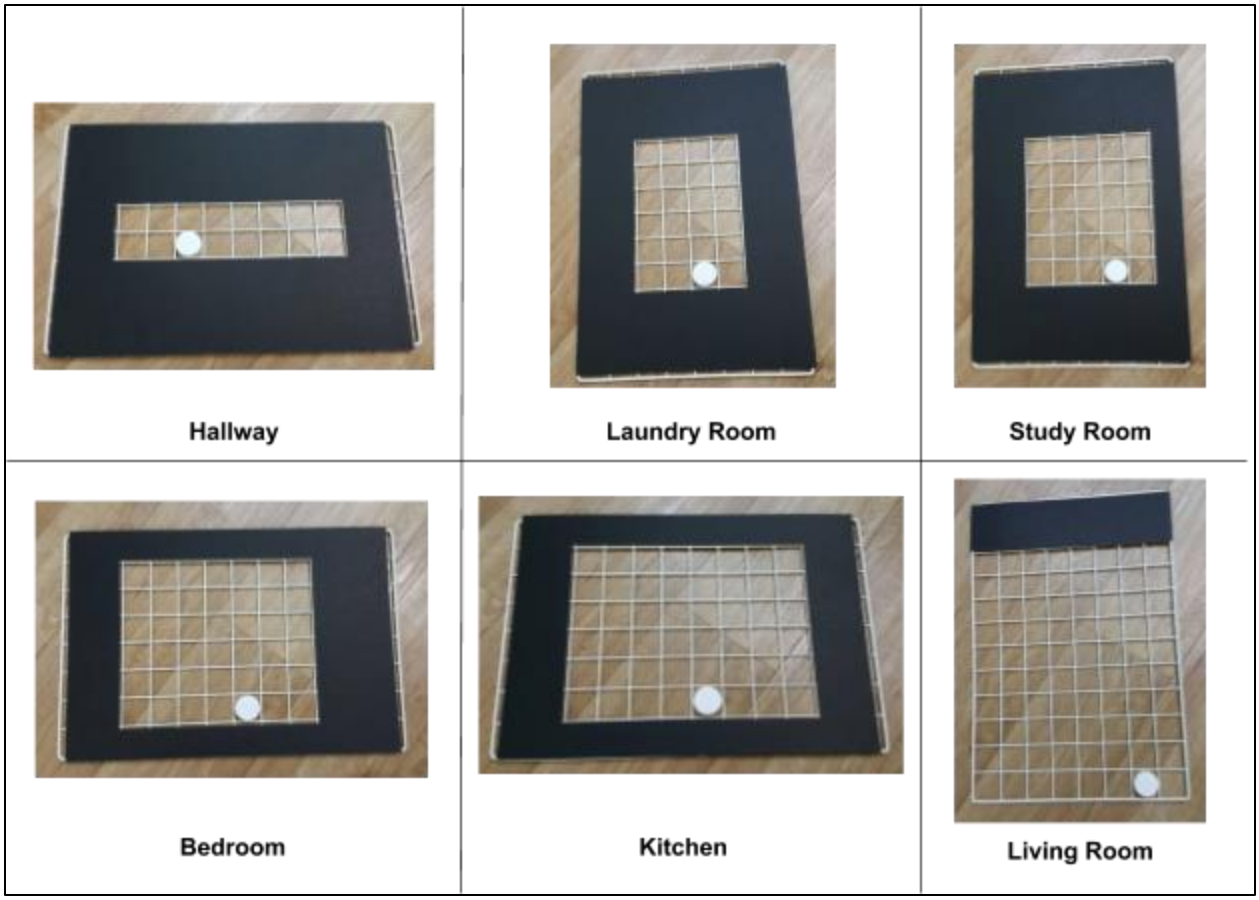

Figure 4.2 Wire Net Frames Representing the Six Rooms

During the wire net test, the participant were asked to point out the size and location of the furniture they have located while exploring in the room. There was no time limit to this test, the participants were asked regarding the furniture placement. The test was completed when the participant had either pointed out all the furniture in the room or could not recall any more furniture placements. The locations of the items were then noted down on a form with an empty layout of the room by the facilitator. Whether the participant had discovered an item or not was also noted down. The form used is shown in Figure 4.3.

It should be noted that wall furniture that cannot be bumped into such as the wall clock or window were not considered in the scoring of the wire net test. Extra items located that were not in the room were noted down and the participant's score was penalized.

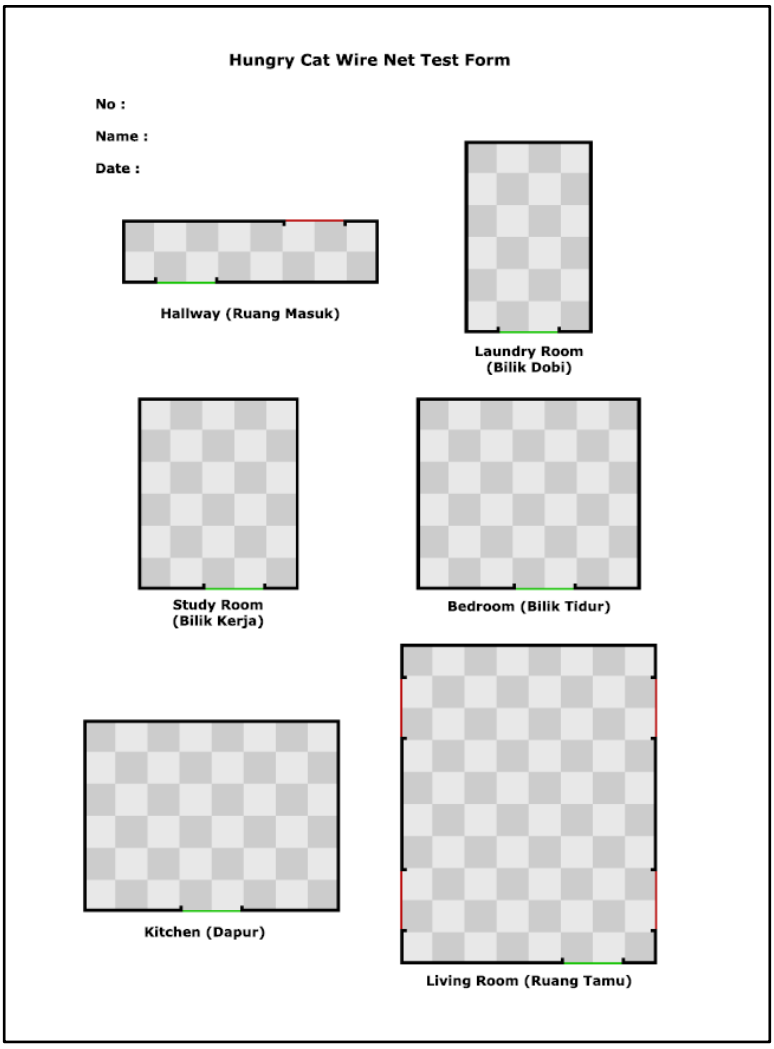

Figure 4.3 *Hungry Cat* Wire Net Test Form

The participant number, participant's name and date were recorded at the top right corner of the form for easier identification during the analysis process. The walls of the room is shown by the thick black border surrounding the chequered area. The chequered floor is to indicate the tiles of the room. For each room, the doorway with the green line shows the starting position or main entrance to the room. In some rooms, there were also doorways with red lines, which show an exit that were locked but serves as another landmark for the participant during exploration.

Calculating Wire Net Test Results:

The accuracy of the item placement in the wire net test was calculated later on based on the three criteria: if item is discovered, item placement, and item size.

To calculate how accurate the room is, each item in the room was measured according to the following:

1) Placement: If it included one tile correctly placed they scored 100% for placement. The score was cut 20% for every tile they were off. Anything with a 5 tile and above difference yielded 0% for placement. (For simplicity sake, anything above 5 is depicted as 5 in the tables and graphs). The difference in placement was based on the centre of the object, a half tile off was considered as 0 tiles difference as it is reflected in the next criteria.

2) Furniture Size: If the item size was correct, it scored 100%. Score difference was based on size difference of item, deducted by 20% per tile. For items with 4 tile size, but they guessed +/-2 tiles, would make them 40% wrong. Guessing 5 tiles size difference or more resulted in 0% score.

3) Item is Discovered: If item was not discovered, Placement and Furniture Size need not be considered and item was awarded 0%. There were cases where participants "discovered" an item that was not in the room, for example, there were only 3 chairs in the room but they found 4. A score penalty was incurred which was a deduction one item worth of score for every extra item. (i.e. a -25% deduction for a 4 item room if they found 5 items instead of 4).

The wire net test was designed so that the participants would not need to navigate around a real environment to prove that they understood the layout of the virtual environment. The test can be conducted in a safe manner without the need to move around.

4.5 Procedures

This section covers the procedures taken when carrying out the tests for the study. The section includes the items required for the testing, the procedures carried out before the tests, the setup required for the test, the testing procedures themselves and also the post test procedures.

4.5.1 Items Required

There were several items needed for the testing:

For Playing *Hungry Cat*:

- Tablets - Where the game was installed and the save files were stored. Tablets used for the testing were required to have accelerometer and magnetometer to detect tilting of device and change in player's direction. Two tablets were obtained for use during the testing.
- Powerbank and Tablet Charger - For weekend sessions, charging was done during lunch break.
- Stereo Bluetooth Headphones - Provided clearer sounds with no wires to hinder movement, also allowed better concentration as sounds outside the game were muffled.
- Swivel Chairs or Stool - Allowed for easier turning movement when playing the game. Swivel chairs were used during the test sessions for the game.

For Wire Net Test:

- Wire Net - Contains square holes and was used to represent the tiles in the room. This is the base of the wire net test.
- Mounting Board Frames - Indicated the size of the room. This was placed on top of the wire net.
- Bottle Cap - Indicated the starting position of the cat.
- Wire Net Test Answer Sheet - Used as reference to the actual placement and size of the items in the room. A copy of this is attached in Appendix 6.
- Wire Net Test Forms - Each participant had one to record their answers for the wire net test. A copy of this is attached in Appendix 7.
- Pencil and Eraser – Used to mark down the answers of the participants on the wire net test forms.

Extra Item:

- Appreciation Gift - A small gift was given to the participants for taking part in the testing.

4.5.2 Pre Test and Setup

Before the commencement of the tests, a visit to the school was performed to obtain information on the testing schedule. The testing location, listening to instructions, preparation before testing and device setup as well as playing the tutorial room are discussed.

Visit to the School

The schedules of participants, weekend availability, school holiday period and exam periods were obtained from the teachers at the school. Testing schedule was arranged to avoid exam periods and holidays. Participants were usually available after class during weekdays and during weekends as most of them were boarding at the school. Section 4.6 will elaborate further on the game testing schedule. The researcher also had a tour around the school and interacted with some of the students and teachers before testing began.

The Testing Location

The researcher was given a vacant classroom after class hours to conduct the testing. For better control over the testing, a maximum of two participants were able to play at once.

Listening to Instructions

Initially, the plan was to get participants to listen to the instructions before beginning the tutorial room. This was so that they may ask questions anytime if they were confused before starting to play. However, upon realizing that it was time consuming and considered boring for the participants, the listening to instructions was replaced by guiding the participants closely while playing the tutorial.

Preparation before Testing and Device Setup

Before beginning the testing, participant names were obtained and registered into a device for the naming of save files. Participant names and participant numbers were also noted down on the wire net test forms. Participant names were also noted down separately to more easily confirm which students have already participated and which have not.

Participants touched (or viewed if they have low vision instead of blindness) the wire net and mounting board frame of the room. The front, back, left and right side of room based on the wire net is pointed out to them and explained. The starting position of the Cat was also indicated with a bottle cap.

Participants were then seated and the headphones were connected to the tablets via Bluetooth. Bluetooth headphones were chosen to avoid wires that may hinder the movement of players. The stereo headphones' volumes were adjusted until the audio output was comfortable for players. Chair heights were also adjusted at this time as they may be uncomfortable for taller or shorter participants.

Participants were asked about their preferred language before beginning. Settings were changed to their preferred language.

Playing the Tutorial Room

After the setup was completed, participants were guided through the tutorial room beginning with the exploration mode.

When the tutorial room exploration mode was completed, they were given time to explore the controls themselves. They were then guided through the tutorial room for food finding mode.

Upon completing the tutorial, the participants were asked if they were sure about the controls or needed more explanations before beginning the actual testing. They were encouraged to ask questions during the actual testing.

4.5.3 Test

As mentioned previously, there were two tests for the game prototype: the food finding test and the wire net test. However, before the participants began the actual testing, they had to first explore the rooms in the game.

Exploration Mode and Food Finding Test

It was made clear to the participants that they could stop exploration any time they felt bored or were ready to take on the food finding level of the same room. The food finding level could be initiated right away should they choose to stop the exploration mode earlier. It was then explained to the participants that both modes have a limit of 5 minutes and not to worry if they could not clear it on time.

Before the participants started playing the games in different rooms, they were shown the wire net and frame of the room to give them an idea of the size of the room. The mounting board frame

was set onto the wire net according to room the participant has just played. The start position of the Cat was indicated clearly with a bottle cap.

The participants then started playing the game on exploration mode after inspecting the wire net test frame. After the exploration mode was completed, the participants got to play the food finding mode of the same room.

Wire Net Test

After the food finding test, the participant's wire net test form was taken out and set beside the wire net test. The wire net test was started immediately after food finding level was completed. During the wire net test, the participant was asked to indicate the rooms they could recall. Furniture on the walls such as the clock and air conditioner were not counted towards wire net test score. The placement and size of furniture pointed out are drawn onto the wire net test form of the participant. A photograph of a filled up wire net test form is attached as an example in Appendix 8. Depending on the participants, if they chose to, breaks were taken after completing the tests for 2 rooms.

4.6 Test Sessions

The smoothness of the testing schedule was subject to the availability of the participants. Sometimes they have not been available to participate due to returning home after class or attending extra co-curricular activities. This was because each participant was required to test for 2 sessions so there was a need to get the same participant for another session. There was also only a small number of participants studying at the school which means that the test sessions being able to be carried out depended on their availability.

The test sessions could be carried out for 2 participants a day on a weekday and 4 (up to 8) participants a day on a weekend. Assistance has been obtained for the weekends for smoother testing as it is easier to monitor the participants with two people around. Due to participants' attention spans and that it takes about 12-15 minutes to run the exploration mode, the food finding mode and the wire net test for each room, the tutorial and 6 rooms were split up into 2 sessions.

The first session included running through the tutorial room and the first 3 rooms. Second session would not require additional briefing unless requested and included running the last 3 rooms. This

resulted in about 45 minutes to 1 hour per session and took longer when breaks are taken in between rooms.

The tests were scheduled to be completed within 4 weeks so as not to clash with the participants' final exams that occurred at the end of October.

Overall there were 63 test sessions carried out from 6th September 2017 to 2nd October 2017. 21 of the sessions were with primary school participants while 42 of the sessions were carried out with secondary school participants. There were 21 secondary school participants that took part in this study so there were 2 test sessions for each of them. However there were only 9 primary school participants taking part in the study, which meant that there will be 18 sessions overall. However, there were 3 primary school participants who performed one session with the researcher but were deemed unable to continue for another full session due to lack of cooperation. The three sessions and the 18 sessions of the confirmed participants resulted in 21 sessions being carried out with the primary school participants.

4.7 Results of Food Finding Test

The food finding tests results were compared among several categories: primary school participants and secondary school participants, participants with no vision and participants with low vision, and, participants with learning difficulties and participants without learning difficulties. The section discusses the result trends of participants' gameplay during exploration mode i.e. those who found the food and those who could not pass the food finding test. Finally, a general result summary of the food finding test is given at the end of this section.

4.7.1 Results: Primary School Participants vs. Secondary School Participants

Out of the 30 participants, 9 of them were primary school participants while 21 were secondary school participants. Figure 4.4 below depicts the food finding success of the two groups. As shown in the figure, the food finding success rate of secondary school participants was generally higher than those of primary school participants with the exception of the study room, which generally had poorer results for both groups due to the difficulty of locating the chair. Secondary school participants generally took less time to locate the food compared to the primary school participants (Figure 4.5). The maximum amount of time that could be taken for the food finding test was 5 minutes, or 300 seconds. Therefore, a high average number of seconds taken indicated that majority of the participants in the group did not manage to locate the food.

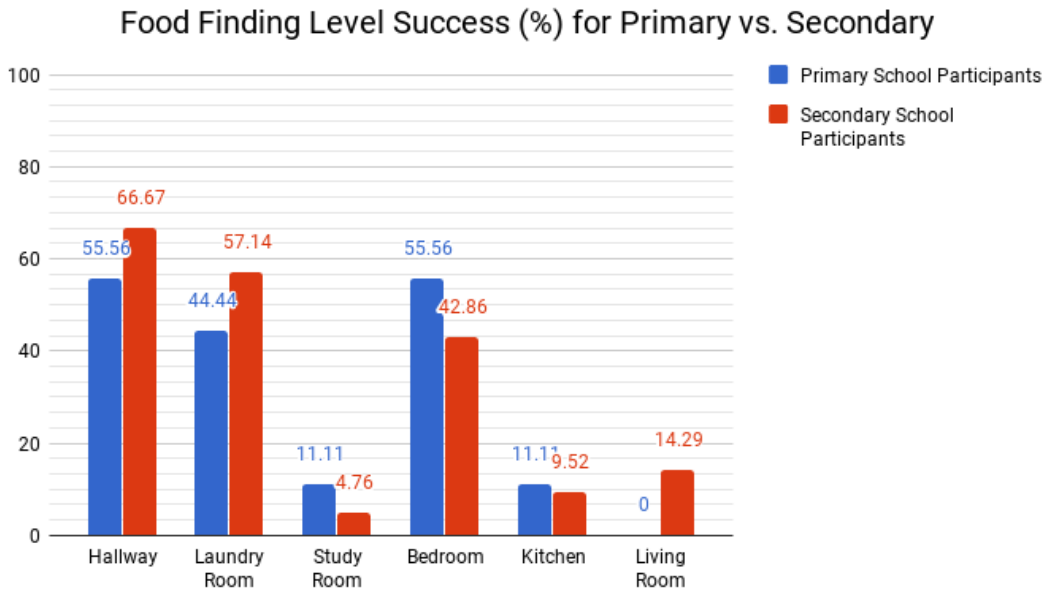

Figure 4.4 Food Finding Success (%) for Primary vs. Secondary

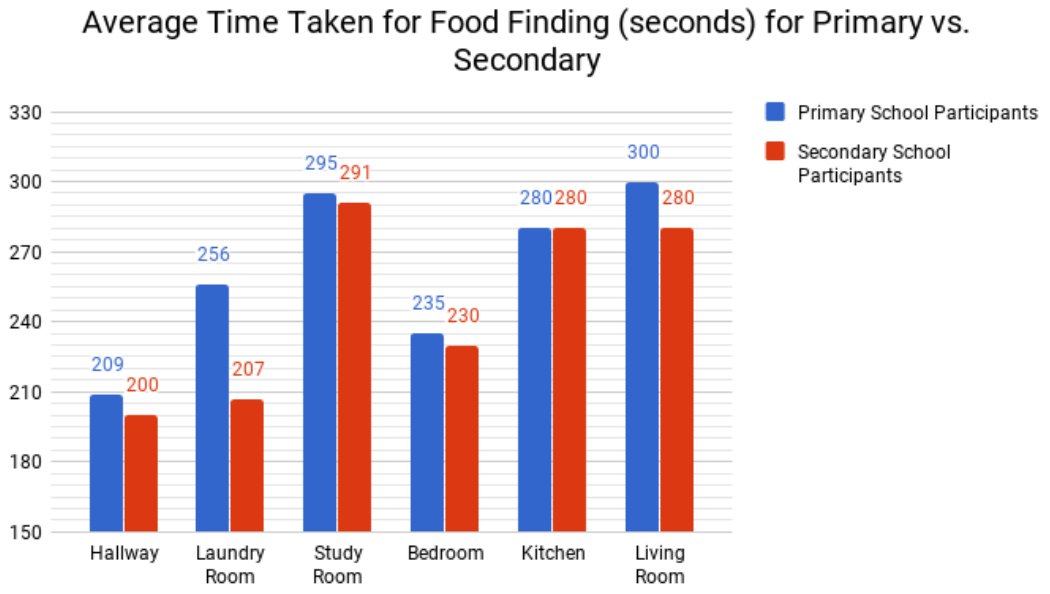

Figure 4.5 Average Time Taken for Food Finding (seconds) for Primary vs. Secondary

4.7.2 Results: Participants with No Vision vs. Participants with Low Vision

Out of the 30 participants, 13 of them had no vision while 17 of them were with low vision. Figure 4.6 below depicts the food finding success of the two groups. As shown in the figure, the food finding success rate of participants with low vision was generally higher than those of no vision participants. Participants with low vision generally took less time to locate the food compared to the participants with no vision (Figure 4.7).

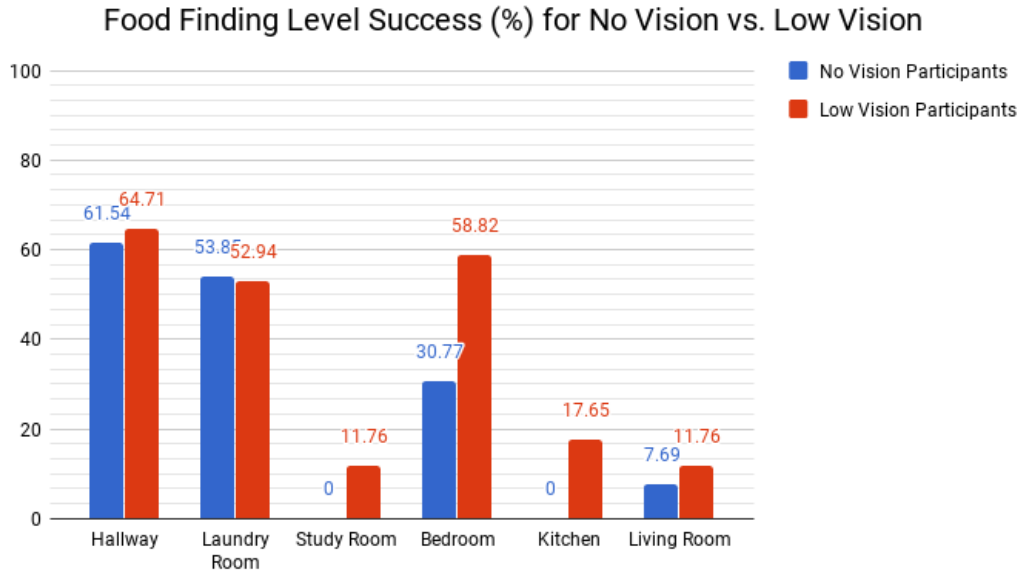

Figure 4.6 Food Finding Level Success (%) for No Vision vs. Low Vision

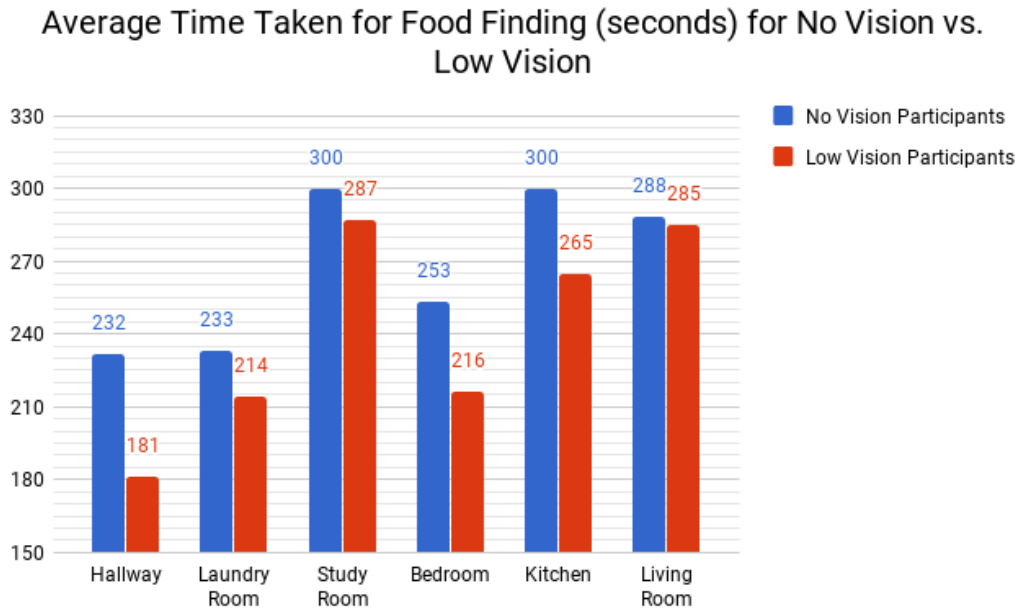

Figure 4.7 Average Time Taken for Food Finding (seconds) for No Vision vs. Low Vision

4.7.3 Results: Participants with Learning Difficulties vs. Participants without Learning Difficulties

Out of the 30 participants, only 7 of them have learning difficulties (LD) while 23 of them were without learning difficulties. Figure 4.8 below depicts the food finding success of the two groups. As shown in the figure, the food finding success rate of participants with no learning difficulties were generally higher than those with learning difficulties. Participants without learning difficulties generally took less time to locate the food compared to the participants with learning difficulties (Figure 4.9).

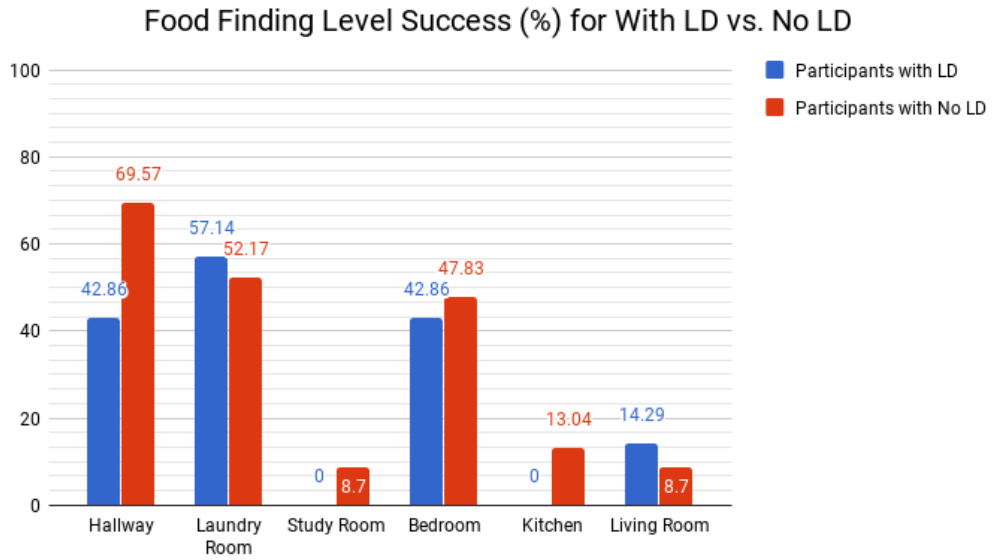

Figure 4.8 Food Finding Level Success (%) for With LD vs. No LD

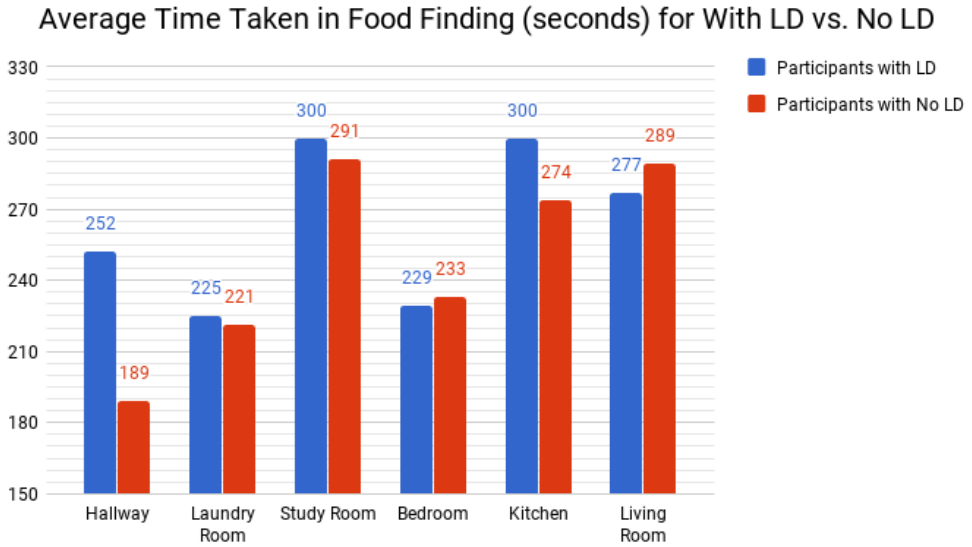

Figure 4.9 Average Time Taken in Food Finding (seconds) for With LD vs. No LD

4.7.4 Exploration Mode Trend of Participants Who Passed Food Finding Test

This section compares the exploration mode trends of participants who managed to pass the food finding test and those that did not. Passing the food finding test means that they have managed to locate the food within the allocated time of 5 minutes. The steps taken, tile checks made and information checks made during exploration modes of these groups of participants will be compared in Figure 4.10 to Figure 4.12 below.

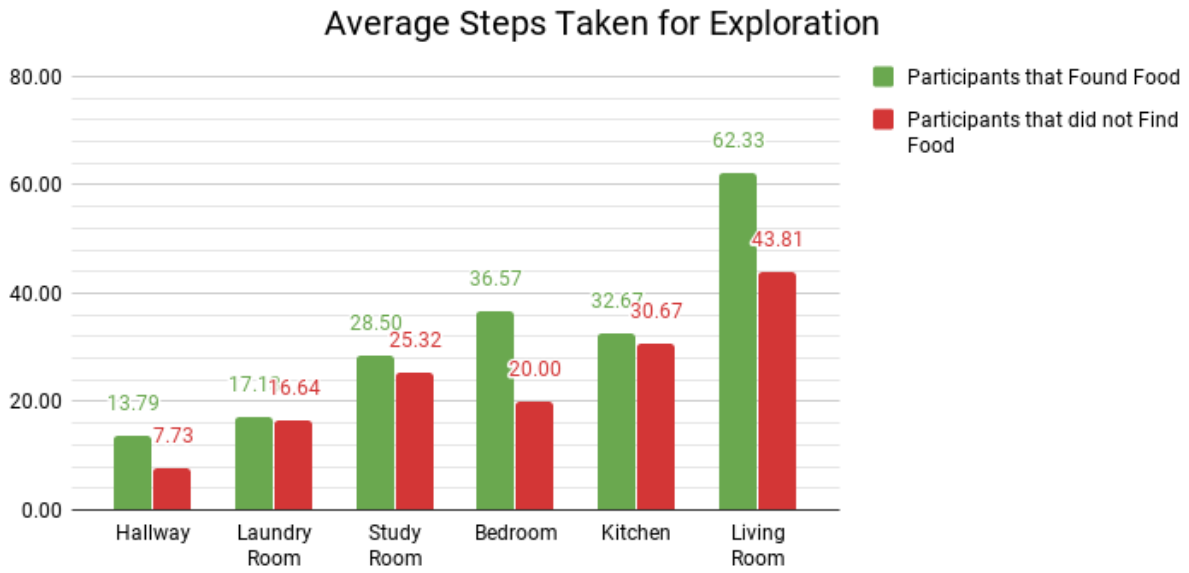

Figure 4.10 Average Steps Taken in Exploration Mode

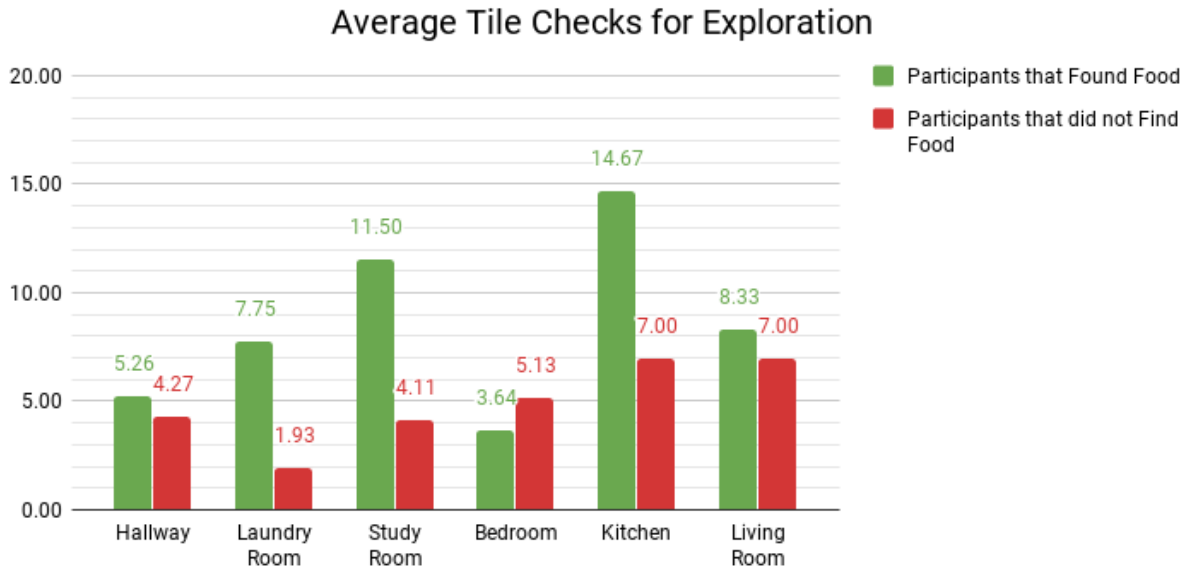

Figure 4.11 Average Number of Tile Checks in Exploration Mode

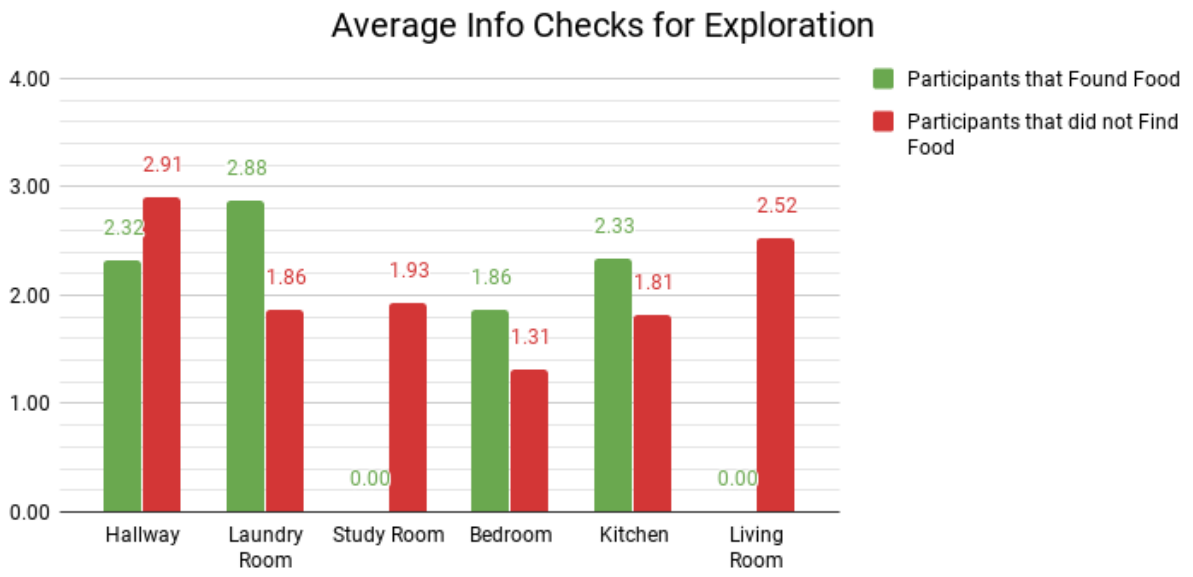

Figure 4.12 Average Number of Information Checks in Exploration Mode

From Figure 4.10 and Figure 4.11 above, it can be seen that participants that have found the food in the food finding mode had actually interacted with the game more during exploration mode. This can be seen from the higher number of steps taken as well as the larger number of checks they made for information of the tile directly in front of them. However, Figure 4.12 does not show that participants who passed the food finding test performed more information checks in every room. This demonstrates that the information check is not required for the participant to gather sufficient data about the room. Spatial information of the room can be obtained from just moving about (taking steps) and finding out what's in (performing tile checks) the environment.

It should also be noted that information check in exploration mode only provided information on your current location by informing you of what tile you are standing on, for example "You are standing on top of a chair".

4.7.5 Result Summary of Food Finding Test

A result comparison among participants for the categories of primary school and secondary school, no vision and low vision, and learning difficulties and no learning difficulties has shown that secondary school participants performed better than primary school participants, participants with low vision did better than participants with no vision while those with no learning difficulties

achieved better results in general than those with learning difficulties. Therefore, a secondary school participant with low vision and no learning difficulties is more likely to find the food.

However, despite the overall trend showing that participants without learning difficulties performed better, there were cases where a participant with learning difficulties outperformed their peers without learning difficulties. This may be due to the individual's ability for storing spatial information, which was not affected by their learning difficulty.

The results also showed that participants that found the food in the food finding test took more steps and tile checks on average during room exploration mode than participants that did not manage to find the food. The number of information checks made during exploration mode does not seem to affect the outcome of the food finding as it only provides information on the player's current location. Taking more steps and checking more tiles proved to be more helpful for locating the food during food finding mode as it means that the participant had explored a larger portion of the room or have visited the same sections of the room more than once in their exploration.

When comparing results of each room, rooms with chairs had much lower success rates for food finding levels as it required the player to first locate the chair, climb up it and then climb up the table to reach the food. This may be because the players have missed the chair during exploration mode and did not have the chance to locate it in food finding mode as well.

The food finding success rate also dropped with the increase of room size as well. In larger rooms such as the kitchen and living room, there might not be sufficient time to succeed in food finding if they are not familiar with the room.

Data for the save games of both exploration mode and food finding mode for each participant for each room is attached in Appendix 9.

4.8 Results of Wire Net Test

The wire net test involved the participant pointing out the location of the furniture they have discovered on a wire net frame. Results of item discovery and average item accuracy might be reliant on if the participant has been truthful. For the sake of this research, it was assumed that no guesswork has been involved.

4.8.1 Calculation for Wire Net Test Results

This section shows how the item discovery score and item accuracy score were calculated for each room.

- Item discovery score

  The item discovery (%) for a room referred to the average item discovery for all items in the room. Each item in the room was awarded a 0% if undiscovered by the participant and 100% if discovered by the participant. Therefore, if a participant had found and listed 3 out of 4 items of the room they will have 75% score for item discovery.

  However, if an extra item was found which does not exist in the room, a penalty of the item discovery score was incurred. The amount deducted was dependent of the number of item in the room, resulting in a 25% deduction for a room of 4 items if 5 items have been listed by the participant during the wire net test.

- Item accuracy score

  When an item was discovered, only then was the item's accuracy score be calculated. The item accuracy for the room referred to the average item accuracy of all the items in that room. The item's accuracy was calculated based on two variables. The placement of the item indicated by the participant and the furniture size of the item they have stated were taken into account for the item's final accuracy.

  The placement of the item when placed in the exact position correctly yielded 100% for placement accuracy. This score was reduced by 20% for every one tile they are off from the original location. Being 5 tiles and above off automatically yielded 0% for placement score. The placement of the tile was based on the center of the object and a half tile difference in position was considered as 0 tile difference as that difference was reflected in the difference in the furniture's item size.

If the item size was correct, the item yielded 100% for size accuracy. The score was reduced by 20% for every tile in size difference. By indicating a size with a difference of 5 tiles or more compared to the original item size, the participant received 0% for item size. The same condition applied whether the size stated by the participant is smaller or larger than the actual item.

The item accuracy was then calculated based on the average of both the item placement score and the item size score. So if the user scored 100% in item placement but 50% in item size, they would get (100% + 50%)/2 = 75% for their final item accuracy of the item. Not discovering the item in the first place will automatically yield a 0% in item accuracy.

4.8.2 Average Item Discovery and Accuracy for All Items in Each Room

The average item discovery and item accuracy for all items in each room are shown in this section. Exploration of the rooms while playing *Hungry Cat* did provide the participants with spatial information about the room during the exploration mode. Although the item discovery and item accuracy scores did decrease as the rooms became more complex due to the same amount of time given for the exploration of it, it still showed that spatial information of the rooms is able to be obtained through the game.

The average item discovery rate for the first room, Hallway, was higher due to the fact that it was the smallest room containing the least number of items. The average item accuracy for each individual item was also high for this room.

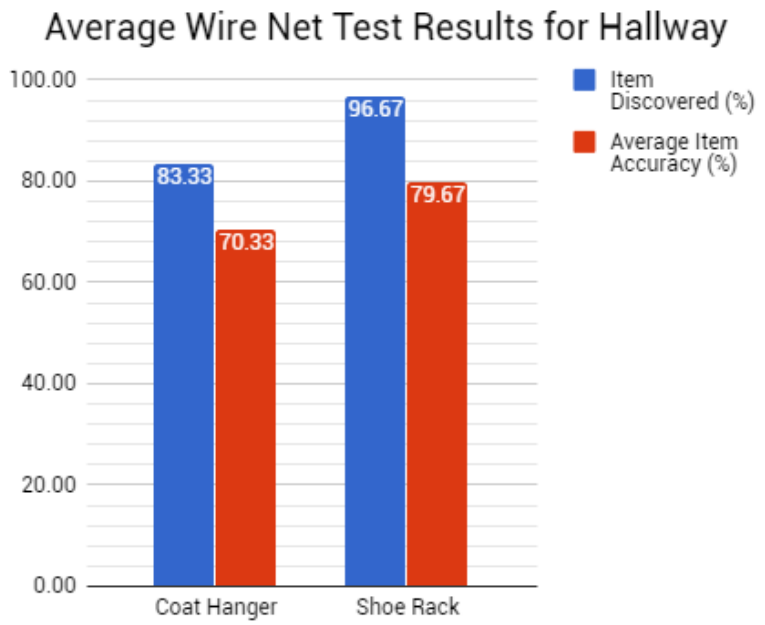

Figure 4.13 Average Wire Net Test Results for Each Item in Hallway

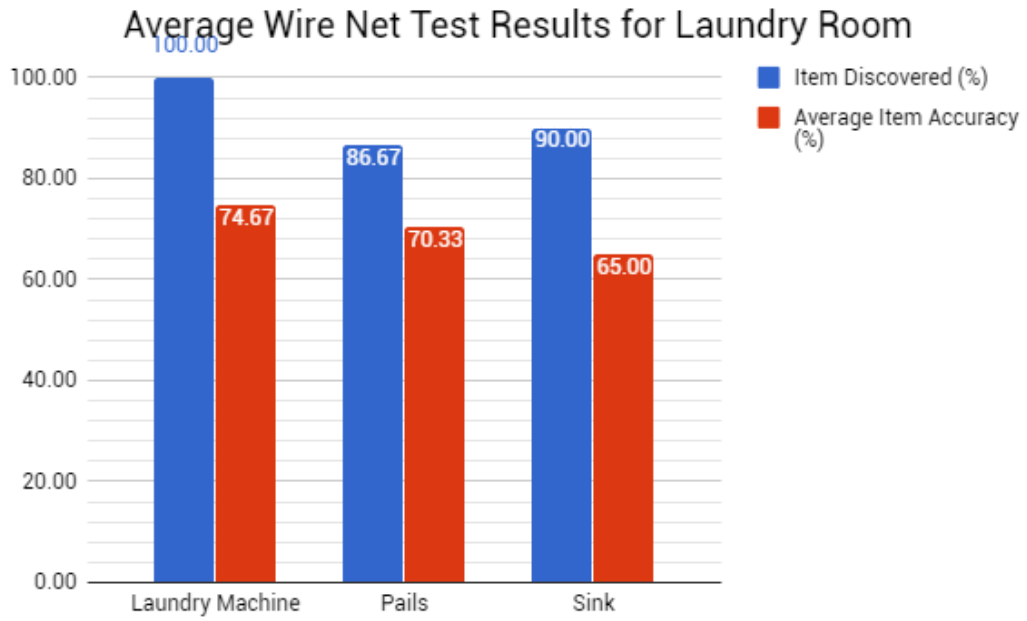

Figure 4.14 Average Wire Net Test Results for Each Item in Laundry Room

In the second room, the Laundry Room, the item discovery rate was still high among the items with the laundry machine getting a 100% item discovery rate. This was due to the small size of the room and the large size of the laundry machine. The average item accuracy for each item in the room was still good.

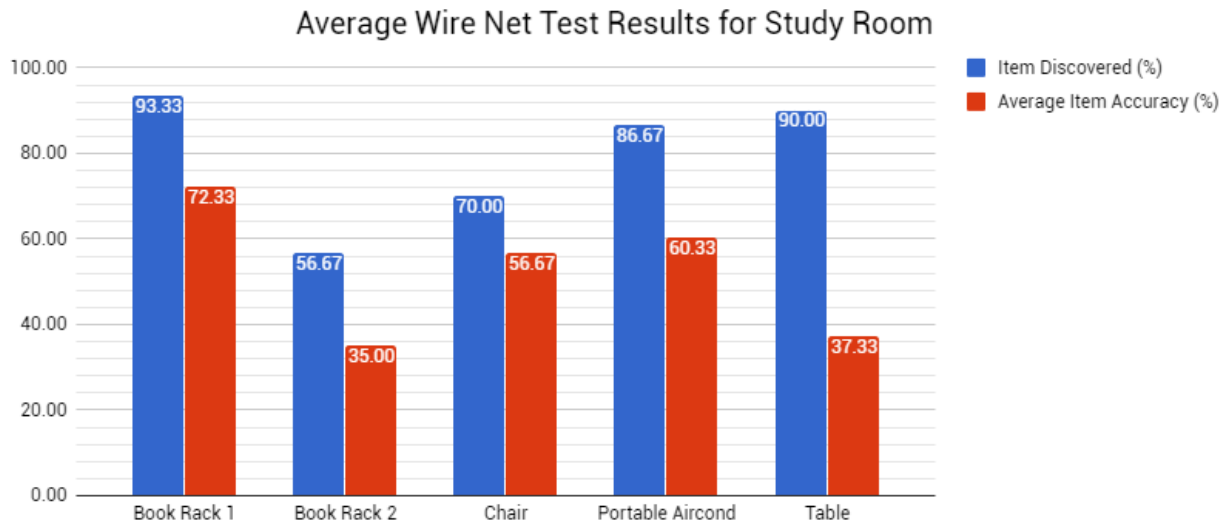

Figure 4.15 Average Wire Net Test Results for Each Item in Study Room

The third room, the Study Room was the first room where a type of furniture appears twice. In this case, it was the book rack. The discovery rate of the first book rack was high but many participants did not notice that there was a second book rack in the room. This resulted in a low item discovery rate and low average item accuracy for the second book rack. The average item accuracy for the table was also low as it was a large item and many participants could not recall the exact size and location of it within the room even though the item discovery for the table was high due to many participants finding it in their exploration of the room.

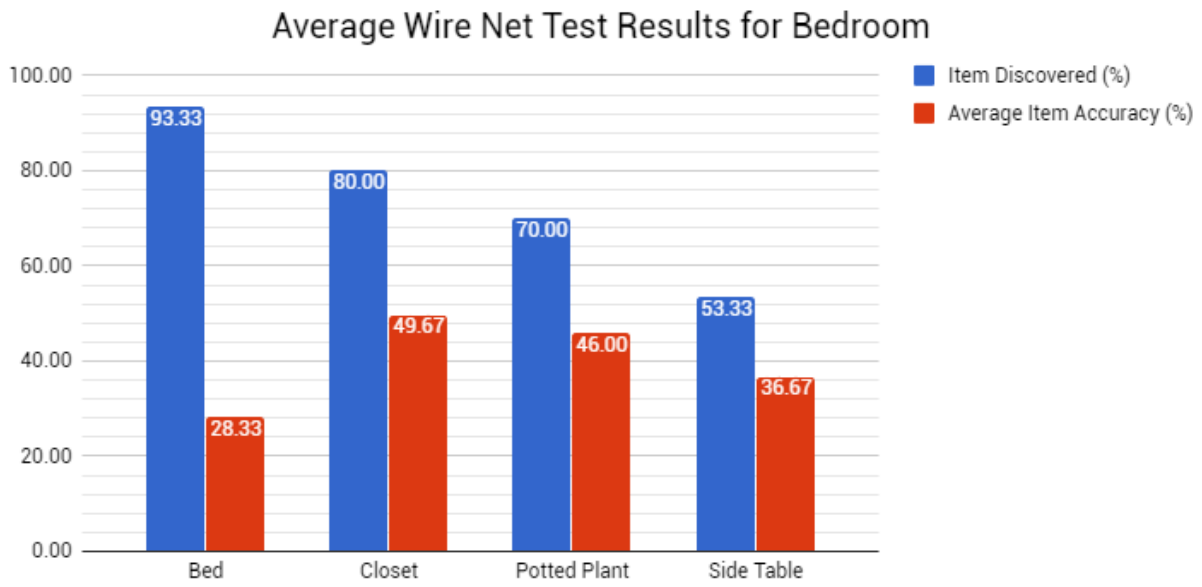

Figure 4.16 Average Wire Net Test Results for Each Item in Bedroom

The next room was the Bedroom. Like the table in the Study Room previously, the bed item also had a high item discovery rate but low item accuracy due to its size. The other items in the room had reasonable item discovery rate and accuracy with the exception of the side table. The large size of the room has resulted in lowered accuracy of both item placement and item size of items in the room. Although participants have heard the beeping sound from the alarm clock on the side table, many did not actually locate the side table due to exploring the other side of the room more.

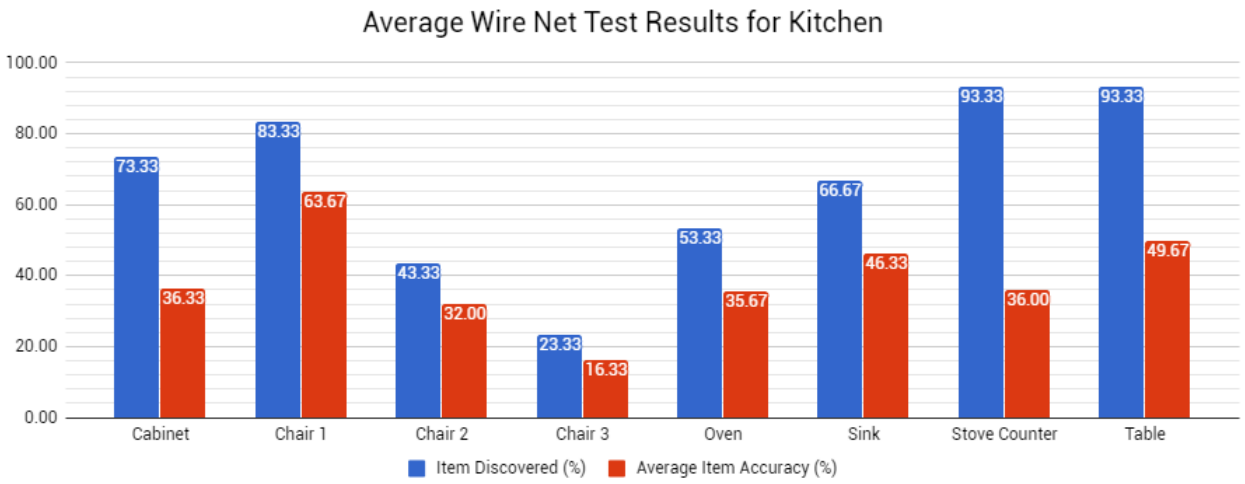

Figure 4.17 Average Wire Net Test Results for Each Item in Kitchen

The fifth room for the test was the Kitchen. It was the second largest room within the game and had the most items in it. Like the book racks in the Study Room, the three chairs in this room had a noticeable decline in discovery rate and item accuracy. Many participants have encountered at least the first chair but many participants did not notice the second and third chair. The item discovery rate for the items in the room was quite high; however, the item accuracy was poor in comparison. This is possibly due to the size of the room. Participants could recall what items they have found but could not accurately place them during the wire net test.

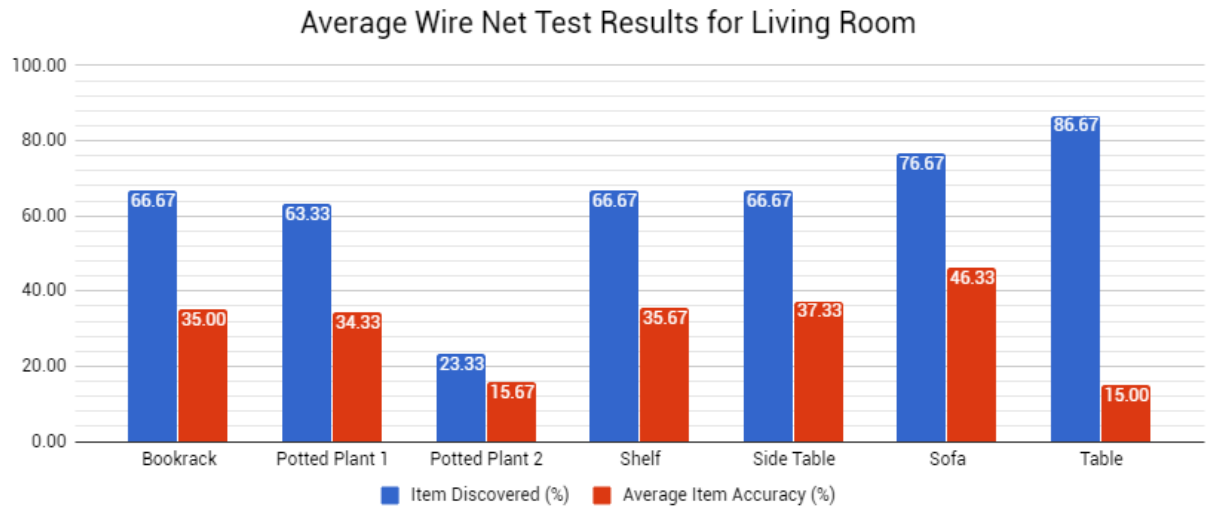

Figure 4.18 Average Wire Net Test Results for Each Item in Living Room

The Living Room was the final room in the game and had the lowest item discovery rate among all the rooms. This was expected due to the living room being the largest room. Many of the participants were not able to fully explore the room within the time given (5 minutes) for exploring the other rooms. The second potted plant of the room showed the lowest item discovery and second lowest accuracy for all the items in the room. Many participants failed to notice a second of an item within the same room. The table item which was the largest item in the room had the highest discovery rate but also the lowest accuracy among the items. Most participants discovered the table but were not clear about its location and size.

4.8.3 Results: Primary School Participants vs. Secondary School Participants

The figures below depict the performances in the wire net tests for primary school participants and secondary school participants. The performance of all participants was included to show the average. As seen in Figure 4.19 to Figure 4.24 below, primary school participants performed slightly better on average than secondary school participants for all rooms with the exception of the hallway. This difference in performance may be due to individual abilities and the higher levels of earnestness of the primary school group in participating in the test. Some secondary school participants were also distracted by the activities going on outside the classroom during the weekend sessions and were unable to pay their fullest attention during the wire net test.

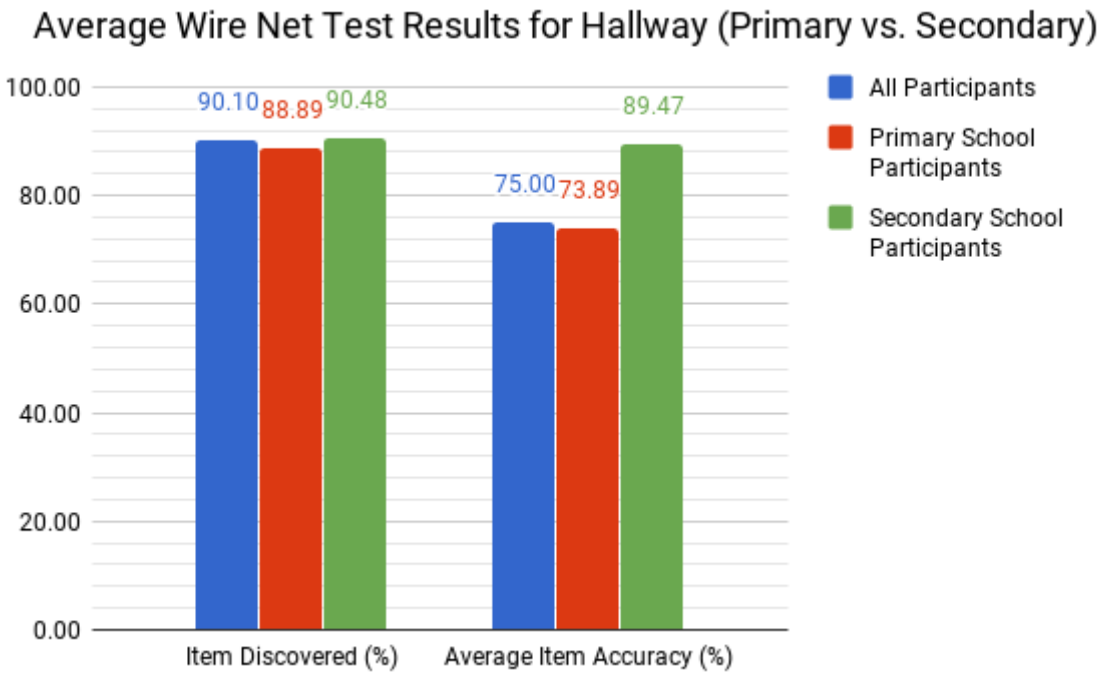

Figure 4.19 Average Wire Net Test Results for Hallway (Primary vs. Secondary)

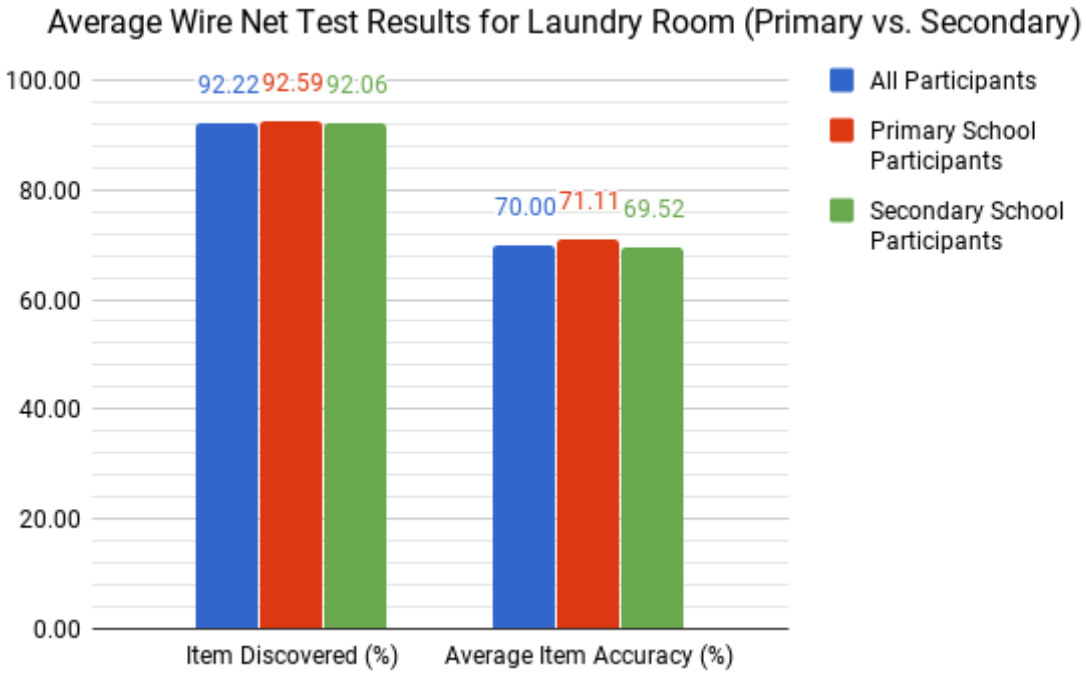

Figure 4.20 Average Wire Net Test Results for Laundry Room (Primary vs. Secondary)

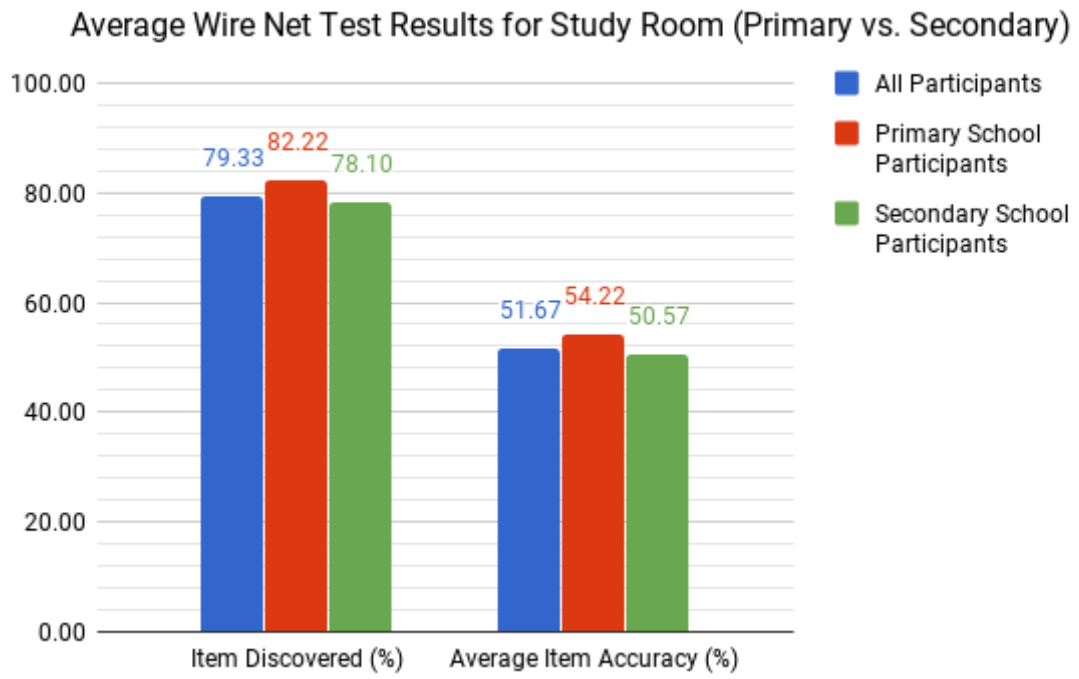

Figure 4.21 Average Wire Net Test Results for Study Room (Primary vs. Secondary)

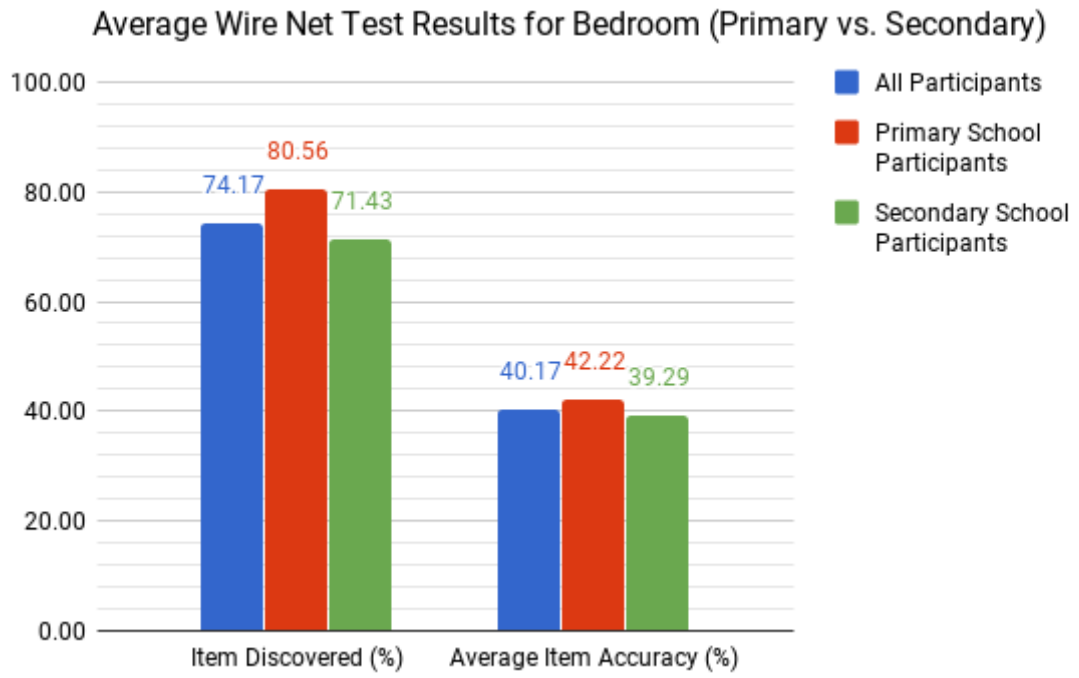

Figure 4.22 Average Wire Net Test Results for Bedroom (Primary vs. Secondary)

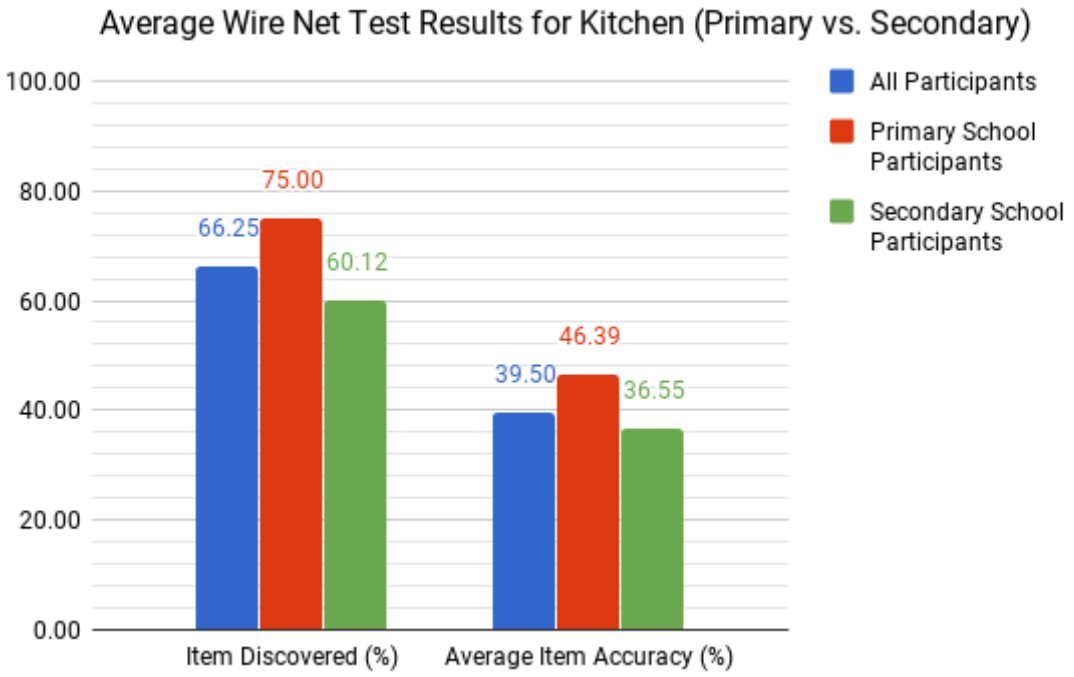

Figure 4.23 Average Wire Net Test Results for Kitchen (Primary vs. Secondary)

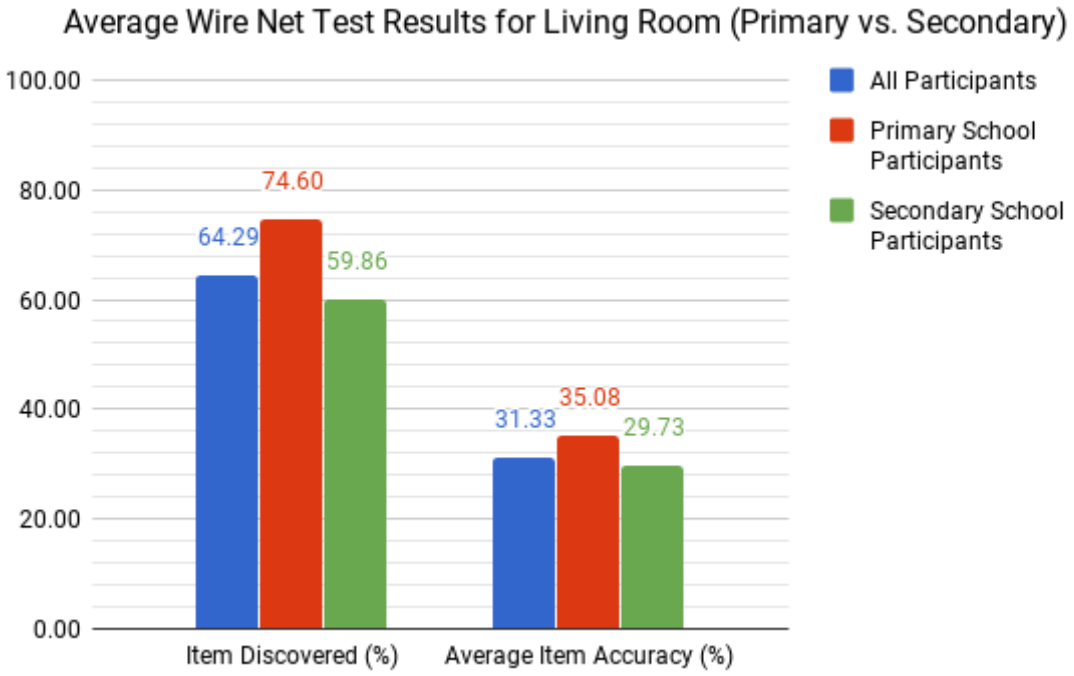

Figure 4.24 Average Wire Net Test Results for Living Room (Primary vs. Secondary)

4.8.4 Results: No Vision Participants vs. Low Vision Participants

The performance comparison among the no vision participants and the low vision participants are shown in Figure 4.25 to Figure 4.30 below. In general, participants with low vision performed better overall than participants with no vision. This is due to participants with low vision being able to arrange their spatial information in a map like way, while participants with no vision who are born blind most likely arrange their spatial information of a location in a route like method, therefore requiring more experience with an environment to build a detailed spatial map of the place.

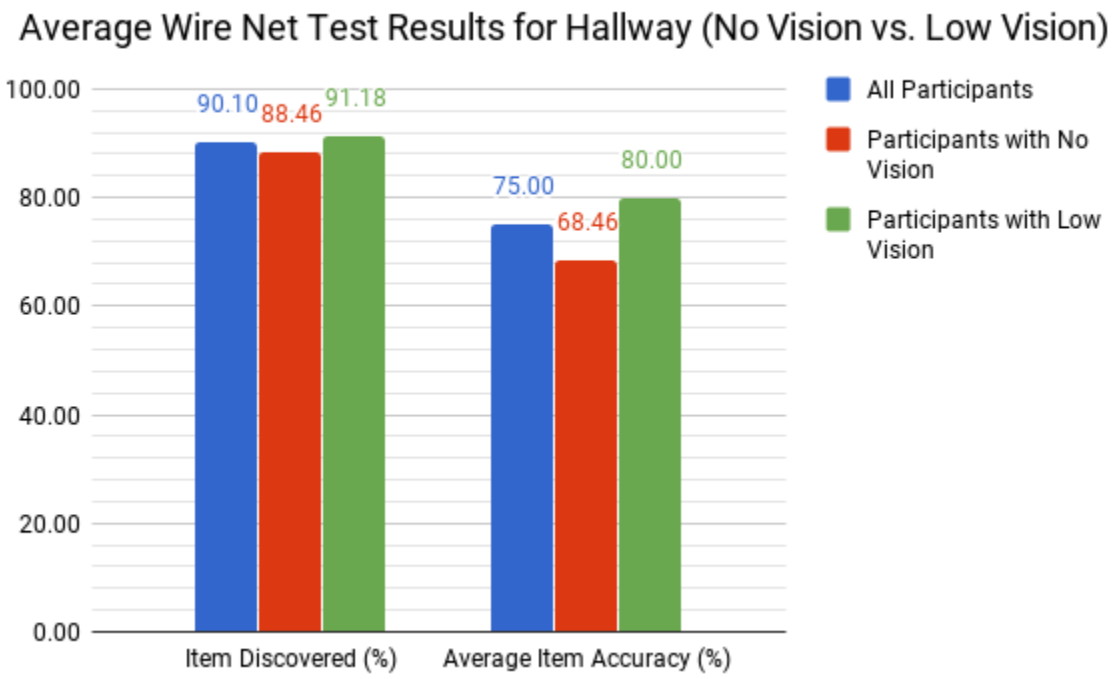

Figure 4.25 Average Wire Net Test Results for Hallway (No Vision vs. Low Vision)

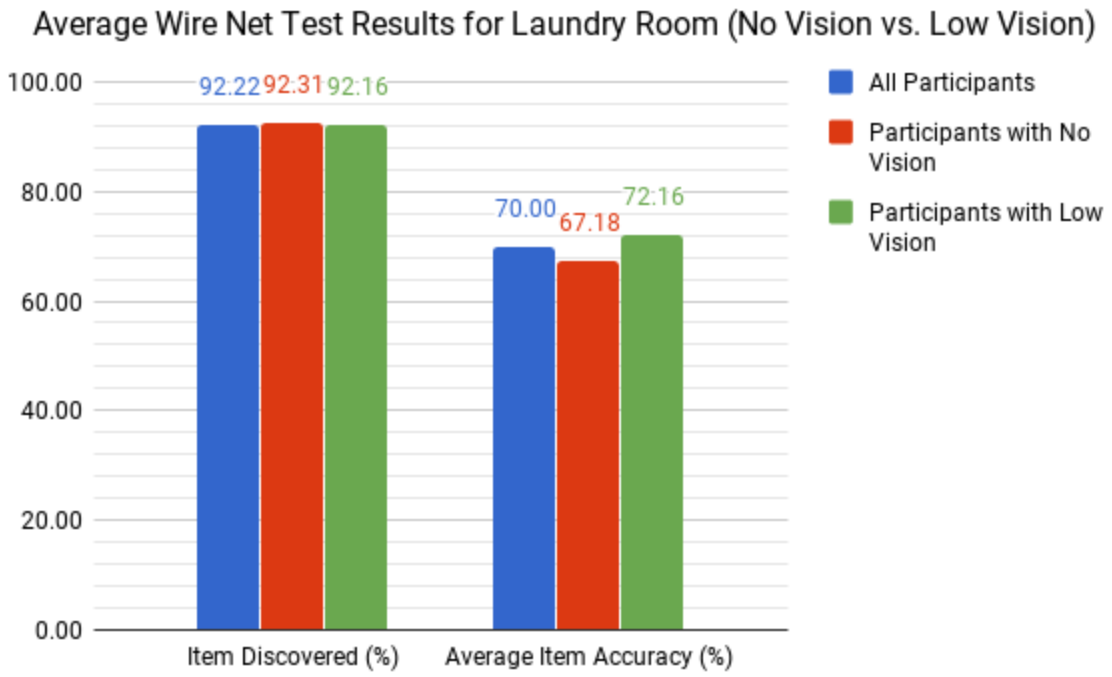

Figure 4.26 Average Wire Net Test Results for Laundry Room (No Vision vs. Low Vision)

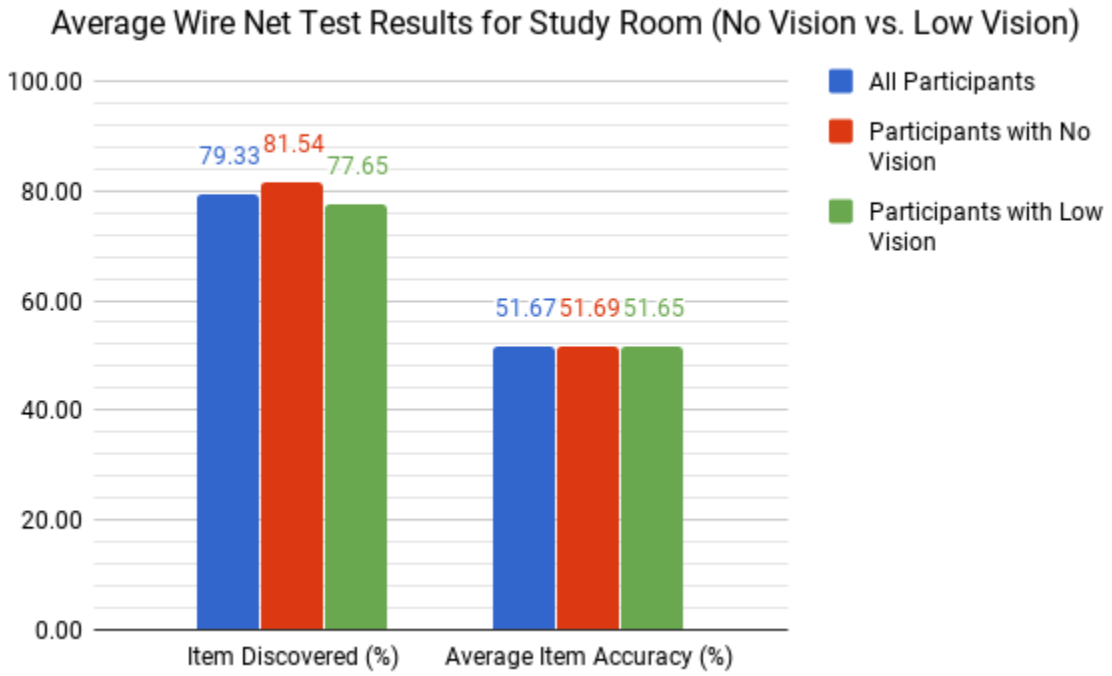

Figure 4.27 Average Wire Net Test Results for Study Room (No Vision vs. Low Vision)

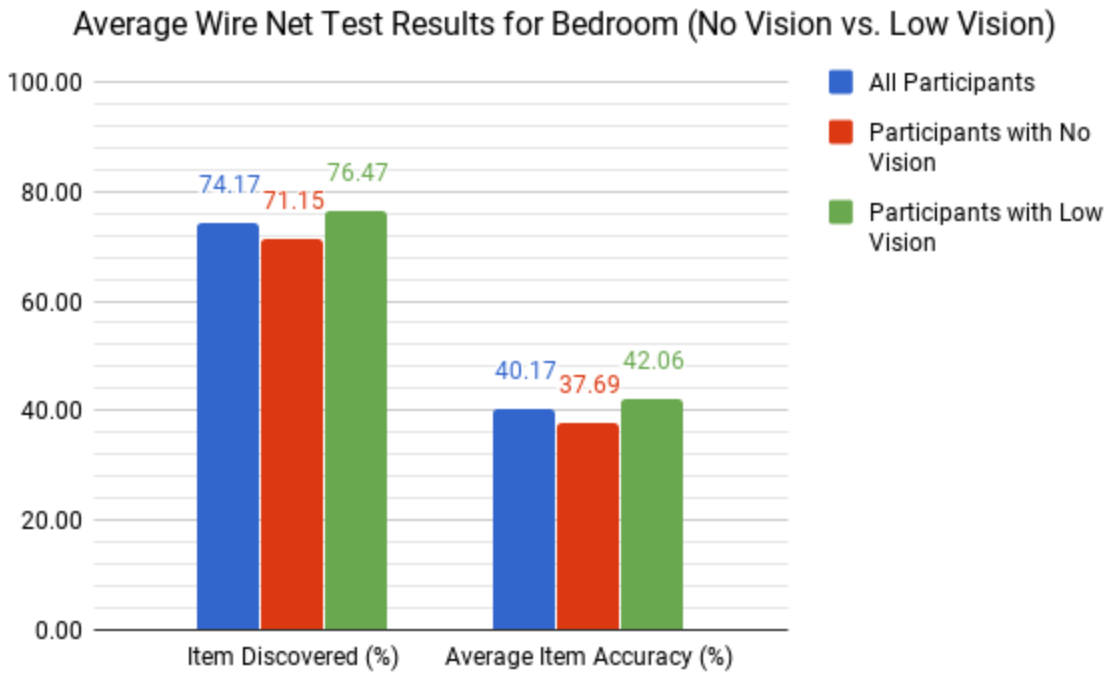

Figure 4.28 Average Wire Net Test Results for Bedroom (No Vision vs. Low Vision)

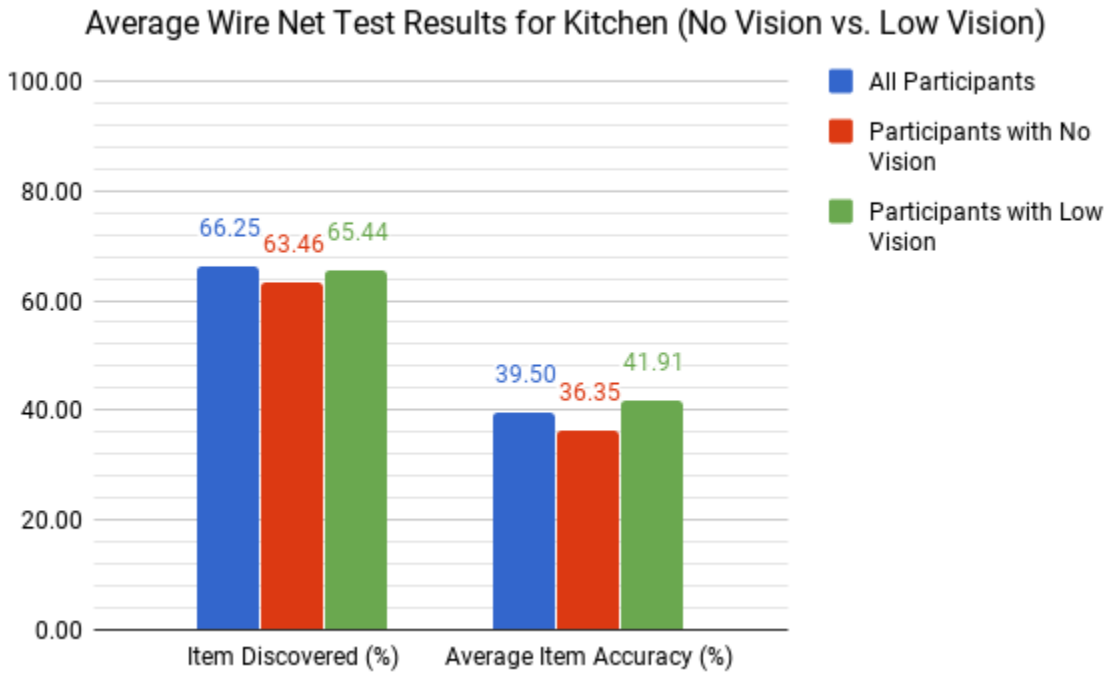

Figure 4.29 Average Wire Net Test Results for Kitchen (No Vision vs. Low Vision)

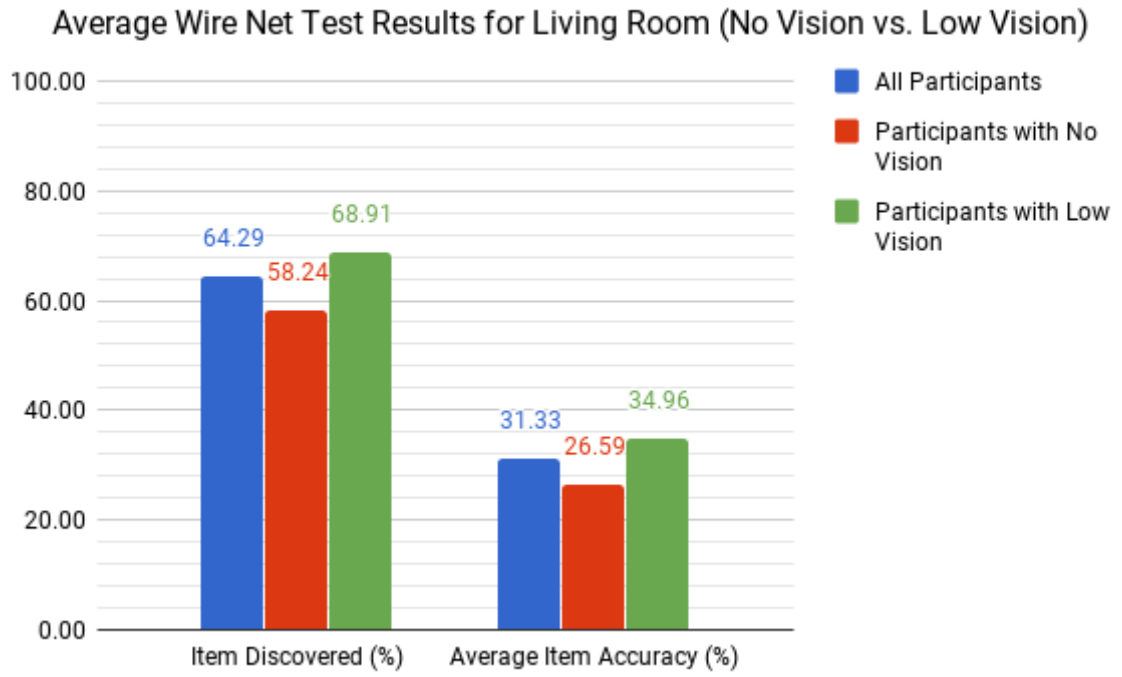

Figure 4.30 Average Wire Net Test Results for Living Room (No Vision vs. Low Vision)

4.8.5 Results: Participants with Learning Difficulties vs. Participants without Learning Difficulties

Figure 4.31 to Figure 4.36 below compares the wire net test results for participants with learning difficulties and participants without learning difficulties. According to the results obtained, participants with and without learning difficulties performed better in different rooms, which is to say that neither group had shown consistently better performance than the other group. Although having learning difficulties might result in being slower at obtaining and storing spatial information, the performances regarding spatial information still vary from individual to individual.

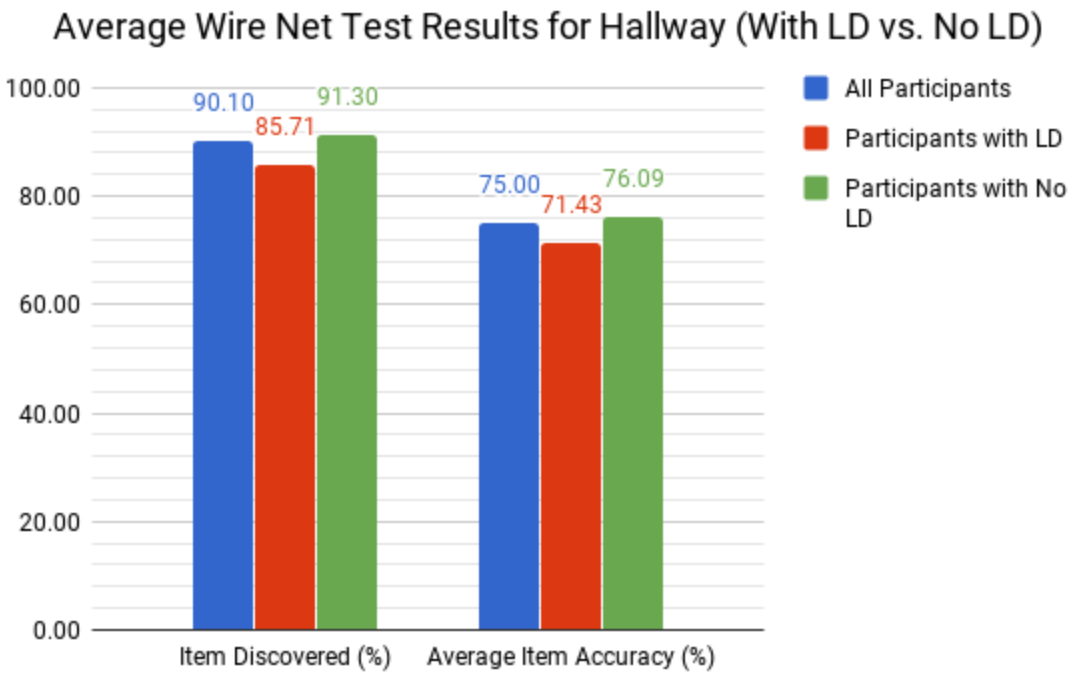

Figure 4.31 Average Wire Net Test Results for Hallway (With LD vs. No LD)

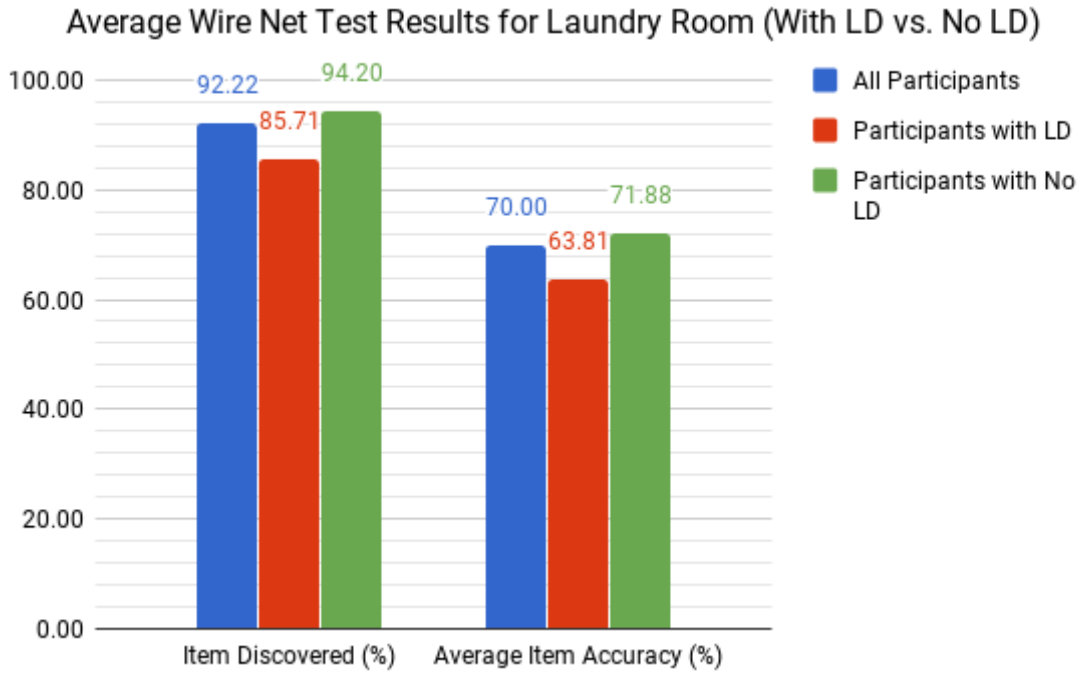

Figure 4.32 Average Wire Net Test Results for Laundry Room (With LD vs. No LD)

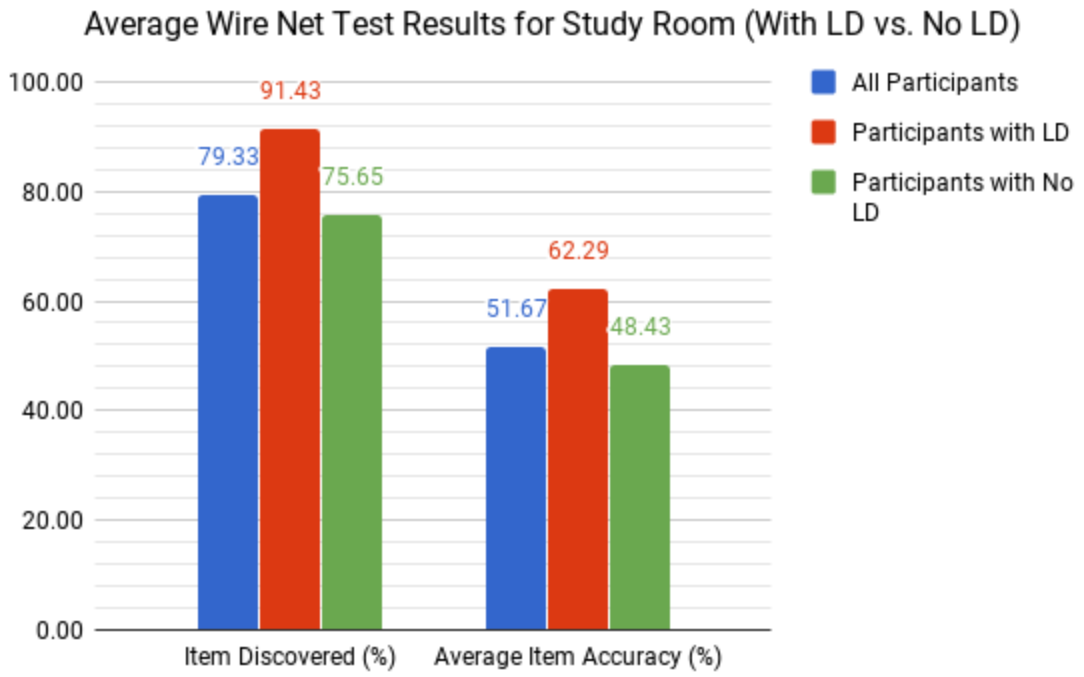

Figure 4.33 Average Wire Net Test Results for Study Room (With LD vs. No LD)

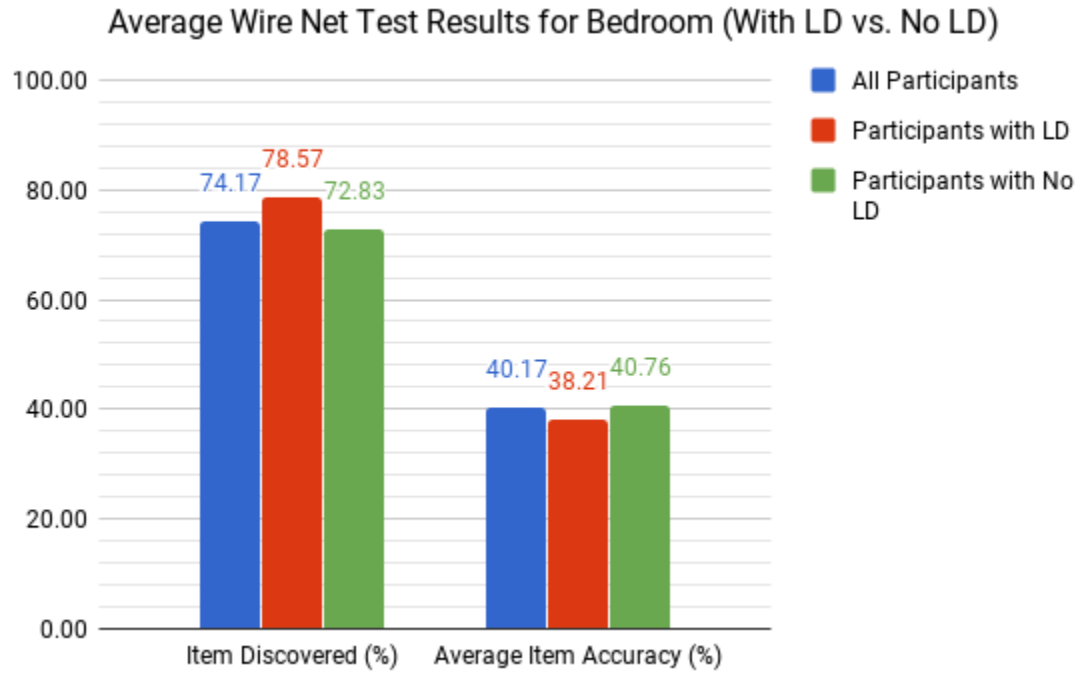

Figure 4.34 Average Wire Net Test Results for Bedroom (With LD vs. No LD)

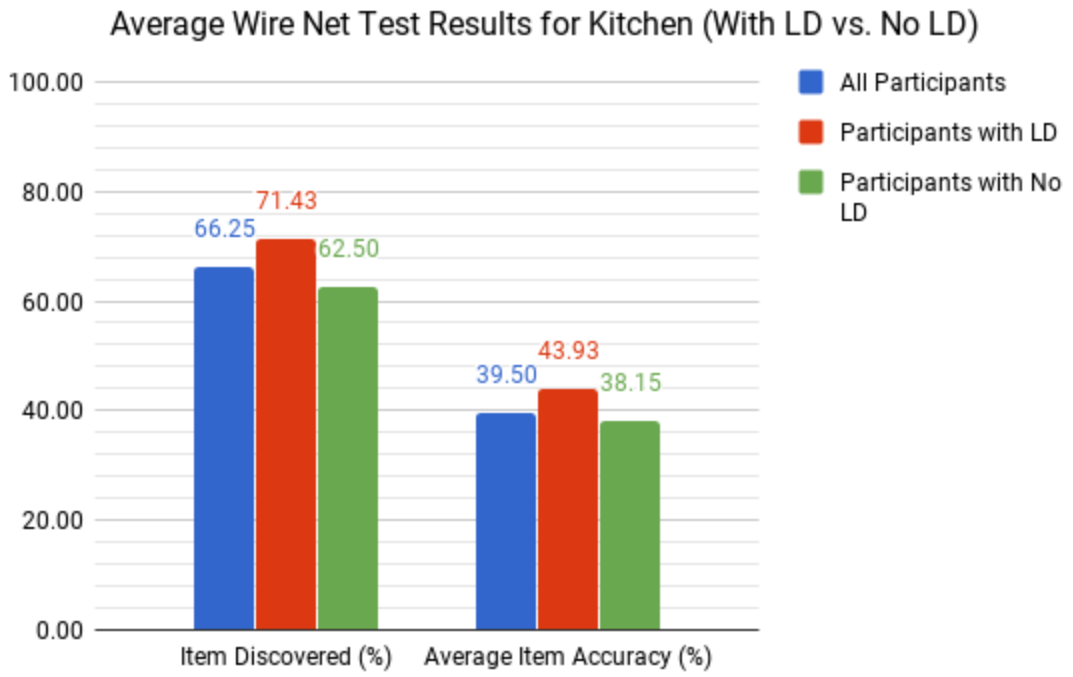

Figure 4.35 Average Wire Net Test Results for Kitchen (With LD vs. No LD)

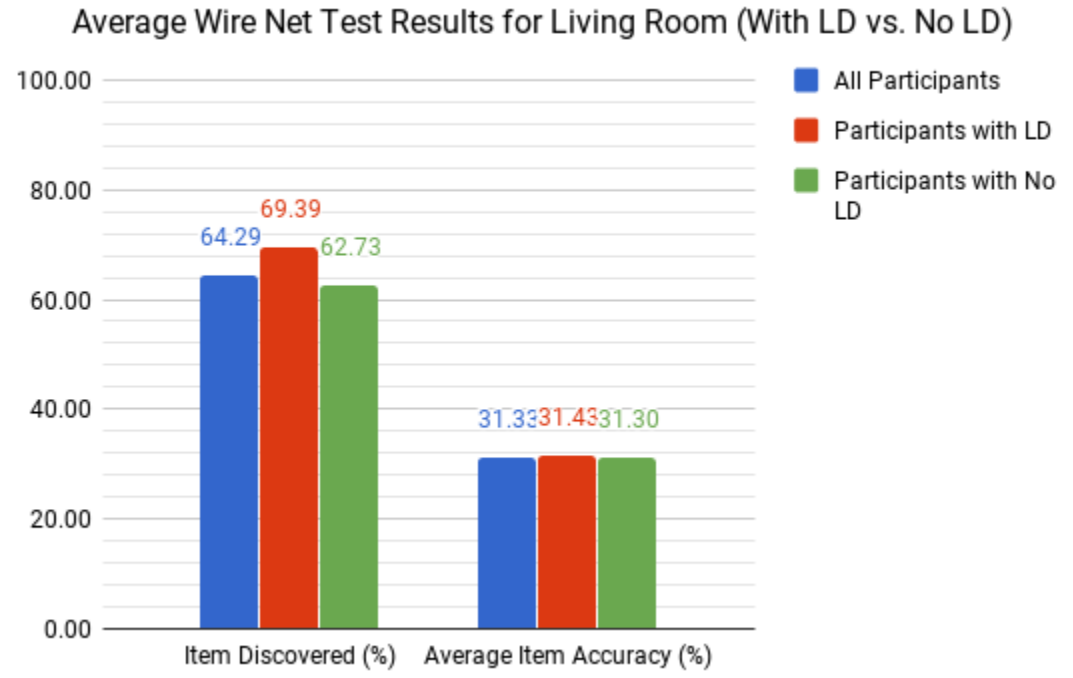

Figure 4.36 Average Wire Net Test Results for Living Room (With LD vs. No LD)

4.8.6 Results: Participants that Found Food vs. Participants that did not Find Food

Figure 4.37 shows the average item accuracy score in wire net test in all rooms, comparing participants who found food items during the food finding test and participants who did not. Figure 4.38 to Figure 4.43 show the results for the wire net test comparing these participants for all rooms, ranging from the Hallway to the Living Room. According to these figures, participants who found the food items in the food finding test had better average item accuracy scores for wire net tests than those who did not. Therefore it can be said that participants who passed the food finding test performed better in the wire net test in all rooms.

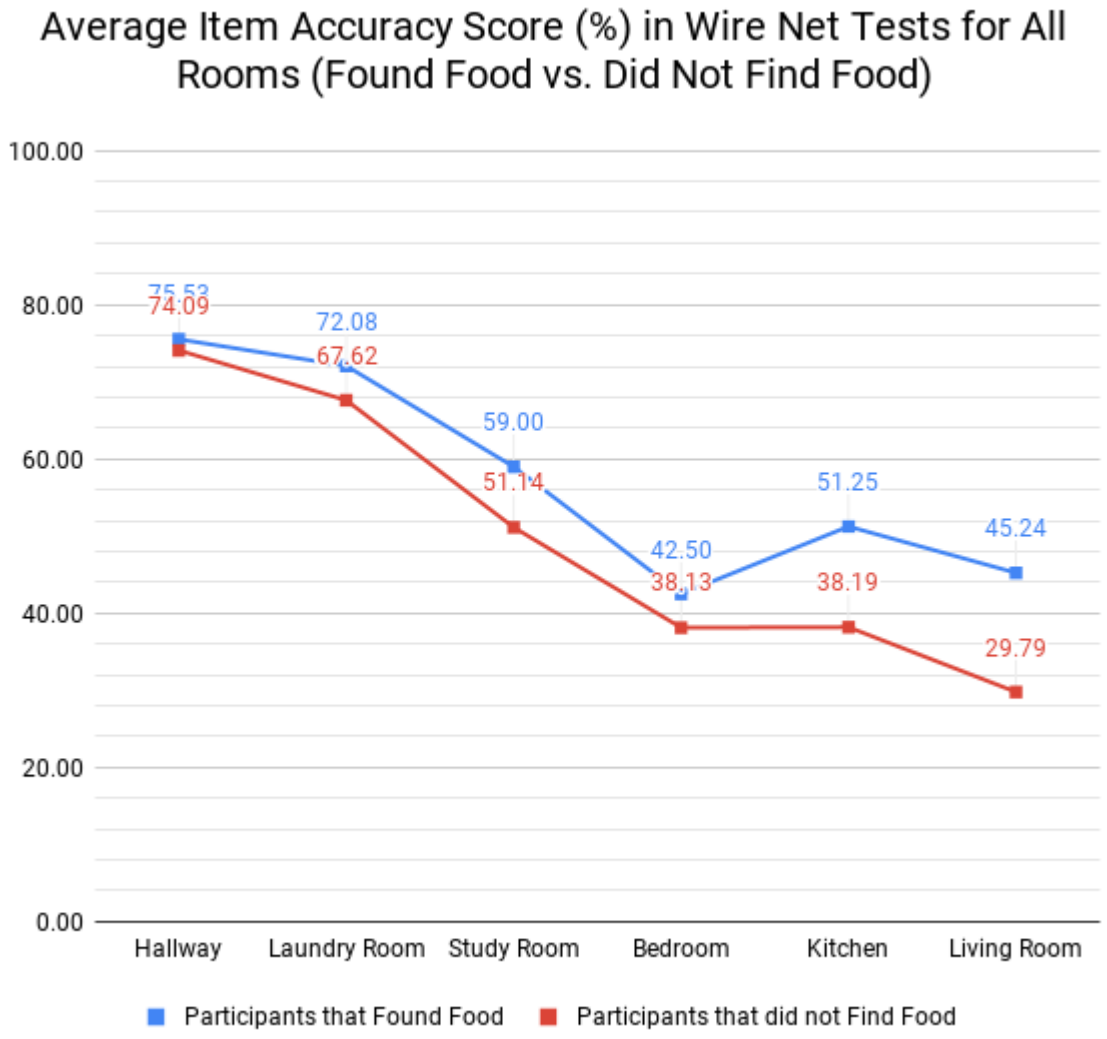

Figure 4.37 Average Item Accuracy Score (%) in Wire Net Tests for All Rooms (Found Food vs. Did Not Find Food)

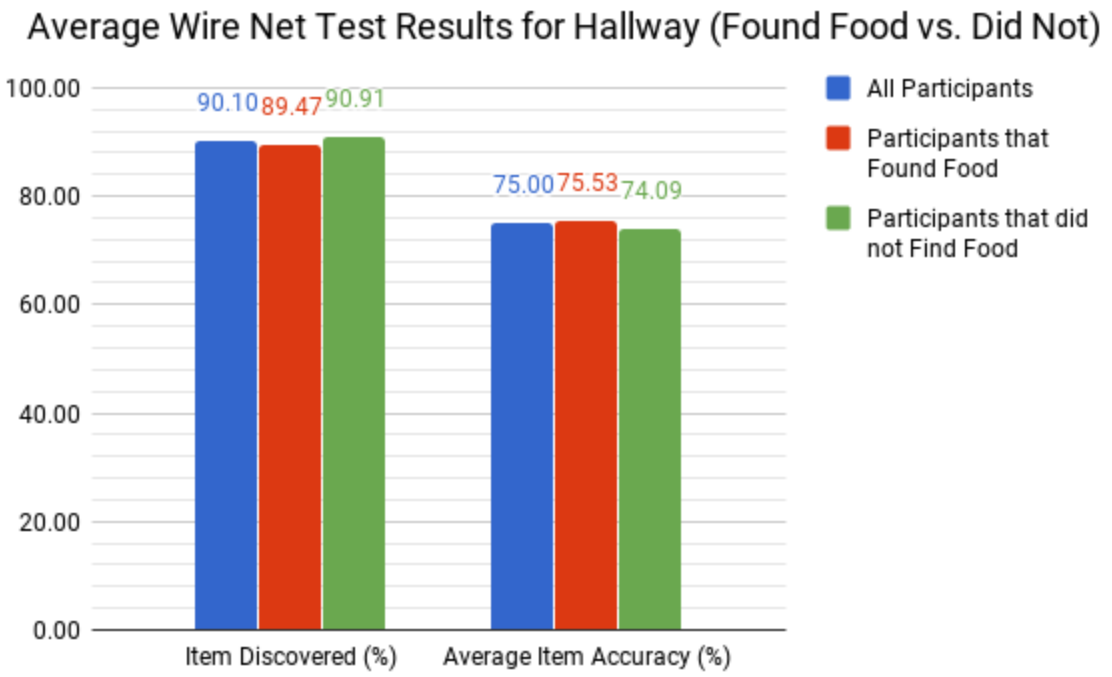

Figure 4.38 Average Wire Net Test Results for Hallway (Found Food vs. Did Not)

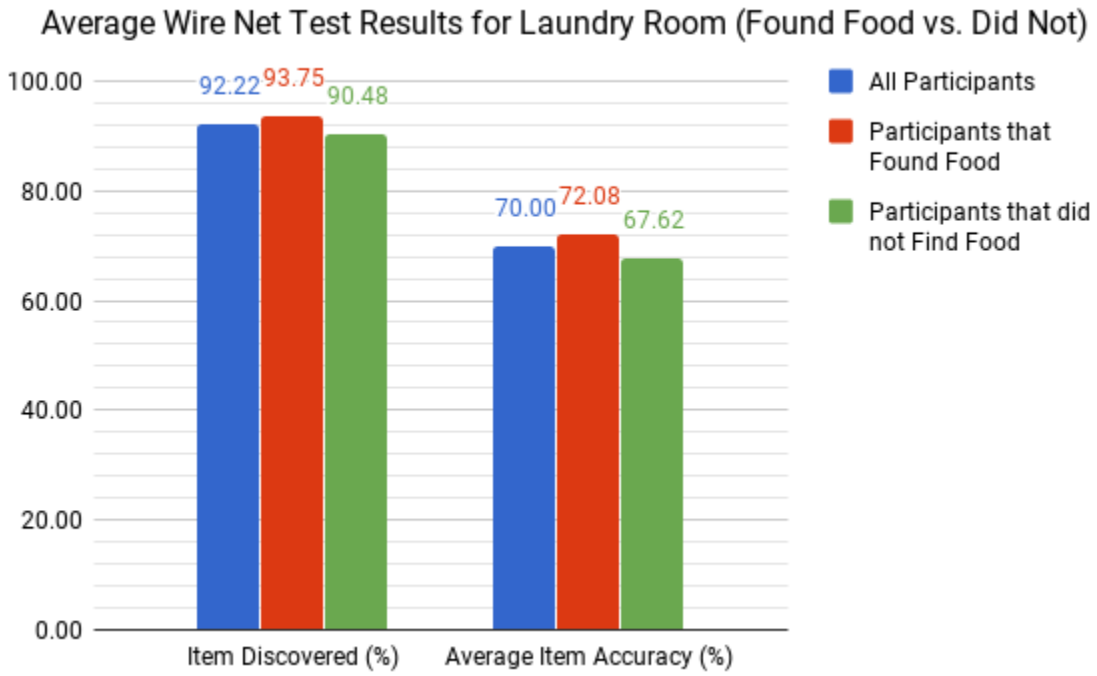

Figure 4.39 Average Wire Net Test Results for Laundry Room (Found Food vs. Did Not)

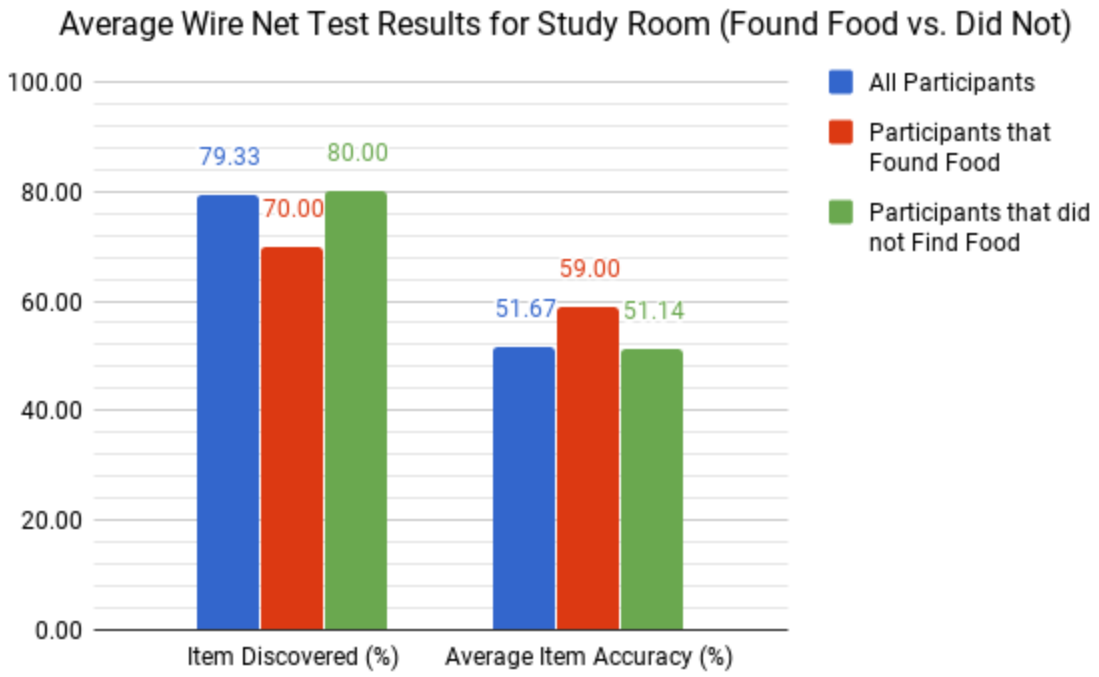

Figure 4.40 Average Wire Net Test Results for Study Room (Found Food vs. Did Not)

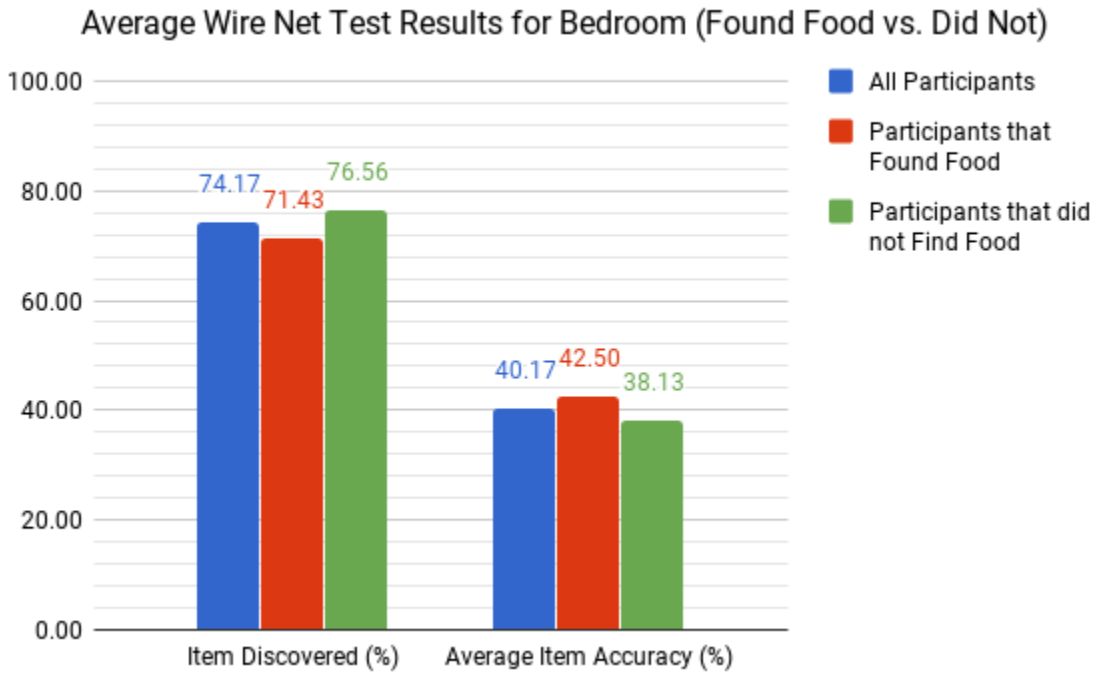

Figure 4.41 Average Wire Net Test Results for Bedroom (Found Food vs. Did Not)

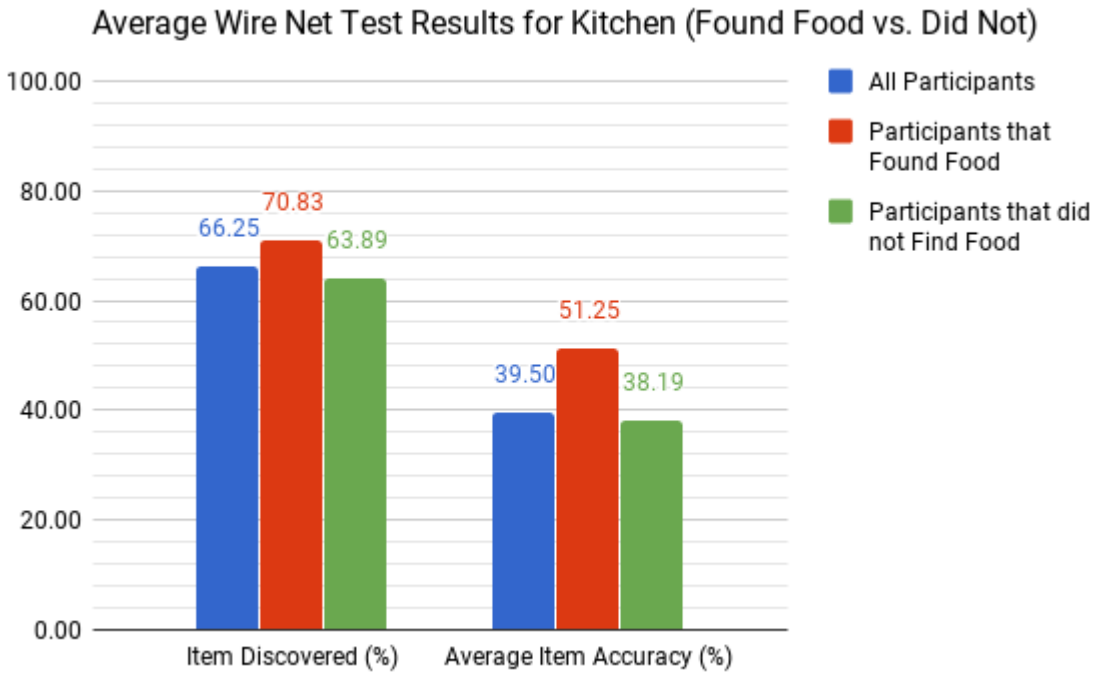

Figure 4.42 Average Wire Net Test Results for Kitchen (Found Food vs. Did Not)

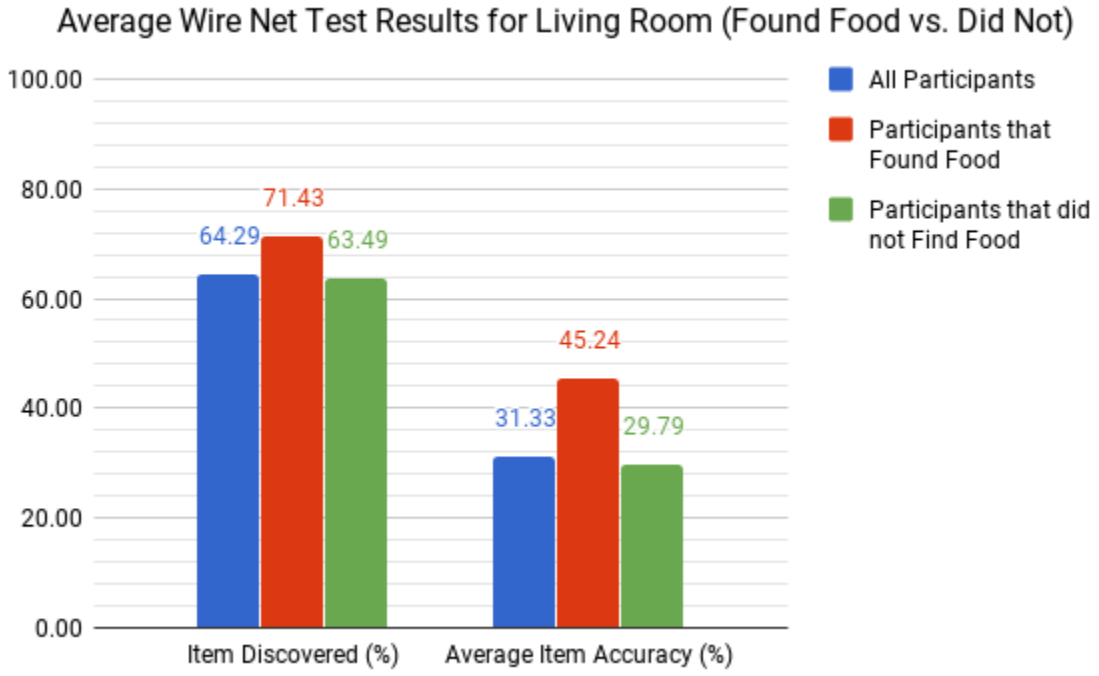

Figure 4.43 Average Wire Net Test Results for Living Room (Found Food vs. Did Not)

Comparison for All Rooms

Figure 4.44 to Figure 4.47 compare the average, maximum, minimum and standard deviation of all room's item accuracy for participants that found food, participants that did not find food and all participants. Item accuracy was chosen as a measurement of the wire net test performance as it is directly affected by item discovery in addition to being an indication of how accurately the item's placement and size is based on the participants' response.

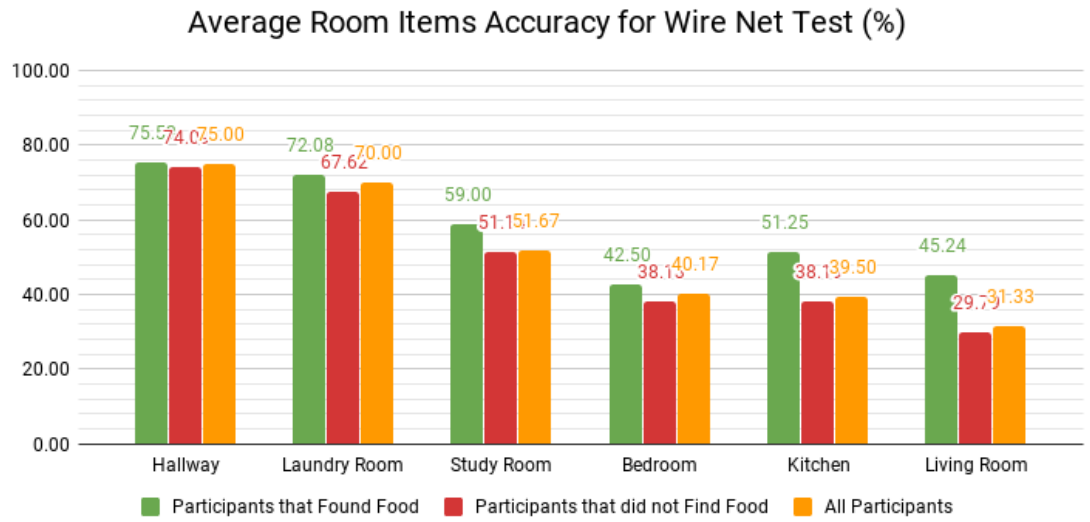

Figure 4.44 Average Item Accuracy for All Rooms (Found Food vs. Did Not)

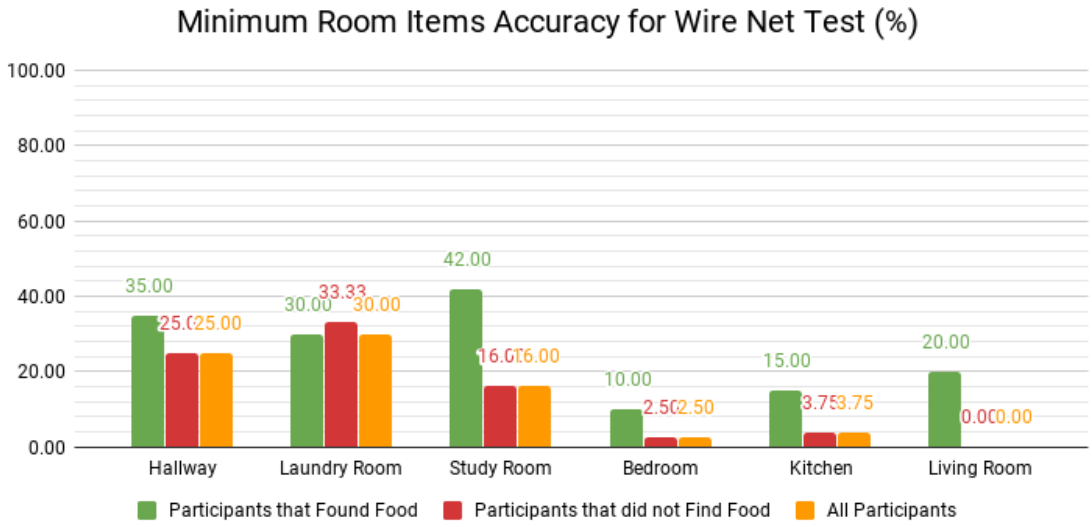

Figure 4.45 Minimum Item Accuracy for All Rooms (Found Food vs. Did Not)

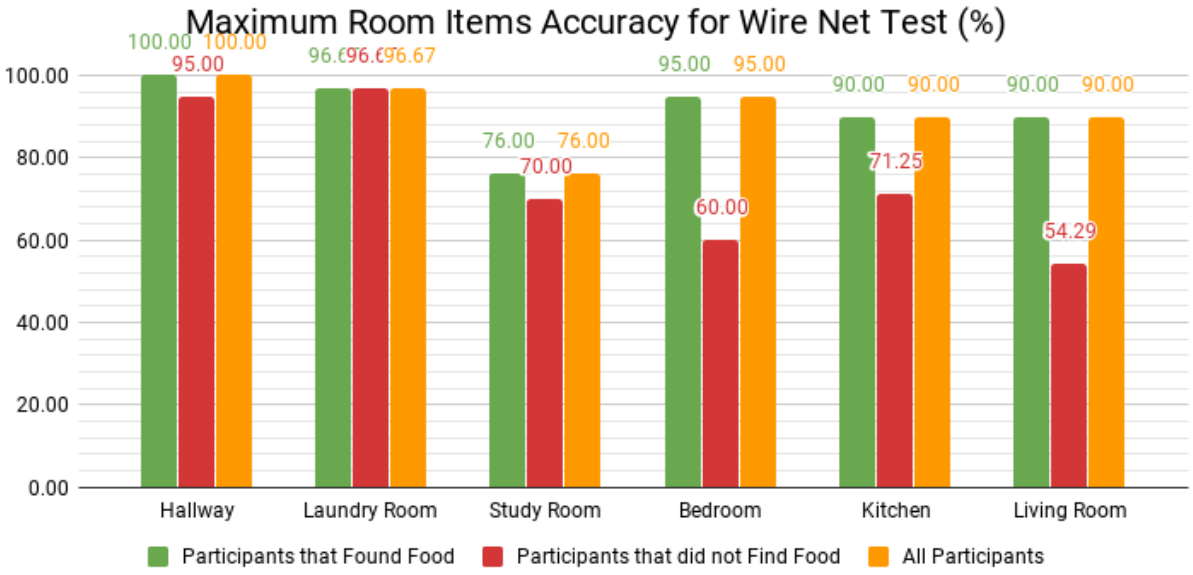

Figure 4.46 Maximum Item Accuracy for All Rooms (Found Food vs. Did Not)

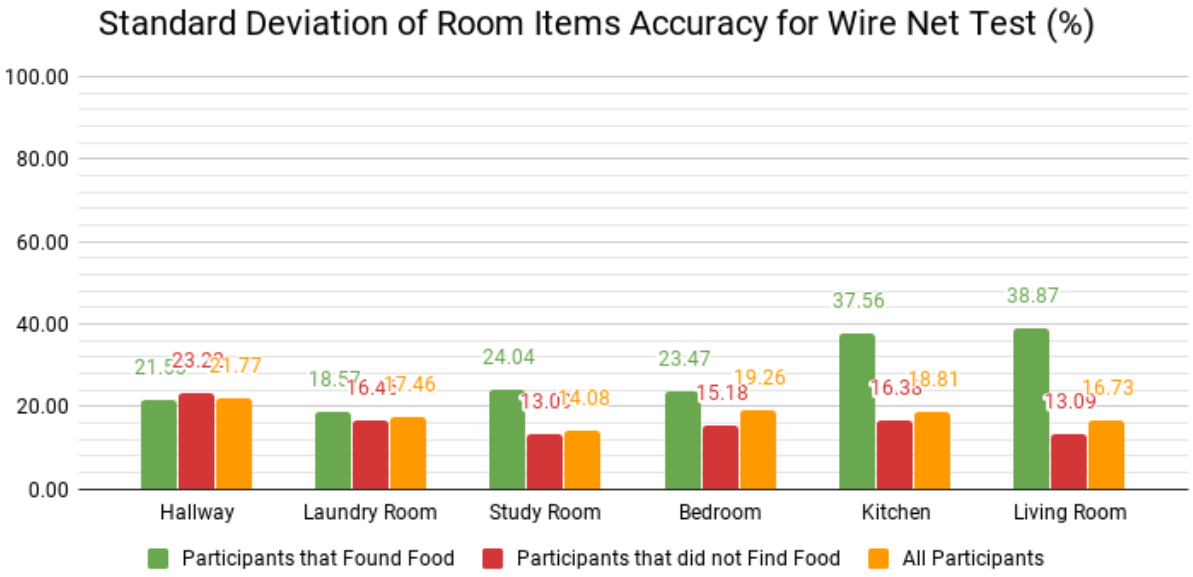

Figure 4.47 Standard Deviation of Item Accuracy for All Rooms (Found Food vs. Did Not)

The room items accuracy of the wire net test among participants that found food is shown to be higher on average. The maximum room accuracy score for participants that found food was high as found in Figure 4.45. The participants that achieved those scores have produced a rather accurate spatial maps of the 6 rooms in their minds. The minimum room accuracy score for participants that found food is still higher than the minimum obtained by participants that did not

manage to find food as shown in Figure 4.45. The standard deviation among participants that found food is high as shown in Figure 4.47. In short, the ability to do well in the food finding test does not correlate with the ability to do well in the wire net test. In fact, those who passed the food finding test scored differently (from high to low) in the wire net test.

4.8.7 Summary of Wire Net Tests

The wire net test results, the same as food finding test results, dropped with the increase in size of the rooms as well. This could be due to the lack of time to fully explore the room and also the increase in the number of furniture placements to remember.

Although big items such as the table and bed had a high item discovery chance, the item accuracy was low. Despite participants finding the item, they did not take note about where exactly it was placed and how large it was.

In rooms where there were duplicate items such as two book racks or three chairs, the 2nd or 3rd item had a lower discovery rate than the first. According to the post-test debriefing session with the participants, there were a few of them who thought the first item was the same as the second or third item. These participants were surprised to learn that the items were actually in separate locations. There were a few participants who did not explore the room thoroughly to identify the exact location of each item, even though they noticed some duplicate items.

Standard deviation was quite high for item accuracy in the wire net test for rooms for participants that found the food in food finding mode. This could be despite having low accuracy of the room placement, they might be good at following instructions or are good at navigating. Similarly, higher wire net test scores do not necessarily mean higher food finding chance. Important interactive furniture required to climb up to find the food such as the chair might not be found. Another reason for not being able to locate the food was that there was not enough time. Some participants had poor wire net test scores but have found the food, this might be due to their being able to follow directions well or it was found by chance when exploring the room.

The trend for food finding success was that with rooms with chairs, which were rooms requiring two climbs up to reach the food, the success chance was much lower. This might be due to players facing difficulties locating the chair to climb up on. Food on top of furniture usually could not be found by accident.

However, on average, participants who found food had a higher average for item accuracy during the wire net test than those that did not. This shows that majority of participants who found food items were also more familiar with the spatial layout of the room. Having a clearer spatial mental map of the room would be able to aid the participants in locating the food during the food finding test. The results of the wire net test for all rooms showed that spatial information could be obtained through the exploration of the virtual rooms.

Data for the wire net test for all participants for every item in all rooms is attached in Appendix 10.

4.9 Comparisons of the Low Vision vs. No Vision Participants

A more in-depth analysis of how the different groups of participants performed in both the food finding test and the wire net test will be done in this section. Figure 4.48 and Figure 4.49 below shows the number of participants for each of the eight groups.

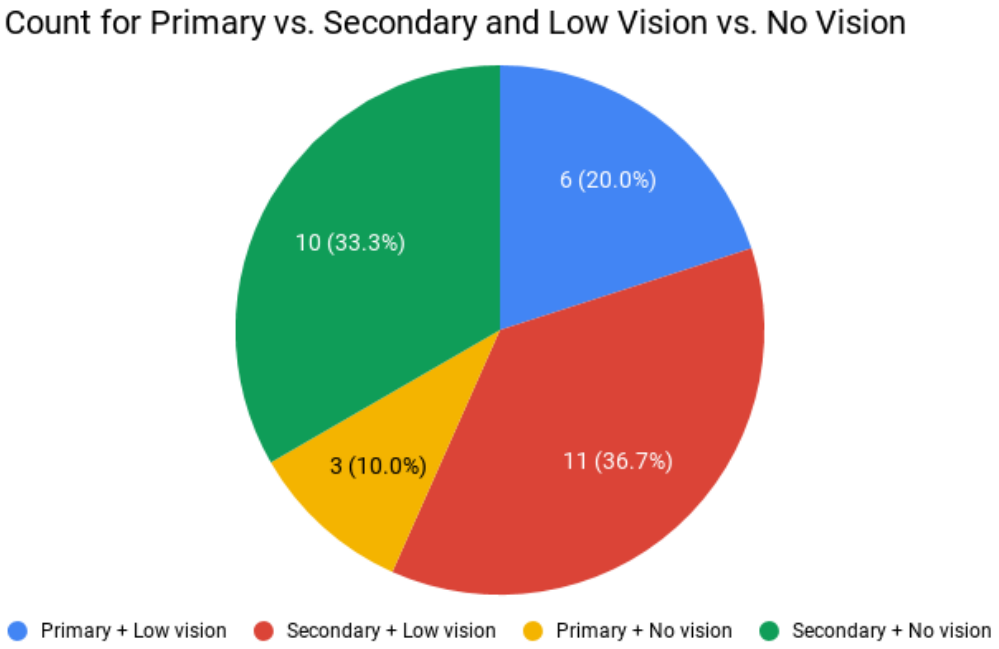

Figure 4.48 Primary vs. Secondary and Low Vision vs. No Vision

Figure 4.48 shows the participants being divided according to whether they are primary school participants or secondary participants who are with low vision or no vision. According to the pie chart above, among the 4 Primary vs. Secondary groups, secondary school participants with

low vision make up the majority (36.7%) while the least numbers were in the primary school participants with no vision group.

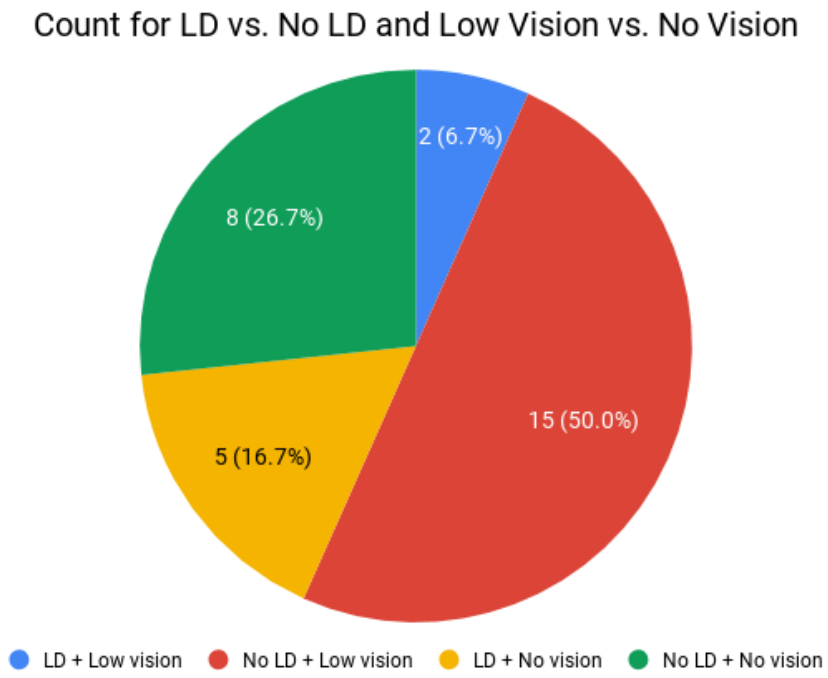

Figure 4.49 LD vs. No LD and Low Vision vs. No Vision

The next figure, Figure 4.49 shows the participants being divided according to whether they have learning difficulties (LD) or not (No LD) and if they have either low vision or no vision. It can be seen that among the 4 LD vs. No LD groups, most participants (50%) fall into the group with no learning difficulties and low vision, while the smallest group is with learning difficulties and low vision at only 6.7%.

4.9.1 Food Finding Success Rate: Primary vs. Secondary and Low Vision vs. No Vision

Figure 4.50 below shows the food finding success rate comparison for primary school vs. secondary school participants with either low vision or no vision. Based on the chart, the group, primary school participants with no vision had scored the lowest overall. On the other hand, secondary school participants with low vision had performed well in comparison across all rooms and was the only group that had managed to locate food across all rooms. However, primary school participants with low vision also had a high average despite not finding food in the most difficult room, the Living Room. The more difficult rooms, namely the Study Room, Kitchen and Living Room, had poor performances across all groups.

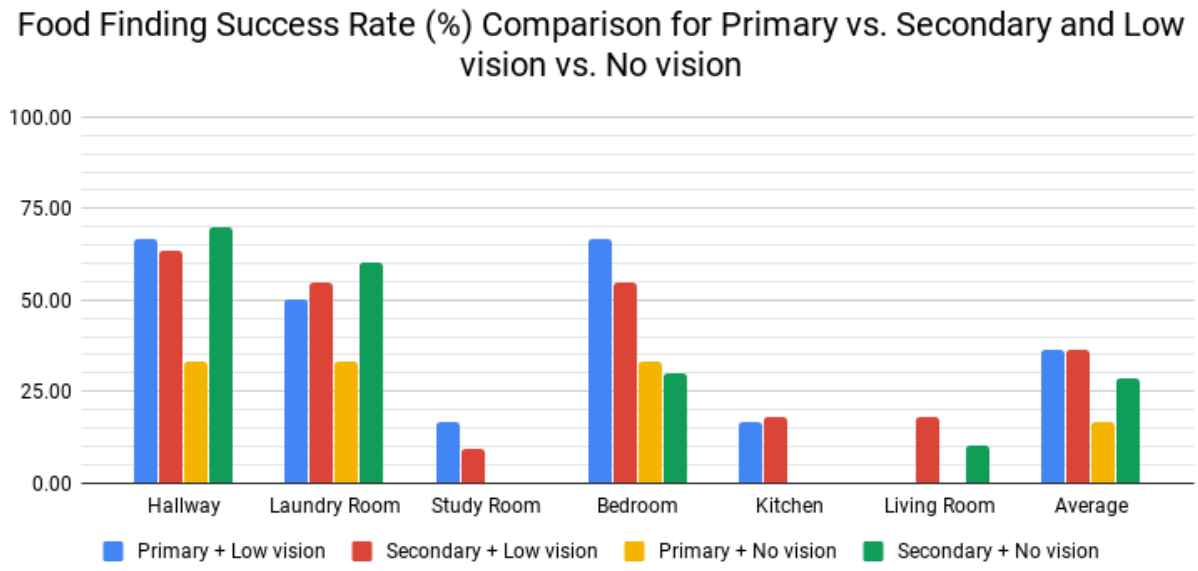

Figure 4.50 Food Finding Success Rate (%) Comparison for Primary vs. Secondary and Low vision vs. No vision

4.9.2 Food Finding Success Rate: LD vs. No LD and Low Vision vs. No Vision

Figure 4.51 shows the food finding success rate comparison for participants with LD versus participants with No LD with either low vision or no vision.

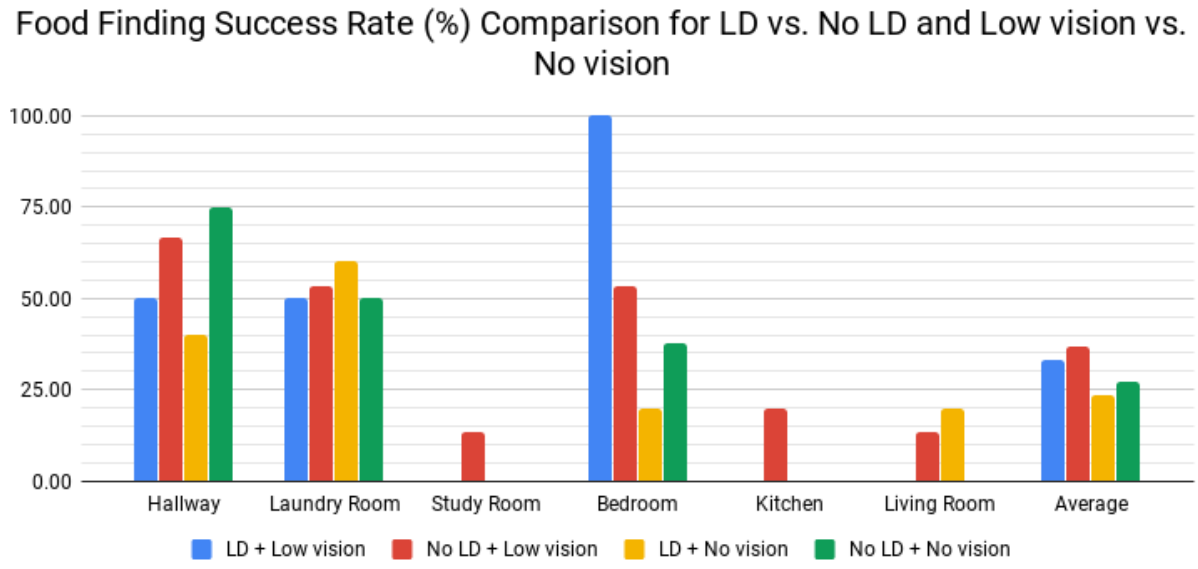

Figure 4.51 Food Finding Success Rate (%) Comparison for LD vs. No LD and Low vision vs. No vision

Based on the chart, the group with no LD and low vision was the only group that had managed to find food for all rooms, and also had the highest average success rate. In comparison, the group with the lowest average were the participants with LD and no vision. Similar to the comparison above with the Primary vs. Secondary participants, participants with low vision, despite having LD or not had performed better overall compared to the no visioned participants. As with the previous comparison, performance for all groups for the more difficult rooms were poor.

4.9.3 Wire Net Test Item Accuracy Score: Primary vs. Secondary and Low Vision vs. No Vision

Figure 4.52 below depicts the average item accuracy (%) in the wire net test for primary school versus secondary school participants with either low vision or no vision.

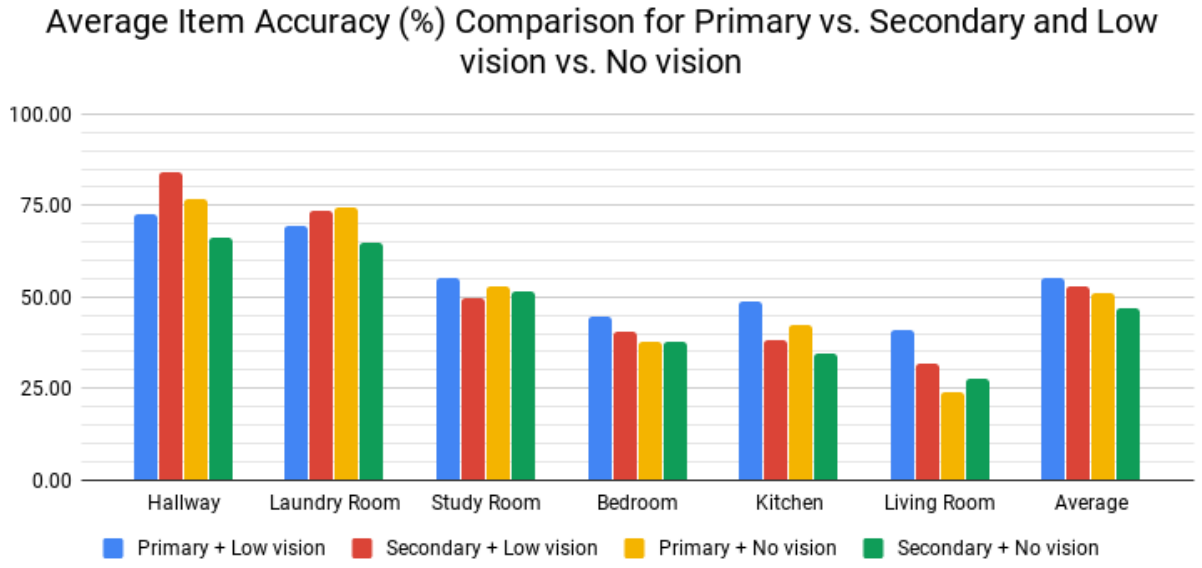

Figure 4.52 Average Item Accuracy (%) Comparison for Primary vs. Secondary and Low vision vs. No vision

Although not by a large difference, primary school students with low vision had the highest average item accuracy when compared to other groups. This is followed by the group of secondary school participants with low vision who had the second highest average among these four groups. As with the comparison for the food finding tests, the groups with low vision had scored higher compared to the no vision groups.

4.9.4 Wire Net Test Item Accuracy Score: LD vs. No LD and Low Vision vs. No Vision

Figure 4.53 shows the average item accuracy (%) in the wire net test comparison for participants with LD versus participants with No LD with either low vision or no vision.

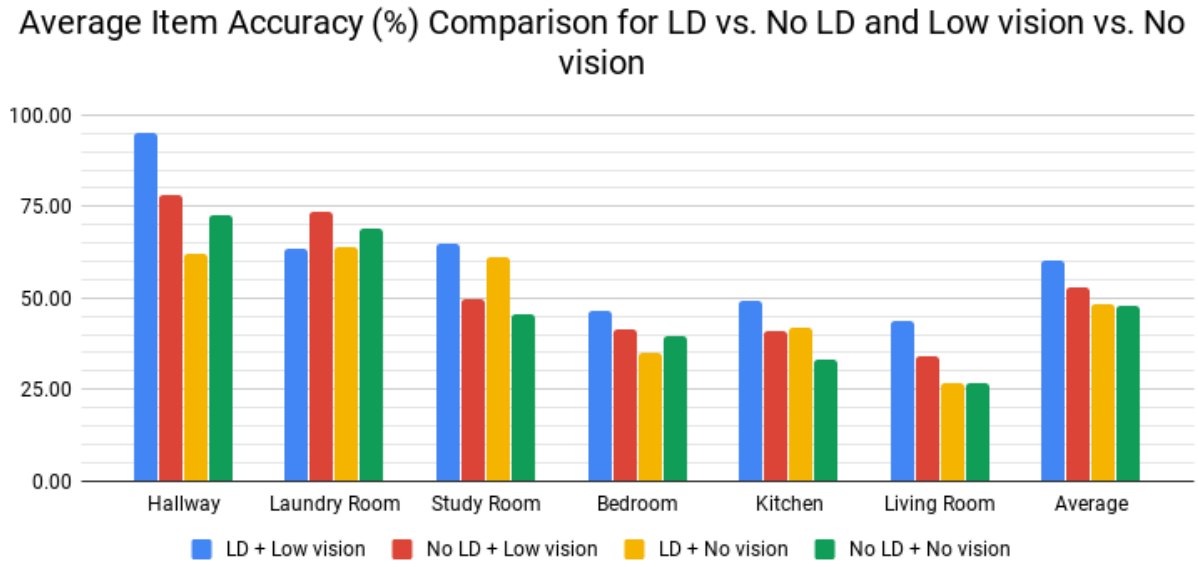

Figure 4.53 Average Item Accuracy (%) Comparison for LD vs. No LD and Low Vision vs. No vision

According to the chart above, the group that had scored the highest were the participants with LD and low vision. However, the sample size for that group is small with only two participants that fit that category, as seen in Figure 4.49. Therefore, it is not possible to conclude if having a learning difficulty would affect spatial navigation abilities or not based on this result.

As with the comparison for the food finding tests, participants with low vision had done better overall compared to their no visioned or blind counterparts for both Primary vs. Secondary and LD vs. No LD groups. Having low vision results in having vision experience, and this has provided an advantage to the low vision group.

However, all groups managed to make spatial mental maps of the 6 rooms despite the increasing difficulties.

4.10 Additional Notes for Food Finding Test and Wire Net Test

Despite the participants being allowed to quit the exploration mode early on, only two of the participants have ever opted to do so. The remainder of the participants have used the exploration time of 5 minutes to the fullest.

There were also instances during the testing where the participants could not participate with their full attention due to being distracted or having a lack of attention span. This resulted in lower performance and results. However, due to the nature of the test of requiring to be performed only once as performing it again will affect the results, the participants did not redo the test and the results were taken as they were.

Results for food finding and wire net tests showed that one group in particular performed consistently better: the low vision participants. This shows that having vision experience does indeed help with one's spatial navigating abilities.

Additionally, although it is speculated that participants with learning difficulties will perform poorly for the tests, they actually performed on par or only slightly lesser than their counterparts with no learning difficulties in this study. Having a learning difficulty is found not affecting spatial navigating abilities. However, the study is unable to fully verify this as there was a limited number of participants with learning difficulties.

Abilities for spatial mapping and spatial navigation varied among the participants. Where one individual from a particular group, for example: having learning difficulties, performed poorly in the tests, another participant who also has learning difficulties was able to perform well in the same task. Despite a general trend found for the average of the group of participants, there were cases where participants within the same group might perform differently from the majority due to their own abilities.

4.11 Discussions

The *Hungry Cat serious* game prototype with six virtual rooms aimed to provide the children who have visual impairment a learning tool to acquire spatial information. As seen from the positive test results of both food finding tests and wire net tests, the game is indeed a suitable mechanism for the participants to learn spatial information mapping via game playing. Even participants who were young or had learning difficulties were able to map out locations of furniture in the rooms

after playing with the games. Although the results for the food finding test and wire net test did decline as the game progressed to more difficult rooms, it was expected due to each room having an equal time limit of 5 minutes for exploration, more time allocations can be designed in future.

Even though there is other software that is able to provide spatial information for the visually impaired, based on the literature reviews from Section 2.6 and Section 2.7, it can be seen that many of the existing research studies have been done with visually impaired adults. Although the *Audio Haptic Maze* was targeted towards visually impaired children, its aim was not to provide spatial information and thus cannot be compared with *Hungry Cat*. The majority of existing games or software created in related studies were also not done on mobile platforms and required complicated setups and hardware to carry out.

This study addressed these issues by providing a mobile game in the form of *Hungry Cat,* which is easy to set up, only requiring a mobile device with the mobile sensors accelerometer and magnetometer. Most importantly, the results of the game playing show that the game based spatial information learning is able to provide spatial information to children in a fun and safe manner. In addition, it is low cost as the user only needs to install and play the app in any Android phone or tablet.

4.12 Summary

The testing was done for *Hungry Cat* to determine if the game prototype would be able to provide spatial information of rooms to visually impaired children. The testing was conducted at a local government boarding school for the blind in an unused classroom after school hours or over the weekends. Ethics clearance and permission of the school were obtained prior to carrying out the tests with the participants.

The participants were 30 children of 7 to 17 years of age with visual impairments. Nine of these children were primary school participants while 21 of them were secondary school participants. In terms of visual impairment, 17 had low vision while the other 13 had no vision. Out of the 30 participants, 7 of them had some learning disabilities while 23 of them did not have any learning disability.

The two tests conducted during testing were the food finding test and the wire net test. Before the testing could begin, the device was set up and the participants were asked to play the Tutorial Room to familiarize themselves with the controls.

The food finding mode of a room was played after the exploration mode of 5 minutes was completed. A participant was deemed to have passed the food finding mode if he/she managed to locate the food within 5 minutes. The wire net test was then carried out after the food finding test to find out the spatial mental map the participant has of the room. The participants were asked to point out the placement and size of the furniture they have discovered in the room. An item accuracy score was calculated for each room from how close the placement and size of the furniture pointed out are.

For the results of the tests, both the food finding and wire net tests were generally positive. Rooms requiring climbing of furniture had a much lower success rate for food finding test than rooms that do not. Participants who were successful had explored the room more during the exploration mode as shown by the higher number of steps taken as well as the higher number of tile checks that they have performed. Participants who passed the food finding test also had higher item accuracy score for the wire net test. Based on the results, *Hungry Cat* has been able to successfully convey spatial information of rooms to visually impaired children.

Chapter 5 Conclusion and Future Works

This chapter concludes the study and elaborates on the contributions of the research, limitations faced during the study as well as future development.

5.1 Contributions to the Research Objectives

As mentioned previously in Section 1.4 in Expected Contributions, the study is expected to yield several results. The most important one is to observe the limitations and drawbacks of existing spatial navigation tools for visually impaired children as well as to develop and test a working game prototype with them. The prototype developed is expected to address the problems discovered in Chapter 2 Literature Review of existing games and studies of tools that convey spatial information such as difficulty setting up and not being targeted for children. The research objectives have been achieved as discussed below:

RO1. *To identify limitations/problems in the existing virtual environment spatial navigation tools for the visually impaired.*

In Chapter 2 Literature Review, several limitations and drawbacks of existing related research have been identified. The first being that most of the research was computer based and required special equipment to be set up. This meant that it was not feasible for general usage due to the difficulty and cost of setting up. The second limitation identified was that the studies were conducted with adult participants. This meant that the studies did not consider visually impaired children when developing their spatial navigation tools and had highly detailed or complex environments. Finally, majority of the navigation tools developed were not in the form of games. This might result in the lack of motivation to participate, as it might not be engaging enough for the participants, especially younger children.

RO2. *To design and develop an enhanced audio and haptic based virtual environment spatial navigation skills learning prototype which is engaging, interactive, portable and able to track the progress of the user.*

The serious game prototype that has been developed for this research is *Hungry Cat*. It was developed for mobile devices, which made it highly portable. Therefore, it is easy to set up and begin the game at any time as long as the mobile device is present, and also helps to save time. As mentioned previously, the game was engaging and interactive enough to keep the participants playing. In terms of being able to track the player's progress, the game was able to produce a text

file with information such as the time taken, number of steps taken, and the number of turns made for the purpose of analysis of how the player plays.

During the tests, although there have been periods of distraction among the participants especially with activities going on outside, the majority of the gameplay has been conducted without distractions. The majority of participants used up the full 5 minutes to explore the room even though they were informed that they can stop playing early anytime they feel ready or are bored. The few times that participants had stopped exploration earlier were because they were already confident about their knowledge of the room and wished to begin the food finding test. This showed that the mobile based serious game really helped to engage the participants enough to obtain spatial information in a fun and interactive manner.

RO3. *To evaluate the performance of the prototype in conveying spatial information to the visually impaired children.*

Using the food finding test as well as the wire net test, the success of the game prototype conveying spatial information has been tested with 30 visually impaired children. The food finding test is a game mode which required the participant to locate a food with general directions given in the same room that they have just explored. On the other hand, the wire net test required the participants to point out the size and placement of items they have located while exploring the room. The results of these tests, especially the wire net test, showed that the game is indeed able to convey spatial information of the fictional rooms explored with the serious game to the visually impaired children.

5.2 Contributions to the Research Questions

To the best of the researcher's knowledge as to date, this is the first study to develop and test a game-based spatial navigation tool for children with visual impairment. For the purpose of elaborating the research contributions of this study, the research questions (RQ) stated in Chapter 1 are answered in this section.

RQ1. *Do spatial mapping skills relate to the prior/existing spatial navigation and vision experience of the visually impaired?*

Based on the results of the tests conducted, it can be seen that participants with low vision performed better overall in comparison to their blind counterparts. This supports the fact that being able to visualize a map of the virtual environment explored during the game in a map like way

rather than the route like way which is normally employed by fully blind people helps the participants with low vision to map the spatial information better. This shows that spatial navigation and vision experience help with spatial mapping skills.

RQ2. *Do spatial mapping skills relate to learning ability of the person especially in a person with visual impairment?*

According to the results obtained, although the average trend showed that a person with learning difficulties performed less well than those without, it was in fact based on the individual's abilities. There were participants who, although they had learning difficulties, performed well on the food finding and wire net tests. An example is the case of Participant 1 who scored 100% on item accuracy in wire net test for the first room (Appendix 10). Another case of participant with learning difficulties is Participant 23 who scored only 25% in the same test. This gives the assumption that spatial mapping skills are not affected by the learning ability of a visually impaired person but by their individual abilities.

However, there were significantly less participants in the learning difficulty group when compared to the group without learning difficulty. Therefore, the results from the tests were not conclusive enough to support that statement, "spatial mapping skills are not affected by one's learning ability".

RQ3. *Do digital based spatial information conveying tools help in creating spatial cognitive maps for the visually impaired?*

Based on the positive test results from the wire net test done with the 30 visually impaired participants, the digital based spatial information conveyed by the serious game has indeed been able to help in the creation of spatial mental maps for the visually impaired.

To conclude, *Hungry Cat* has answered the research questions and met the research objectives set for the study.

5.3 Limitations

Due to the time and resource constraint for the study, the *Hungry Cat* serious game was developed only for the Android platform and was not fully navigable by the visually impaired. Improvements based on the limitations just stated will be elaborated in Section 5.4 Future Works.

There were also limitations and difficulties faced while testing the game. It was difficult to get cooperation from the children and some of them, especially those who are young or with learning difficulties required to be asked multiple times in order to obtain responses. Some participants also lacked attention spans and were easily distracted by activities that were going on outside the classroom. This required the test facilitator to try to get their attention back to the game testing.
The schedule of the testing was also heavily reliant on the availability of the participants. Although it is a boarding school, a large number of participants do not stay at the hostel and might return home after school hours to their family. As each participant required two sessions to finish the game testing, there were times where the researcher had to wait for a participant to be available for a second session of the test. The lack of number of participants that met the test participant requirement also made participant availability a significant factor in the test schedule. This was because even though there were students available at the school for testing, they had either already finished both sessions or were not able to participate mostly due to difficulty in communication or were unable to cooperate.

5.4 Future Works

There are several improvements that can be made for *Hungry Cat*. These improvements are described in this section.

Navigable Completely by the Visually Impaired

In the current version of the game, there are several user interfaces that are not friendly for the visually impaired, meaning that they are dependent on the user being able to read the screen in order to interact with them. Although the gameplay itself which are the tutorial rooms and 6 game play rooms are completely playable without sight, screens such as the main menu, level selection menu and player registration menu still required reading labels on the screen to understand them.

An improvement to this game would be to provide audio feedback in the form of speech for these screens. This will be for easier understanding of the visually impaired and to make the interactions with the user interface easier to use. Pressing a button without knowing the location of it will be difficult for the visually impaired so the interface should use larger buttons or touch areas or even use different gestures such as swiping the screen as a replacement.

Game Setting for Speed of Steps

In the current gameplay, the Cat avatar moves forward at one step per second when the device is tilted forward. This may be too slow or too fast for certain players. Therefore, a game setting to allow the user to choose at what speed the steps should be could be added to improve the game. This will allow for more comfortable gameplay for beginners that may require a slower stepping speed as they get used to the control and for advanced players who wish to move around the game play room more quickly.

A More Challenging Food Finding Mode

The current food finding mode will let the user know in which direction the food is located and how many steps away it is. A more challenging form of food finding mode can be implemented without this detail. Instead of providing the direction and number of steps, the location of the food can be described in relation to an item in the room. For example, by saying “The food is to the right of the laundry machine.” it will require the player to utilize their spatial mental map of the room, which they have gained through exploration mode to know where the food is quickly. This will remove the likelihood that players can locate the food without spatial knowledge of the room if they are good at following directions.

Multiple Food Placement in Food Finding Mode

Currently, whenever players start the food finding mode, the food will always be in a fixed location. Although this is sufficient for testing the game once, it may become boring and too easy for the players to have the goal of the game be at the same place every time they play it.

To remedy this, the food placement in the room can be randomly generated at the beginning of the food finding mode. It may also be good to allow the location of the food in the room to be chosen before beginning the game play for testing the abilities of the players. This will allow the players to challenge the same room again without the problem of prior experience of locating the food affecting their results. They will also be able reuse the spatial map they already have of the room and will not require exploring a new room to be able to have a new challenge in the food finding mode.

More Game Levels with Increased Difficulties

There are 6 rooms altogether in the current version of *Hungry Cat* with the difficulty increasing with each room. An improvement to the game will be to add more stages to the game, especially those with higher difficulties. A step up in difficulty to houses in a room would be more complex environments such as apartments. The next stage can begin with a simple two room apartment and scale up from there. It will also be beneficial to have more stages added that are of lower difficulties to help beginner players to practice with the game and to develop the confidence to tackle the more difficult levels.

Availability on Other Mobile Platforms

Hungry Cat is currently only available for the Android platform due to the time and resource limitation. For the purpose of making it more accessible, it should be developed for other popular mobile platforms such as for iOS.

Adaptation for Real Life Testing

The current version of *Hungry Cat* only has game levels consisting of fictitious rooms. Due to the rooms not being mapped out according to real rooms, there is no chance for testing to be done in the real world. New levels can be added that will be mapped according to real rooms or building floors. With the addition of those levels, it will be possible to perform real life navigation testing with the visually impaired.

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Appendix

Appendix 1 - Ethics Clearance

From: Astrid Nordmann
To: Denny Meyer
Cc: RES Ethics; Lil Deverell
Subject: SHR Project 2016/316 - Ethics clearance
Date: Monday, 20 February 2017 8:12:22 AM
Attachments: image001.png

To: A/Prof. Denny Meyer, FHAD

Dear Denny,

SHR Project 2016/316 – Optimising technology to measure functional vision, mobility and service outcomes for people with low vision or blindness
A/Prof. Denny Meyer *et al* - FHAD
Approved duration: 20-02-2017 to 18-10-2020 [adjusted]

I refer to the ethical review of the above project protocol by Swinburne's Human Research Ethics Committee (SUHREC). Your response to the review, as emailed on 09 February 2016, accords with the Committee review.

I am pleased to advise that, as submitted to date, the project may proceed in line with standard on-going ethics clearance conditions outlined below.

- The approved duration is 20 February 2017 to 18 October 2020 unless an extension request is subsequently approved.

- All human research activity undertaken under Swinburne auspices must conform to Swinburne and external regulatory standards, including the *National Statement on Ethical Conduct in Human Research* and with respect to secure data use, retention and disposal.

- The named Swinburne Chief Investigator/Supervisor remains responsible for any personnel appointed to or associated with the project being made aware of ethics clearance conditions, including research and consent procedures or instruments approved. Any change in chief investigator/supervisor, and addition or removal of other personnel/students from the project, requires timely notification and SUHREC endorsement.

- The above project has been approved as submitted for ethical review by or on behalf of SUHREC. Amendments to approved procedures or instruments ordinarily require prior ethical appraisal/clearance. SUHREC must be notified immediately or as soon as possible thereafter of (a) any serious or unexpected adverse effects on participants and any redress measures; (b) proposed changes in protocols; and (c) unforeseen events which might affect continued ethical acceptability of the project.

- At a minimum, an annual report on the progress of the project is required as well as at the conclusion (or abandonment) of the project. Information on project monitoring and variations/additions, self-audits and progress reports can be found on the Research Ethics Internet pages.

- A duly authorised external or internal audit of the project may be undertaken at any time.

Please contact the Research Ethics Office if you have any queries about on-going ethics clearance, citing the Swinburne project number. A copy of this email should be retained as part of project record-keeping.

Best wishes for the project.

Yours sincerely

Astrid Nordmann
Secretary, SUHREC

Dr Astrid Nordmann | Research Ethics Coordinator
Swinburne Research| Swinburne University of Technology
Ph +61 3 9214 3845| anordmann@swin.edu.au
Level 1, Swinburne Place South
24 Wakefield St, Hawthorn VIC 3122, Australia
www.swinburne.edu.au

Appendix 2 - Letter of Approval from School (Bahasa Melayu and English)

SEKOLAH KEBANGSAAN PENDIDIKAN KHAS KUCHING
JALAN MATANG JAYA,
93050 KUCHING SARAWAK
TEL:082-536794 FAKS: 082 - 536109
KOD SEKOLAH:YBB1205
email: skpkkuching1205@gmail.com

KEMENTERIAN PENDIDIKAN MALAYSIA

Ruj.Kami: JPS(W)/SKPK(perj)/153/08/05/01(11)
Tarikh : 14.7.2017

Prof. Madya Lau Bee Theng
Faculty of Engineering Computing dan Science
Swinburne University of Technology Sarawak
Jalan Simpang Tiga
93350 Kuching.

Tuan,

JEMPUTAN UNTUK MENGAMBIL BAHAGIAN DALAM PENYELIDIKAN
TARIKH : OGOS - OKTOBER 2017 DAN JANUARI - MAR 2018

Dengan segala hormatnya surat tuan bertarikh 3 Julai 2017 adalah dirujuk

2. Sehubungan itu, berkaitan aktiviti penyelidikan yang akan dijalankan oleh pihak tuan bersama pelajar-pelajar pendidikan khas di SK Pendidikan Khas Kuching , pihak sekolah tiada halangan menerima lawatan penyelidikan dari pihak tuan / puan pada tarikh dan masa tersebut.

Sekian, terima kasih.

" BERKHIDMAT UNTUK NEGARA "

Saya yang menurut perintah,

SHARIFAH BINTI MAT JUSOH
Penolong Kanan HEM
b.p.Guru Besar
SK Pendidikan Khas Kuching
Kuching.

Ref. No: JPS (W)/SKPK (perj)/153/08/05/01(11)
Date: 14.07.2017

Associate Professor Lau Bee Theng
Faculty of Engineering, Computing and Science
Swinburne University of Technology Sarawak
Jalan Simpang Tiga
93350, Kuching, Sarawak.

Madam,

RE: INVITATION TO PARTICIPATE IN ORIENTATION AND MOBILITY RELATED RESEARCH (AUG-OCT 2017 and Jan-Mar 2018)

With all due respect, your letter dated 3 July 2017 is referred.

2. In relation to that, the school has approved your research evaluation activity with the boarding students of SK Pendidikan Khas Kuching.

Thank you very much.

"SERVING THE COUNTRY"

Sincerely,

SHARIFAH BINTI MAT JUSOH
Deputy Headmaster (Student Affairs)
pp. Headmaster
SK Pendidikan Khas Kuching
Kuching

Appendix 3 - Parent/Guardian Consent Form (English)

Parent/Guardian Consent Form

"Optimising technology to measure functional vision, mobility and service outcomes for people with low vision or blindness"

Principal Investigator: Prof Denny Meyer; **Project Manager:** Dr Lil Deverell

Introduction

The research investigates the performance of a mobile game in providing spatial information to children with visual impairment. The purpose of this research is to help visually impaired children by providing a means of obtaining spatial information by learning it through a game.

Procedure

The child/ dependent will be invited to complete the following tasks using a tablet in the classroom: (1) Play the game levels which allows exploration of virtual rooms. (2) Inform about what the placement and size of objects that they have found in the virtual rooms. This will take about 45 minutes to one hour for each session, with a total of two sessions. We will analyze the results obtained from to determine the effectiveness of the game.

Participation

The participation is completely voluntary. The child/dependent has the right to choose not to participate in the research or to withdraw from the research any time.

Benefit

Using the mobile game, your child will be able to practice their spatial navigation skills through navigating a virtual room while playing the game. This will allow them to obtain spatial information of the game level rooms. Results from this research may be able to aid other visually impaired children or help other researchers for future research. The results obtained from this mobile game may encourage the usage of mobile games in the special education field as well.

Risk

The research will be conducted only when your child/ dependent is free. These research activities will not interfere with his/her normal school activities. We will cooperate with teachers to make sure your child's learning is not interrupted.

Confidentiality

Participation is totally confidential. You and your child's/dependent's names will not appear on any presentation and publication of this research. No image, audio and video will be recorded throughout the research. If you have any doubts or questions regarding this research, please do not hesitate to contact the researcher: Dr Lau Bee Theng, Tel: 082–260686, Email: blau@swinburne.edu.my.

I have read and understood information provided in the Parent/Guardian Consent Form. We agree to participate in the research on our own will.

Name of Parent/Guardian: _____
Name of Child/Dependent: _____

Signature of Parent/Guardian: _____
Date: _____

Appendix 4 - Parent/Guardian Consent Form (Bahasa Melayu)

Borang Persetujuan Ibubapa/Penjaga

"Mengoptimumkan teknologi untuk mengukur visi berfungsi, mobility dan hasil perkhidmatan untuk orang yang berpenglihatan terhad atau buta"

Penyelidik Utama: Prof Denny Meyer; **Pengurus Projek:** Dr Lil Deverell

Pendahuluan

Kajian ini bertujuan untuk menyiasat keberkesanan penggunaan permainan mudah alih sebagai cara memberi maklumat spatial kepada kanak-kanak yang berpenglihatan terhad. Tujuan utama kajian ini adalah untuk membantu kanak-kanak berpenglihatan terhad dengan memberi cara mendapat maklumat spatial melalui permainan.

Prosedur

Anak/jagaan anda akan diminta untuk menyelesaikan dua aktiviti dengan menggunakan tablet di dalam kelas. Antara tugasan yang akan diberikan adalah (1) Bermain tahap permainan dengan mengexplorasi bilik-bilik maya (2) Maklumkan penempatan dan saiz objek-objek yang dijumpai dalam bilik-bilik maya tersebut. Aktiviti-aktiviti ini akan mengambil masa antara 45 minit sampai 1 jam setiap sesi, untuk dua sesi. Keputusan yang didapati akan dianalisiskan untuk menentukan keberkesanan permainan.

Penyertaan

Penyertaan adalah secara sukarela. Anak/jagaan boleh memilih untuk tidak mengambil bahagian atau menarik diri dari penyelidikan pada bila-bila masa.

Faedah

Dengan mengunakan permainan mudah alih ini, anak/jagaan anda boleh melatihi kemahiran navigasi spatial mereka dengan meneroka bilik maya dalam tahan permainan. Mereka akan mendapati maklumat spatial bilik-bilik maya yang diterokai melalui permainan. Hasil daripada kajian ini mungkin dapat membantu kanak-kanak berpenglihatan terhad lain atau mungkin dapat membantu penyelidik lain untuk penyelidikan selanjutnya. Hasil permainan mudah alih ini juga dapat menggalakkan penggunaan permainan mudah alih dalam pendidikan khas.

Risiko

Kajian ini akan dijalankan hanya pada masa lapang anak/jagaan anda. Aktiviti penyelidikan tidak akan mengganggu aktiviti sekolah. Kami akan bekerjasama dengan guru-guru untuk memastikan proses penyelidikan tidak mengganggu pembelajaran anak/jagaan anda.

Sulit

Penyertaan anak/jagaan anda dalam penyelidikan ini adalah sulit. Identiti/nama anak/jagaan anda tidak akan digunakan bagi tujuan pembentangan dan penerbitan kajian ini. Tiada gambar, audio mahupun video akan diambil sepanjang penyelidikan tersebut. Jika anda mempunyai sebarang keraguan atau pertanyaan mengenai kajian ini, sila hubungi penyelidik: Dr Lau Bee Theng di 082-260686, email: blau@swinburne.edu.my.

Saya telah membaca dan memahami maklumat yang disediakan dalam Borang Persetujuan ini Ibubapa/Penjaga ini. Kami bersetuju untuk mengambil bahagian atas kehendak kami sendiri.

Nama Ibubapa/Penjaga: _____
Nama Anak/Jagaan: _____

Tandatangan Ibubapa/Penjaga: _____
Tarikh: _____

Appendix 5 - Participant Details

Age Group	No.	Student	No Vision/Low Vision	Learning Difficulty
Primary School	1	Participant 1	Low Vision	✓
	2	Participant 2	Low Vision	
	3	Participant 3	Low Vision	
	4	Participant 4	No Vision	
	5	Participant 5	No Vision	
	6	Participant 6	Low Vision	
	7	Participant 7	No Vision	✓
	8	Participant 8	Low Vision	
	9	Participant 9	Low Vision	✓
Secondary School	10	Participant 10	Low Vision	
	11	Participant 11	Low Vision	
	12	Participant 12	Low Vision	
	13	Participant 13	Low Vision	
	14	Participant 14	No Vision	
	15	Participant 15	Low Vision	
	16	Participant 16	Low Vision	
	17	Participant 17	Low Vision	
	18	Participant 18	No Vision	
	19	Participant 19	No Vision	
	20	Participant 20	No Vision	✓
	21	Participant 21	Low Vision	
	22	Participant 22	No Vision	
	23	Participant 23	No Vision	✓
	24	Participant 24	No Vision	
	25	Participant 25	No Vision	✓
	26	Participant 26	No Vision	
	27	Participant 27	Low Vision	
	28	Participant 28	Low Vision	
	29	Participant 29	No Vision	✓
	30	Participant 30	Low Vision	

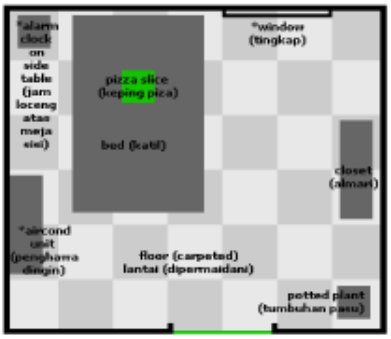
Appendix 6 - Wire Net Test Answer Sheet

Hungry Cat Answer Sheet

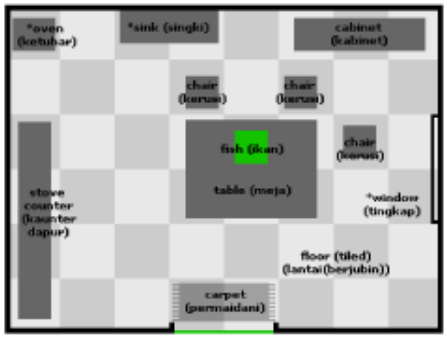
Hallway (Ruang Masuk)

Laundry Room
(Bilik Dobi)

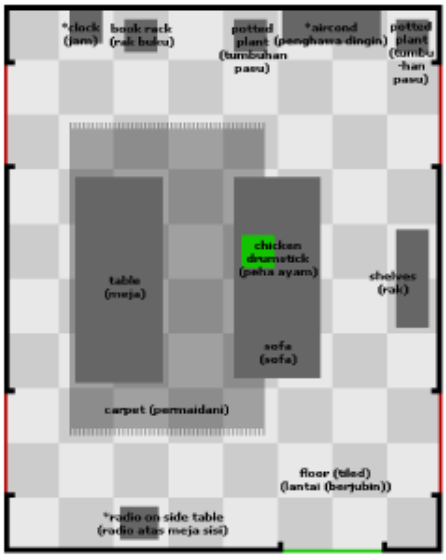
Study Room
(Bilik Kerja)



Bedroom (Bilik Tidur)

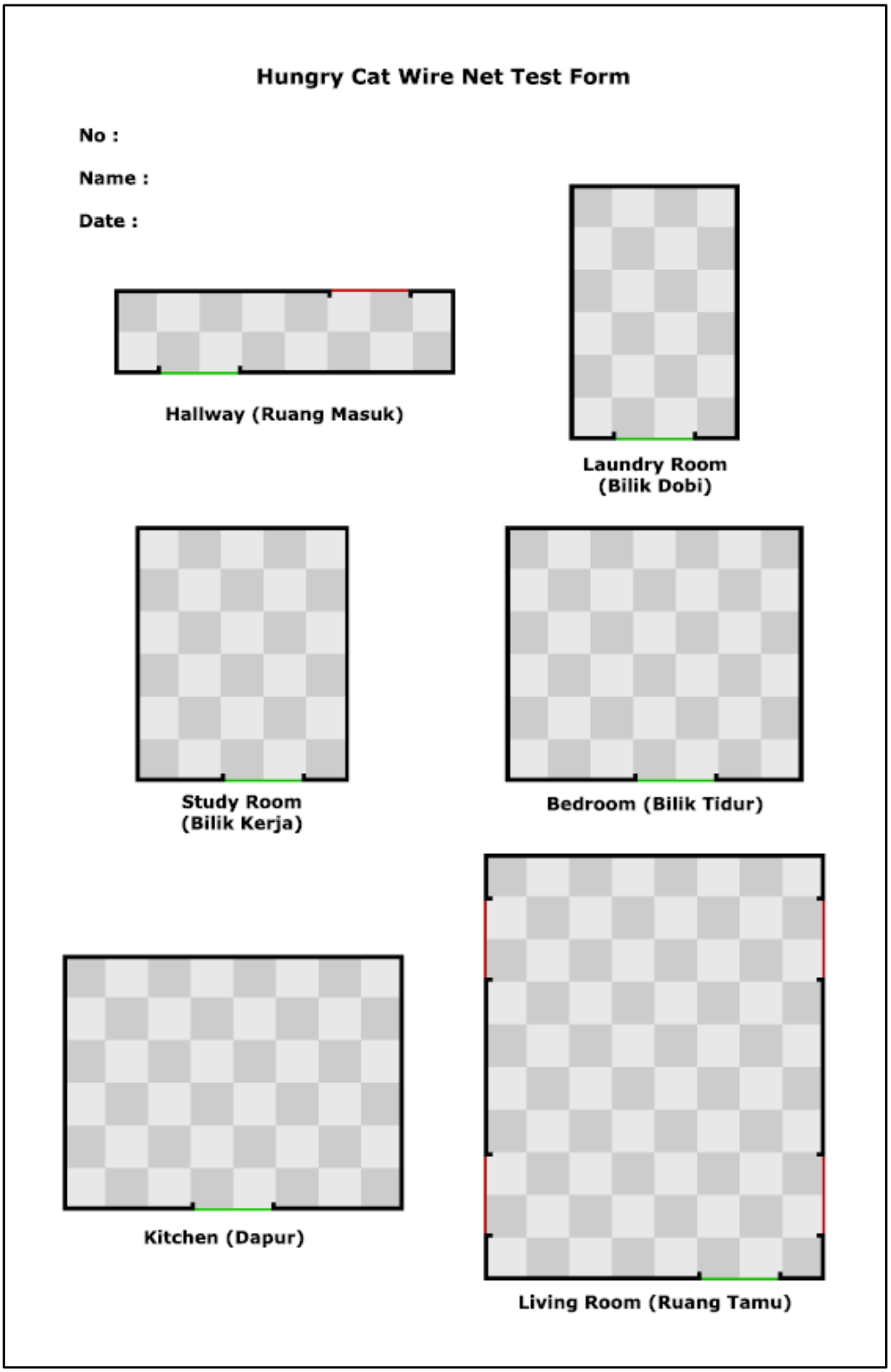


Kitchen (Dapur)

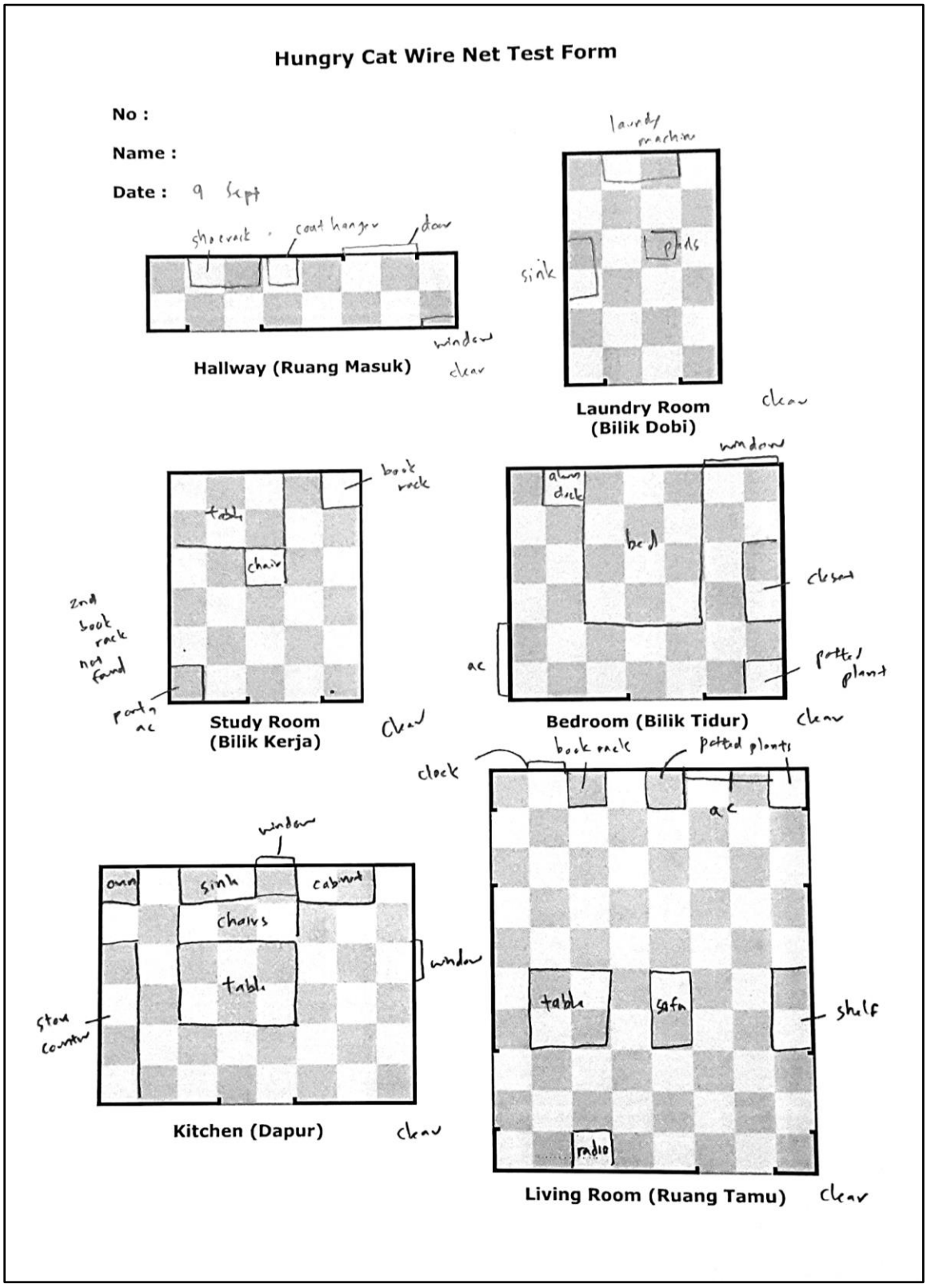


Living Room (Ruang Tamu)

Appendix 7 - Wire Net Test Form (Empty)



Appendix 8 - Photo of Sample Filled Out Wire Net Test Form (Name Removed)



Appendix 9 - Data for Exploration Mode and Food Finding Mode Save Game

Room	Hallway

No.	Student	Exploration								Food Finding										
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed	Diagnosis	Learning Difficulties
1	Participant 1	300	5:00	24	47	5	3	13	0	205	3:25	22	43	0	0	9	0	TRUE	Low Vision	TRUE
2	Participant 2	300	5:00	28	76	0	1	27	0	25	0:25	4	4	0	0	1	0	TRUE	Low Vision	FALSE
3	Participant 3	300	5:00	4	60	15	0	23	0	300	5:00	20	50	25	0	32	0	FALSE	Low Vision	FALSE
4	Participant 4	300	5:00	0	43	13	2	14	0	300	5:00	4	2	12	1	12	0	FALSE	No Vision	FALSE
5	Participant 5	300	5:00	6	9	0	1	12	0	290	4:50	10	16	0	2	14	0	TRUE	No Vision	FALSE
6	Participant 6	300	5:00	5	40	1	4	11	0	125	2:05	8	6	6	2	5	0	TRUE	Low Vision	FALSE
7	Participant 7	300	5:00	7	34	0	0	3	0	300	5:00	12	13	2	1	4	0	FALSE	No Vision	TRUE
8	Participant 8	300	5:00	0	103	0	0	2	0	42	0:42	8	14	0	0	1	0	TRUE	Low Vision	FALSE
9	Participant 9	300	5:00	6	12	2	6	5	0	300	5:00	12	11	0	6	16	0	FALSE	Low Vision	TRUE
10	Participant 10	300	5:00	16	13	5	8	16	0	300	5:00	6	16	6	5	12	0	FALSE	Low Vision	FALSE
11	Participant 11	300	5:00	5	40	1	0	7	0	300	5:00	6	43	0	1	10	0	FALSE	Low Vision	FALSE
12	Participant 12	300	5:00	0	50	7	1	2	0	300	5:00	2	45	7	0	6	0	FALSE	Low Vision	FALSE
13	Participant 13	300	5:00	31	38	32	2	10	0	18	0:18	2	3	1	0	0	0	TRUE	Low Vision	FALSE
14	Participant 14	300	5:00	3	48	0	0	6	0	145	2:25	8	22	1	0	5	0	TRUE	No Vision	FALSE
15	Participant 15	300	5:00	8	34	0	1	23	0	121	2:01	2	16	0	1	5	0	TRUE	Low Vision	FALSE
16	Participant 16	300	5:00	0	60	0	0	0	0	300	5:00	0	43	1	2	0	0	FALSE	Low Vision	FALSE
17	Participant 17	300	5:00	3	22	8	2	7	0	217	3:37	12	7	5	4	2	0	TRUE	Low Vision	FALSE
18	Participant 18	300	5:00	0	22	5	10	1	0	246	4:06	8	25	5	1	2	0	TRUE	No Vision	FALSE
19	Participant 19	300	5:00	4	26	1	0	6	0	279	4:39	8	27	1	1	3	0	TRUE	No Vision	FALSE
20	Participant 20	300	5:00	6	56	11	7	2	0	252	4:12	8	12	14	2	2	0	TRUE	No Vision	TRUE
21	Participant 21	300	5:00	12	39	2	3	9	0	74	1:14	12	11	0	0	5	0	TRUE	Low Vision	FALSE
22	Participant 22	300	5:00	31	53	0	0	38	0	300	5:00	15	80	0	0	29	0	FALSE	No Vision	FALSE
23	Participant 23	300	5:00	6	24	3	4	24	0	300	5:00	6	15	3	8	31	0	FALSE	No Vision	TRUE
24	Participant 24	300	5:00	0	16	3	5	3	0	190	3:10	8	9	0	5	3	0	TRUE	No Vision	FALSE
25	Participant 25	300	5:00	25	25	7	0	17	0	107	1:47	8	11	2	0	5	0	TRUE	No Vision	TRUE
26	Participant 26	300	5:00	14	13	1	0	0	0	12	0:12	2	2	0	0	0	0	TRUE	No Vision	FALSE
27	Participant 27	300	5:00	7	10	20	0	0	0	144	2:24	12	6	18	0	0	0	TRUE	Low Vision	FALSE
28	Participant 28	300	5:00	49	25	1	0	26	0	162	2:42	12	18	0	1	6	0	TRUE	Low Vision	FALSE
29	Participant 29	300	5:00	10	13	1	11	9	0	300	5:00	18	38	3	2	25	0	FALSE	No Vision	TRUE
30	Participant 30	279	4:39	37	23	3	5	17	0	148	2:28	18	15	2	1	3	0	TRUE	Low Vision	FALSE

Room	Hallway

Students	Summary	Exploration								Food Finding								
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed
All Students	Average	299.30	4:59	11.57	35.80	4.90	2.53	11.10	0.00	203.40	3:23	9.10	20.77	3.80	1.53	8.27	0.00	TRUE:FALSE
	Standard Deviation	3.83	0:03	12.82	21.58	7.18	3.18	9.72	0.00	101.71	1:41	5.59	18.07	6.05	2.06	9.42	0.00	19:11
	Minimum	279.00	4:39	0.00	9.00	0.00	0.00	0.00	0.00	12.00	0:12	0.00	2.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	49.00	103.00	32.00	11.00	38.00	0.00	300.00	5:00	22.00	80.00	25.00	8.00	32.00	0.00	63.33
Primary School Students	Average	300.00	5:00	8.89	47.11	4.00	1.89	12.22	0.00	209.67	3:29	11.11	17.67	5.00	1.33	10.44	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	10.07	29.68	5.92	2.09	8.53	0.00	116.46	1:56	6.33	17.10	8.54	1.94	9.76	0.00	5:4
	Minimum	300.00	5:00	0.00	9.00	0.00	0.00	2.00	0.00	25.00	0:25	4.00	2.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	28.00	103.00	15.00	6.00	27.00	0.00	300.00	5:00	22.00	50.00	25.00	6.00	32.00	0.00	55.56
Secondary School Students	Average	299.00	4:59	12.71	30.95	5.29	2.81	10.62	0.00	200.71	3:20	8.24	22.10	3.29	1.62	7.33	0.00	TRUE:FALSE
	Standard Deviation	4.58	0:04	13.90	15.51	7.77	3.56	10.35	0.00	97.72	1:37	5.16	18.71	4.79	2.16	9.36	0.00	14:7
	Minimum	279.00	4:39	0.00	10.00	0.00	0.00	0.00	0.00	12.00	0:12	0.00	2.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	49.00	60.00	32.00	11.00	38.00	0.00	300.00	5:00	18.00	80.00	18.00	8.00	31.00	0.00	66.67
All Students that Found the Food	Average	298.89	4:58	13.79	35.37	5.26	2.32	10.11	0.00	147.47	2:27	9.05	14.05	2.89	1.05	3.74	0.00	
	Standard Deviation	4.82	0:04	14.31	23.59	8.19	2.81	8.58	0.00	87.53	1:27	5.09	10.02	5.04	1.43	3.45	0.00	
	Minimum	279.00	4:39	0.00	9.00	0.00	0.00	0.00	0.00	12.00	0:12	2.00	2.00	0.00	0.00	0.00	0.00	
	Maximum	300.00	5:00	49.00	103.00	32.00	10.00	27.00	0.00	290.00	4:50	22.00	43.00	18.00	5.00	14.00	0.00	
All Students that Did Not Find the Food	Average	300.00	5:00	7.73	36.55	4.27	2.91	12.82	0.00	300.00	5:00	9.18	32.36	5.36	2.36	16.09	0.00	
	Standard Deviation	0.00	0:00	9.07	18.66	5.31	3.86	11.67	0.00	0.00	0:00	6.62	23.07	7.49	2.73	11.40	0.00	
	Minimum	300.00	5:00	0.00	12.00	0.00	0.00	0.00	0.00	300.00	5:00	0.00	2.00	0.00	0.00	0.00	0.00	
	Maximum	300.00	5:00	31.00	60.00	15.00	11.00	38.00	0.00	300.00	5:00	20.00	80.00	25.00	8.00	32.00	0.00	
No Vision Students	Average	300.00	5:00	8.62	29.38	3.46	3.08	10.38	0.00	232.38	3:52	8.85	20.92	3.31	1.77	10.38	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	9.57	15.98	4.37	4.01	10.89	0.00	92.49	1:32	4.24	20.40	4.57	2.31	11.02	0.00	8:5
	Minimum	300.00	5:00	0.00	9.00	0.00	0.00	0.00	0.00	12.00	0:12	2.00	2.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	31.00	56.00	13.00	11.00	38.00	0.00	300.00	5:00	18.00	80.00	14.00	8.00	31.00	0.00	61.54
Low Vision Students	Average	298.76	4:58	13.82	40.71	6.00	2.12	11.65	0.00	181.24	3:01	9.29	20.65	4.18	1.35	6.65	0.00	TRUE:FALSE
	Standard Deviation	5.09	0:05	14.72	24.36	8.73	2.42	9.03	0.00	105.49	1:45	6.56	16.71	7.09	1.90	7.97	0.00	11:6
	Minimum	279.00	4:39	0.00	10.00	0.00	0.00	0.00	0.00	18.00	0:18	0.00	3.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	49.00	103.00	32.00	8.00	27.00	0.00	300.00	5:00	22.00	50.00	25.00	6.00	32.00	0.00	64.71
Students with Learning Difficulties	Average	300.00	5:00	12.00	30.14	4.14	4.43	10.43	0.00	252.00	4:12	12.29	20.43	3.43	2.71	13.14	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	8.66	16.61	3.85	3.95	8.08	0.00	73.54	1:13	5.82	13.85	4.83	3.09	11.25	0.00	3:4
	Minimum	300.00	5:00	6.00	12.00	0.00	0.00	2.00	0.00	107.00	1:47	6.00	11.00	0.00	0.00	2.00	0.00	Found (%)
	Maximum	300.00	5:00	25.00	56.00	11.00	11.00	24.00	0.00	300.00	5:00	22.00	43.00	14.00	8.00	31.00	0.00	42.86
Students without Learning Difficulties	Average	299.09	4:59	11.43	37.52	5.13	1.96	11.30	0.00	188.61	3:08	8.13	20.87	3.91	1.17	6.78	0.00	TRUE:FALSE
	Standard Deviation	4.38	0:04	14.00	22.92	7.98	2.75	10.32	0.00	105.74	1:45	5.26	19.44	6.47	1.56	8.53	0.00	16:7
	Minimum	279.00	4:39	0.00	9.00	0.00	0.00	0.00	0.00	12.00	0:12	0.00	2.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	49.00	103.00	32.00	10.00	38.00	0.00	300.00	5:00	20.00	80.00	25.00	5.00	32.00	0.00	69.57

Room	Laundry Room

No.	Student	Exploration								Food Finding										
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed	Diagnosis	Learning Difficulties
1	Participant 1	300	5:00	42	52	1	2	35	0	300	5:00	20	41	3	2	19	0	FALSE	Low Vision	TRUE
2	Participant 2	300	5:00	32	91	3	1	16	0	140	2:20	9	53	0	1	6	0	TRUE	Low Vision	FALSE
3	Participant 3	300	5:00	37	55	5	1	34	0	300	5:00	13	41	3	3	13	0	FALSE	Low Vision	FALSE
4	Participant 4	300	5:00	6	7	3	2	75	0	300	5:00	10	40	2	7	7	0	FALSE	No Vision	FALSE
5	Participant 5	300	5:00	5	11	1	0	22	0	252	4:12	11	21	0	0	28	0	TRUE	No Vision	FALSE
6	Participant 6	300	5:00	8	82	3	3	3	0	300	5:00	12	25	8	4	6	0	FALSE	Low Vision	FALSE
7	Participant 7	300	5:00	5	13	1	0	31	0	300	5:00	6	23	0	1	1	0	FALSE	No Vision	TRUE
8	Participant 8	300	5:00	9	68	0	0	6	0	287	4:47	5	82	0	0	3	0	TRUE	Low Vision	FALSE
9	Participant 9	300	5:00	12	11	0	6	16	0	128	2:08	5	3	1	2	6	0	TRUE	Low Vision	TRUE
10	Participant 10	300	5:00	12	11	1	6	33	0	300	5:00	18	32	0	0	40	0	FALSE	Low Vision	FALSE
11	Participant 11	300	5:00	6	41	2	0	6	0	174	2:54	5	30	0	0	5	0	TRUE	Low Vision	FALSE
12	Participant 12	300	5:00	10	47	2	0	4	0	300	5:00	8	65	2	0	13	0	FALSE	Low Vision	FALSE
13	Participant 13	300	5:00	18	52	34	0	1	0	33	0:33	5	6	0	0	2	0	TRUE	Low Vision	FALSE
14	Participant 14	300	5:00	10	72	0	0	13	0	244	4:04	43	63	0	0	16	0	TRUE	No Vision	FALSE
15	Participant 15	300	5:00	40	63	1	0	23	0	300	5:00	40	76	5	0	12	0	FALSE	Low Vision	FALSE
16	Participant 16	300	5:00	0	58	0	0	0	0	300	5:00	12	52	0	0	14	0	FALSE	Low Vision	FALSE
17	Participant 17	300	5:00	37	25	4	2	22	0	37	0:37	5	3	0	0	2	0	TRUE	Low Vision	FALSE
18	Participant 18	300	5:00	9	15	6	8	4	0	137	2:17	9	16	0	0	6	0	TRUE	No Vision	FALSE
19	Participant 19	300	5:00	10	25	2	0	4	0	300	5:00	10	23	3	1	4	0	FALSE	No Vision	FALSE
20	Participant 20	300	5:00	18	30	4	4	16	0	261	4:21	5	15	17	9	1	0	TRUE	No Vision	TRUE
21	Participant 21	300	5:00	20	38	2	3	36	0	300	5:00	23	45	3	2	16	0	FALSE	Low Vision	FALSE
22	Participant 22	300	5:00	25	56	1	0	29	0	300	5:00	19	77	2	1	19	0	FALSE	No Vision	FALSE
23	Participant 23	300	5:00	9	26	5	21	4	0	95	1:35	5	9	2	1	3	0	TRUE	No Vision	TRUE
24	Participant 24	300	5:00	6	23	4	5	4	0	300	5:00	9	43	1	6	16	0	FALSE	No Vision	FALSE
25	Participant 25	300	5:00	12	17	10	1	15	0	194	3:14	5	21	4	1	4	0	TRUE	No Vision	TRUE
26	Participant 26	300	5:00	33	26	21	0	11	0	40	0:40	5	5	1	0	2	0	TRUE	No Vision	FALSE
27	Participant 27	300	5:00	19	17	32	1	2	0	286	4:46	13	14	32	2	1	0	TRUE	Low Vision	FALSE
28	Participant 28	300	5:00	22	34	2	2	51	0	136	2:16	21	19	0	1	13	0	TRUE	Low Vision	FALSE
29	Participant 29	300	5:00	12	50	1	4	4	0	300	5:00	10	37	3	1	28	0	FALSE	No Vision	TRUE
30	Participant 30	173	2:53	23	26	0	0	11	0	17	0:17	5	2	0	0	0	0	TRUE	Low Vision	FALSE

Room	Laundry Room

Students	Summary	Exploration								Food Finding								
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed
All Students	Average	295.77	4:55	16.90	38.07	5.03	2.40	17.70	0.00	222.03	3:42	12.20	32.73	3.07	1.50	10.20	0.00	TRUE:FALSE
	Standard Deviation	23.19	0:23	11.80	22.99	8.61	4.15	17.10	0.00	100.15	1:40	9.61	23.41	6.43	2.26	9.59	0.00	16:14
	Minimum	173.00	2:53	0.00	7.00	0.00	0.00	0.00	0.00	17.00	0:17	5.00	2.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	42.00	91.00	34.00	21.00	75.00	0.00	300.00	5:00	43.00	82.00	32.00	9.00	40.00	0.00	53.33
Primary School Students	Average	300.00	5:00	17.33	43.33	1.89	1.67	26.44	0.00	256.33	4:16	10.11	36.56	1.89	2.22	9.89	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	15.12	33.39	1.69	1.94	21.55	0.00	71.15	1:11	4.76	22.56	2.62	2.22	8.67	0.00	4:5
	Minimum	300.00	5:00	5.00	7.00	0.00	0.00	3.00	0.00	128.00	2:08	5.00	3.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	42.00	91.00	5.00	6.00	75.00	0.00	300.00	5:00	20.00	82.00	8.00	7.00	28.00	0.00	44.44
Secondary School Students	Average	293.95	4:53	16.71	35.81	6.38	2.71	13.95	0.00	207.33	3:27	13.10	31.10	3.57	1.19	10.33	0.00	TRUE:FALSE
	Standard Deviation	27.71	0:27	10.50	17.39	10.00	4.81	13.75	0.00	108.46	1:48	11.05	24.11	7.51	2.25	10.16	0.00	12:9
	Minimum	173.00	2:53	0.00	11.00	0.00	0.00	0.00	0.00	17.00	0:17	5.00	2.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	40.00	72.00	34.00	21.00	51.00	0.00	300.00	5:00	43.00	77.00	32.00	9.00	40.00	0.00	57.14
All Students that Found the Food	Average	292.06	4:52	17.13	35.13	7.75	2.88	13.50	0.00	153.81	2:33	9.75	22.63	3.56	1.06	6.13	0.00	
	Standard Deviation	31.75	0:31	10.01	23.79	11.17	5.39	12.02	0.00	93.57	1:33	9.90	23.52	8.69	2.24	7.26	0.00	
	Minimum	173.00	2:53	5.00	11.00	0.00	0.00	1.00	0.00	17.00	0:17	5.00	2.00	0.00	0.00	0.00	0.00	
	Maximum	300.00	5:00	37.00	91.00	34.00	21.00	51.00	0.00	287.00	4:47	43.00	82.00	32.00	9.00	28.00	0.00	
All Students that Did Not Find the Food	Average	300.00	5:00	16.64	41.43	1.93	1.86	22.50	0.00	300.00	5:00	15.00	44.29	2.50	2.00	14.86	0.00	
	Standard Deviation	0.00	0:00	13.95	22.43	1.38	2.07	20.95	0.00	0.00	0:00	8.78	17.73	2.14	2.25	10.03	0.00	
	Minimum	300.00	5:00	0.00	7.00	0.00	0.00	0.00	0.00	300.00	5:00	6.00	23.00	0.00	0.00	1.00	0.00	
	Maximum	300.00	5:00	42.00	82.00	5.00	6.00	75.00	0.00	300.00	5:00	40.00	77.00	8.00	7.00	40.00	0.00	
No Vision Students	Average	300.00	5:00	12.31	28.54	4.54	3.46	17.85	0.00	232.54	3:52	11.31	30.23	2.69	2.15	10.38	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	8.37	19.35	5.65	5.85	19.63	0.00	89.08	1:29	10.27	21.14	4.50	3.05	9.88	0.00	7:6
	Minimum	300.00	5:00	5.00	7.00	0.00	0.00	4.00	0.00	40.00	0:40	5.00	5.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	33.00	72.00	21.00	21.00	75.00	0.00	300.00	5:00	43.00	77.00	17.00	9.00	28.00	0.00	53.85
Low Vision Students	Average	292.53	4:52	20.41	45.35	5.41	1.59	17.59	0.00	214.00	3:34	12.88	34.65	3.35	1.00	10.06	0.00	TRUE:FALSE
	Standard Deviation	30.80	0:30	13.01	23.39	10.49	1.97	15.52	0.00	109.87	1:49	9.33	25.47	7.72	1.27	9.67	0.00	9:8
	Minimum	173.00	2:53	0.00	11.00	0.00	0.00	0.00	0.00	17.00	0:17	5.00	2.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	42.00	91.00	34.00	6.00	51.00	0.00	300.00	5:00	40.00	82.00	32.00	4.00	40.00	0.00	52.94
Students with Learning Difficulties	Average	300.00	5:00	15.71	28.43	3.14	5.43	17.29	0.00	225.43	3:45	8.00	21.29	4.29	2.43	8.86	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	12.23	16.84	3.53	7.16	12.00	0.00	87.02	1:27	5.60	13.92	5.77	2.94	10.48	0.00	4:3
	Minimum	300.00	5:00	5.00	11.00	0.00	0.00	4.00	0.00	95.00	1:35	5.00	3.00	0.00	1.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	42.00	52.00	10.00	21.00	35.00	0.00	300.00	5:00	20.00	41.00	17.00	9.00	28.00	0.00	57.14
Students without Learning Difficulties	Average	294.48	4:54	17.26	41.00	5.61	1.48	17.83	0.00	221.00	3:41	13.48	36.22	2.70	1.22	10.61	0.00	TRUE:FALSE
	Standard Deviation	26.48	0:26	11.92	24.10	9.63	2.21	18.60	0.00	105.60	1:45	10.29	24.80	6.70	2.00	9.51	0.00	12:11
	Minimum	173.00	2:53	0.00	7.00	0.00	0.00	0.00	0.00	17.00	0:17	5.00	2.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	40.00	91.00	34.00	8.00	75.00	0.00	300.00	5:00	43.00	82.00	32.00	7.00	40.00	0.00	52.17

Room	Study Room

No.	Student	Exploration								Food Finding										
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed	Diagnosis	Learning Difficulties
1	Participant 1	300	5:00	5	34	2	4	11	0	300	5:00	33	45	2	1	11	0	FALSE	Low Vision	TRUE
2	Participant 2	300	5:00	46	67	0	0	14	0	300	5:00	47	79	0	0	18	0	FALSE	Low Vision	FALSE
3	Participant 3	300	5:00	11	37	14	9	3	0	300	5:00	0	31	10	6	0	0	FALSE	Low Vision	FALSE
4	Participant 4	300	5:00	4	46	13	1	6	0	300	5:00	1	25	14	9	4	0	FALSE	No Vision	FALSE
5	Participant 5	300	5:00	19	24	0	0	32	0	300	5:00	51	30	0	0	29	0	FALSE	No Vision	FALSE
6	Participant 6	300	5:00	3	43	15	6	1	0	300	5:00	3	94	22	13	3	0	FALSE	Low Vision	FALSE
7	Participant 7	300	5:00	14	14	0	0	15	0	300	5:00	9	10	0	0	3	0	FALSE	No Vision	TRUE
8	Participant 8	300	5:00	21	77	1	0	15	0	260	4:20	10	110	1	0	3	0	TRUE	Low Vision	FALSE
9	Participant 9	300	5:00	31	23	0	3	26	0	300	5:00	25	15	4	4	14	0	FALSE	Low Vision	TRUE
10	Participant 10	300	5:00	52	28	0	1	23	0	300	5:00	67	25	0	0	25	0	FALSE	Low Vision	FALSE
11	Participant 11	300	5:00	60	76	0	0	18	0	300	5:00	56	62	0	1	12	0	FALSE	Low Vision	FALSE
12	Participant 12	300	5:00	8	59	3	2	6	0	300	5:00	8	50	3	1	6	0	FALSE	Low Vision	FALSE
13	Participant 13	300	5:00	36	48	22	0	8	0	124	2:04	20	21	4	0	2	0	TRUE	Low Vision	FALSE
14	Participant 14	300	5:00	39	66	0	0	14	0	300	5:00	12	58	0	0	21	0	FALSE	No Vision	FALSE
15	Participant 15	300	5:00	42	56	0	0	17	0	300	5:00	32	58	2	0	19	0	FALSE	Low Vision	FALSE
16	Participant 16	300	5:00	6	83	6	0	13	0	300	5:00	12	52	4	0	19	0	FALSE	Low Vision	FALSE
17	Participant 17	300	5:00	19	33	3	4	11	0	300	5:00	26	33	3	2	11	0	FALSE	Low Vision	FALSE
18	Participant 18	300	5:00	8	35	1	3	2	0	300	5:00	20	23	1	3	6	0	FALSE	No Vision	FALSE
19	Participant 19	300	5:00	19	16	3	0	7	0	300	5:00	20	16	3	0	7	0	FALSE	No Vision	FALSE
20	Participant 20	300	5:00	11	15	3	6	5	0	300	5:00	21	20	1	2	16	0	FALSE	No Vision	TRUE
21	Participant 21	300	5:00	44	36	3	2	15	0	300	5:00	61	56	2	0	20	0	FALSE	Low Vision	FALSE
22	Participant 22	300	5:00	30	93	1	0	20	0	300	5:00	27	53	0	0	20	0	FALSE	No Vision	FALSE
23	Participant 23	300	5:00	11	52	2	5	5	0	300	5:00	9	51	1	5	8	0	FALSE	No Vision	TRUE
24	Participant 24	300	5:00	31	32	1	5	10	0	300	5:00	8	35	2	0	9	0	FALSE	No Vision	FALSE
25	Participant 25	300	5:00	33	18	8	0	8	0	300	5:00	26	40	7	0	6	0	FALSE	No Vision	TRUE
26	Participant 26	300	5:00	25	46	6	0	7	0	300	5:00	26	59	6	0	8	0	FALSE	No Vision	FALSE
27	Participant 27	300	5:00	6	24	28	1	0	0	300	5:00	15	19	30	0	0	0	FALSE	Low Vision	FALSE
28	Participant 28	300	5:00	76	42	0	1	31	0	300	5:00	44	28	2	3	25	0	FALSE	Low Vision	FALSE
29	Participant 29	300	5:00	12	42	1	0	27	0	300	5:00	12	25	3	2	36	0	FALSE	No Vision	TRUE
30	Participant 30	300	5:00	44	46	2	1	14	0	300	5:00	20	24	7	5	3	0	FALSE	Low Vision	FALSE

Room	Study Room

Students	Summary	Exploration								Food Finding								
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed
All Students	Average	300.00	5:00	25.53	43.70	4.60	1.80	12.80	0.00	292.80	4:52	24.03	41.57	4.47	1.90	12.13	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	18.67	20.99	7.00	2.41	8.62	0.00	32.71	0:32	17.96	23.85	6.76	3.09	9.32	0.00	2:28
	Minimum	300.00	5:00	3.00	14.00	0.00	0.00	0.00	0.00	124.00	2:04	0.00	10.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	76.00	93.00	28.00	9.00	32.00	0.00	300.00	5:00	67.00	110.00	30.00	13.00	36.00	0.00	6.67
Primary School Students	Average	300.00	5:00	17.11	40.56	5.00	2.56	13.67	0.00	295.56	4:55	19.89	48.78	5.89	3.67	9.44	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	14.19	20.63	6.80	3.24	10.20	0.00	13.33	0:13	19.86	36.40	7.82	4.77	9.50	0.00	1:8
	Minimum	300.00	5:00	3.00	14.00	0.00	0.00	1.00	0.00	260.00	4:20	0.00	10.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	46.00	77.00	15.00	9.00	32.00	0.00	300.00	5:00	51.00	110.00	22.00	13.00	29.00	0.00	11.11
Secondary School Students	Average	300.00	5:00	29.14	45.05	4.43	1.48	12.43	0.00	291.62	4:51	25.81	38.48	3.86	1.14	13.29	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	19.47	21.49	7.24	1.97	8.10	0.00	38.41	0:38	17.29	16.16	6.36	1.65	9.23	0.00	1:20
	Minimum	300.00	5:00	6.00	15.00	0.00	0.00	0.00	0.00	124.00	2:04	8.00	16.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	76.00	93.00	28.00	6.00	31.00	0.00	300.00	5:00	67.00	62.00	30.00	5.00	36.00	0.00	4.76
All Students that Found the Food	Average	300.00	5:00	28.50	62.50	11.50	0.00	11.50	0.00	192.00	3:12	15.00	65.50	2.50	0.00	2.50	0.00	
	Standard Deviation	0.00	0:00	10.61	20.51	14.85	0.00	4.95	0.00	96.17	1:36	7.07	62.93	2.12	0.00	0.71	0.00	
	Minimum	300.00	5:00	21.00	48.00	1.00	0.00	8.00	0.00	124.00	2:04	10.00	21.00	1.00	0.00	2.00	0.00	
	Maximum	300.00	5:00	36.00	77.00	22.00	0.00	15.00	0.00	260.00	4:20	20.00	110.00	4.00	0.00	3.00	0.00	
All Students that Did Not Find the Food	Average	300.00	5:00	25.32	42.36	4.11	1.93	12.89	0.00	300.00	5:00	24.68	39.86	4.61	2.04	12.82	0.00	
	Standard Deviation	0.00	0:00	19.22	20.72	6.38	2.45	8.87	0.00	0.00	0:00	18.39	20.46	6.97	3.16	9.27	0.00	
	Minimum	300.00	5:00	3.00	14.00	0.00	0.00	0.00	0.00	300.00	5:00	0.00	10.00	0.00	0.00	0.00	0.00	
	Maximum	300.00	5:00	76.00	93.00	28.00	9.00	32.00	0.00	300.00	5:00	67.00	94.00	30.00	13.00	36.00	0.00	
No Vision Students	Average	300.00	5:00	19.69	38.38	3.00	1.54	12.15	0.00	300.00	5:00	18.62	34.23	2.92	1.62	13.31	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	10.95	23.05	3.85	2.33	9.15	0.00	0.00	0:00	12.69	16.54	4.03	2.72	10.36	0.00	0:13
	Minimum	300.00	5:00	4.00	14.00	0.00	0.00	2.00	0.00	300.00	5:00	1.00	10.00	0.00	0.00	3.00	0.00	Found (%)
	Maximum	300.00	5:00	39.00	93.00	13.00	6.00	32.00	0.00	300.00	5:00	51.00	59.00	14.00	9.00	36.00	0.00	0.00
Low Vision Students	Average	300.00	5:00	30.00	47.76	5.82	2.00	13.29	0.00	287.29	4:47	28.18	47.18	5.65	2.12	11.24	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	22.20	18.95	8.60	2.52	8.43	0.00	43.18	0:43	20.54	27.36	8.19	3.41	8.66	0.00	2:15
	Minimum	300.00	5:00	3.00	23.00	0.00	0.00	0.00	0.00	124.00	2:04	0.00	15.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	76.00	83.00	28.00	9.00	31.00	0.00	300.00	5:00	67.00	110.00	30.00	13.00	25.00	0.00	11.76
Students with Learning Difficulties	Average	300.00	5:00	16.71	28.29	2.29	2.57	13.86	0.00	300.00	5:00	19.29	29.43	2.57	2.00	13.43	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	10.81	14.71	2.75	2.57	9.32	0.00	0.00	0:00	9.43	15.88	2.37	1.91	10.92	0.00	0:7
	Minimum	300.00	5:00	5.00	14.00	0.00	0.00	5.00	0.00	300.00	5:00	9.00	10.00	0.00	0.00	3.00	0.00	Found (%)
	Maximum	300.00	5:00	33.00	52.00	8.00	6.00	27.00	0.00	300.00	5:00	33.00	51.00	7.00	5.00	36.00	0.00	0.00
Students without Learning Difficulties	Average	300.00	5:00	28.22	48.39	5.30	1.57	12.48	0.00	290.61	4:50	25.48	45.26	5.04	1.87	11.74	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	19.88	20.57	7.77	2.37	8.59	0.00	37.26	0:37	19.79	24.89	7.56	3.40	9.01	0.00	2:21
	Minimum	300.00	5:00	3.00	16.00	0.00	0.00	0.00	0.00	124.00	2:04	0.00	16.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	76.00	93.00	28.00	9.00	32.00	0.00	300.00	5:00	67.00	110.00	30.00	13.00	29.00	0.00	8.70

Room	Bedroom

No.	Student	Exploration								Food Finding										
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed	Diagnosis	Learning Difficulties
1	Participant 1	300	5:00	47	63	2	2	36	0	177	2:57	17	27	3	1	10	0	TRUE	Low Vision	TRUE
2	Participant 2	241	4:01	20	31	3	0	15	0	177	2:57	10	204	5	0	8	1	TRUE	Low Vision	FALSE
3	Participant 3	300	5:00	17	29	11	3	12	0	300	5:00	13	33	23	4	10	0	FALSE	Low Vision	FALSE
4	Participant 4	300	5:00	3	18	5	10	18	0	300	5:00	24	55	2	3	17	0	FALSE	No Vision	FALSE
5	Participant 5	300	5:00	61	24	0	0	44	0	166	2:46	29	16	1	0	33	0	TRUE	No Vision	FALSE
6	Participant 6	300	5:00	6	26	3	7	2	2	228	3:48	9	22	12	4	2	1	TRUE	Low Vision	FALSE
7	Participant 7	300	5:00	9	5	1	0	6	0	300	5:00	9	15	1	0	14	0	FALSE	No Vision	TRUE
8	Participant 8	300	5:00	30	55	2	0	15	1	300	5:00	6	60	3	1	12	0	FALSE	Low Vision	FALSE
9	Participant 9	300	5:00	15	16	11	7	15	0	173	2:53	13	18	3	2	21	0	TRUE	Low Vision	TRUE
10	Participant 10	300	5:00	60	43	0	0	54	0	300	5:00	47	36	0	0	44	0	FALSE	Low Vision	FALSE
11	Participant 11	300	5:00	50	53	0	0	27	0	285	4:45	35	47	5	0	18	5	TRUE	Low Vision	FALSE
12	Participant 12	300	5:00	9	30	2	1	0	0	300	5:00	5	20	1	1	2	0	FALSE	Low Vision	FALSE
13	Participant 13	300	5:00	37	54	23	0	12	0	28	0:28	7	4	1	0	1	0	TRUE	Low Vision	FALSE
14	Participant 14	300	5:00	36	57	0	0	35	0	300	5:00	39	52	0	0	30	0	FALSE	No Vision	FALSE
15	Participant 15	300	5:00	54	31	0	0	24	0	131	2:11	22	11	2	0	8	1	TRUE	Low Vision	FALSE
16	Participant 16	300	5:00	17	67	5	0	22	0	300	5:00	13	87	10	0	12	0	FALSE	Low Vision	FALSE
17	Participant 17	300	5:00	49	28	0	1	26	0	252	4:12	48	24	1	0	29	1	TRUE	Low Vision	FALSE
18	Participant 18	300	5:00	8	113	8	1	6	0	300	5:00	12	51	4	2	8	0	FALSE	No Vision	FALSE
19	Participant 19	300	5:00	27	28	0	0	9	0	300	5:00	5	41	13	0	8	0	FALSE	No Vision	FALSE
20	Participant 20	300	5:00	14	61	5	2	17	0	300	5:00	14	42	0	2	16	0	FALSE	No Vision	TRUE
21	Participant 21	300	5:00	21	41	3	1	18	0	300	5:00	30	30	5	1	22	0	FALSE	Low Vision	FALSE
22	Participant 22	300	5:00	34	51	4	1	20	0	235	3:55	13	104	1	0	7	7	TRUE	No Vision	FALSE
23	Participant 23	300	5:00	7	41	1	2	25	0	300	5:00	9	23	5	5	19	0	FALSE	No Vision	TRUE
24	Participant 24	300	5:00	5	31	2	7	1	0	139	2:19	13	5	3	0	18	0	TRUE	No Vision	FALSE
25	Participant 25	263	4:23	20	27	3	0	15	2	50	0:50	10	5	1	0	2	0	TRUE	No Vision	TRUE
26	Participant 26	300	5:00	34	39	19	0	10	1	300	5:00	24	37	7	1	5	0	FALSE	No Vision	FALSE
27	Participant 27	300	5:00	20	11	13	0	0	0	300	5:00	16	18	19	0	1	0	FALSE	Low Vision	FALSE
28	Participant 28	300	5:00	60	43	0	0	45	0	85	1:25	14	9	1	0	6	3	TRUE	Low Vision	FALSE
29	Participant 29	300	5:00	8	8	7	1	32	0	300	5:00	4	10	0	4	8	0	FALSE	No Vision	TRUE
30	Participant 30	300	5:00	54	54	0	1	24	0	37	0:37	5	3	1	0	1	0	TRUE	Low Vision	FALSE

Room	Bedroom

Students	Summary	Exploration								Food Finding								
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed
All Students	Average	296.80	4:56	27.73	39.27	4.43	1.57	19.50	0.20	232.10	3:52	17.17	36.97	4.43	1.03	13.07	0.63	TRUE:FALSE
	Standard Deviation	12.52	0:12	18.98	21.78	5.78	2.64	13.73	0.00	91.79	1:31	12.23	39.60	5.67	1.52	10.59	0.00	14:16
	Minimum	241.00	4:01	3.00	5.00	0.00	0.00	0.00	0.00	28.00	0:28	4.00	3.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	61.00	113.00	23.00	10.00	54.00	2.00	300.00	5:00	48.00	204.00	23.00	5.00	44.00	7.00	46.67
Primary School Students	Average	293.44	4:53	23.11	29.67	4.22	3.22	18.11	0.33	235.67	3:55	14.44	50.00	5.89	1.67	14.11	0.22	TRUE:FALSE
	Standard Deviation	19.67	0:19	19.57	18.48	4.09	3.83	13.52	0.71	63.52	1:03	7.62	60.05	7.24	1.66	8.91	0.44	5:4
	Minimum	241.00	4:01	3.00	5.00	0.00	0.00	2.00	0.00	166.00	2:46	6.00	15.00	1.00	0.00	2.00	0.00	Found (%)
	Maximum	300.00	5:00	61.00	63.00	11.00	10.00	44.00	2.00	300.00	5:00	29.00	204.00	23.00	4.00	33.00	1.00	55.56
Secondary School Students	Average	298.24	4:58	29.71	43.38	4.52	0.86	20.10	0.14	230.57	3:50	18.33	31.38	3.81	0.76	12.62	0.81	TRUE:FALSE
	Standard Deviation	8.07	0:08	18.85	22.18	6.46	1.56	14.10	0.48	102.93	1:42	13.75	26.87	4.93	1.41	11.41	1.89	9:12
	Minimum	263.00	4:23	5.00	8.00	0.00	0.00	0.00	0.00	28.00	0:28	4.00	3.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	60.00	113.00	23.00	7.00	54.00	2.00	300.00	5:00	48.00	104.00	19.00	5.00	44.00	7.00	42.86
All Students that Found the Food	Average	293.14	4:53	36.57	38.00	3.64	1.86	21.86	0.29	154.50	2:34	17.50	35.64	2.86	0.50	11.71	1.36	
	Standard Deviation	17.96	0:17	19.90	14.54	6.30	2.85	13.44	0.73	81.46	1:21	12.13	55.12	3.01	1.16	10.45	2.17	
	Minimum	241.00	4:01	5.00	16.00	0.00	0.00	1.00	0.00	28.00	0:28	5.00	3.00	1.00	0.00	1.00	0.00	
	Maximum	300.00	5:00	61.00	63.00	23.00	7.00	45.00	2.00	285.00	4:45	48.00	204.00	12.00	4.00	33.00	7.00	
All Students that Did Not Find the Food	Average	300.00	5:00	20.00	40.38	5.13	1.31	17.44	0.13	300.00	5:00	16.88	38.13	5.81	1.50	14.25	0.00	
	Standard Deviation	0.00	0:00	14.71	27.03	5.40	2.50	14.07	0.34	0.00	0:00	12.71	19.87	7.06	1.67	10.90	0.00	
	Minimum	300.00	5:00	3.00	5.00	0.00	0.00	0.00	0.00	300.00	5:00	4.00	10.00	0.00	0.00	1.00	0.00	
	Maximum	300.00	5:00	60.00	113.00	19.00	10.00	54.00	1.00	300.00	5:00	47.00	87.00	23.00	5.00	44.00	0.00	
No Vision Students	Average	297.15	4:57	20.46	38.69	4.23	1.85	18.31	0.23	253.08	4:13	15.77	35.08	2.92	1.31	14.23	0.54	TRUE:FALSE
	Standard Deviation	10.26	0:10	17.09	28.20	5.18	3.11	12.73	0.60	82.65	1:22	10.26	27.58	3.71	1.75	9.36	1.94	4:9
	Minimum	263.00	4:23	3.00	5.00	0.00	0.00	1.00	0.00	50.00	0:50	4.00	5.00	0.00	0.00	2.00	0.00	Found (%)
	Maximum	300.00	5:00	61.00	113.00	19.00	10.00	44.00	2.00	300.00	5:00	39.00	104.00	13.00	5.00	33.00	7.00	30.77
Low Vision Students	Average	296.53	4:56	33.29	39.71	4.59	1.35	20.41	0.18	216.06	3:36	18.24	38.41	5.59	0.82	12.18	0.71	TRUE:FALSE
	Standard Deviation	14.31	0:14	18.92	16.20	6.35	2.29	14.76	0.53	97.55	1:37	13.77	47.61	6.68	1.33	11.64	1.36	10:7
	Minimum	241.00	4:01	6.00	11.00	0.00	0.00	0.00	0.00	28.00	0:28	5.00	3.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	60.00	67.00	23.00	7.00	54.00	2.00	300.00	5:00	48.00	204.00	23.00	4.00	44.00	5.00	58.82
Students with Learning Difficulties	Average	294.71	4:54	17.14	31.57	4.29	2.00	20.86	0.29	228.57	3:48	10.86	20.00	1.86	2.00	12.86	0.00	TRUE:FALSE
	Standard Deviation	13.98	0:13	13.95	24.04	3.68	2.38	10.61	0.76	98.36	1:38	4.22	12.22	1.86	1.91	6.64	0.00	3:4
	Minimum	263.00	4:23	7.00	5.00	1.00	0.00	6.00	0.00	50.00	0:50	4.00	5.00	0.00	0.00	2.00	0.00	Found (%)
	Maximum	300.00	5:00	47.00	63.00	11.00	7.00	36.00	2.00	300.00	5:00	17.00	42.00	5.00	5.00	21.00	0.00	42.86
Students without Learning Difficulties	Average	297.43	4:57	30.96	41.61	4.48	1.43	19.09	0.17	233.17	3:53	19.09	42.13	5.22	0.74	13.13	0.83	TRUE:FALSE
	Standard Deviation	12.30	0:12	19.37	21.04	6.35	2.74	14.73	0.49	91.99	1:31	13.26	43.66	6.22	1.29	11.65	1.80	11:12
	Minimum	241.00	4:01	3.00	11.00	0.00	0.00	0.00	0.00	28.00	0:28	5.00	3.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	61.00	113.00	23.00	10.00	54.00	2.00	300.00	5:00	48.00	204.00	23.00	4.00	44.00	7.00	47.83

Room	Kitchen

No.	Student	Exploration								Food Finding										
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed	Diagnosis	Learning Difficulties
1	Participant 1	300	5:00	13	37	6	5	0	0	300	5:00	18	75	0	2	11	0	FALSE	Low Vision	TRUE
2	Participant 2	300	5:00	45	119	2	1	27	0	300	5:00	22	91	23	6	5	0	FALSE	Low Vision	FALSE
3	Participant 3	300	5:00	38	49	3	3	16	0	127	2:07	6	17	6	1	0	3	TRUE	Low Vision	FALSE
4	Participant 4	300	5:00	10	31	4	3	10	0	300	5:00	15	46	2	5	13	0	FALSE	No Vision	FALSE
5	Participant 5	300	5:00	86	29	0	0	52	0	300	5:00	61	25	3	1	30	0	FALSE	No Vision	FALSE
6	Participant 6	300	5:00	5	21	26	15	14	0	300	5:00	8	64	22	11	5	0	FALSE	Low Vision	FALSE
7	Participant 7	300	5:00	7	11	0	0	7	0	300	5:00	9	18	0	0	1	0	FALSE	No Vision	TRUE
8	Participant 8	300	5:00	20	55	0	0	10	0	300	5:00	6	58	0	0	10	0	FALSE	Low Vision	FALSE
9	Participant 9	300	5:00	18	29	13	2	17	0	300	5:00	25	21	12	3	29	0	FALSE	Low Vision	TRUE
10	Participant 10	300	5:00	81	33	0	0	44	0	300	5:00	84	33	0	0	50	0	FALSE	Low Vision	FALSE
11	Participant 11	300	5:00	48	51	0	0	23	0	300	5:00	72	65	1	0	20	0	FALSE	Low Vision	FALSE
12	Participant 12	300	5:00	9	22	6	0	1	0	300	5:00	12	25	0	1	6	0	FALSE	Low Vision	FALSE
13	Participant 13	300	5:00	38	48	16	3	10	0	47	0:47	8	7	1	0	1	0	TRUE	Low Vision	FALSE
14	Participant 14	300	5:00	43	63	0	0	31	0	300	5:00	55	62	0	0	20	0	FALSE	No Vision	FALSE
15	Participant 15	300	5:00	38	16	13	4	12	0	300	5:00	42	37	13	2	17	0	FALSE	Low Vision	FALSE
16	Participant 16	300	5:00	14	69	11	0	9	0	300	5:00	24	66	6	0	17	0	FALSE	Low Vision	FALSE
17	Participant 17	300	5:00	45	28	6	1	25	5	300	5:00	37	20	7	3	11	0	FALSE	Low Vision	FALSE
18	Participant 18	300	5:00	13	43	2	0	5	0	300	5:00	10	19	0	5	0	0	FALSE	No Vision	FALSE
19	Participant 19	300	5:00	18	94	10	0	4	0	300	5:00	69	136	9	0	5	0	FALSE	No Vision	FALSE
20	Participant 20	300	5:00	16	76	1	1	29	0	300	5:00	5	115	1	2	7	0	FALSE	No Vision	TRUE
21	Participant 21	300	5:00	50	28	7	0	20	0	300	5:00	50	28	7	0	20	0	FALSE	Low Vision	FALSE
22	Participant 22	300	5:00	38	97	0	0	20	0	300	5:00	35	122	7	0	16	0	FALSE	No Vision	FALSE
23	Participant 23	300	5:00	11	22	20	11	9	0	300	5:00	5	29	9	9	9	0	FALSE	No Vision	TRUE
24	Participant 24	300	5:00	15	23	15	5	27	0	300	5:00	5	19	8	3	41	0	FALSE	No Vision	FALSE
25	Participant 25	300	5:00	34	17	14	0	14	0	300	5:00	29	23	12	1	7	0	FALSE	No Vision	TRUE
26	Participant 26	300	5:00	27	23	15	0	2	6	300	5:00	19	33	6	2	0	0	FALSE	No Vision	FALSE
27	Participant 27	300	5:00	22	18	25	1	0	0	137	2:17	12	5	14	0	0	0	TRUE	Low Vision	FALSE
28	Participant 28	300	5:00	70	38	3	0	34	0	300	5:00	51	30	7	1	18	0	FALSE	Low Vision	FALSE
29	Participant 29	300	5:00	10	13	15	0	61	0	300	5:00	4	4	15	0	0	0	FALSE	No Vision	TRUE
30	Participant 30	300	5:00	44	59	0	1	13	0	300	5:00	21	26	9	3	0	4	FALSE	Low Vision	FALSE

Room	Kitchen

Students	Summary	Exploration								Food Finding								
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed
All Students	Average	300.00	5:00	30.87	42.07	7.77	1.87	18.20	0.37	280.37	4:40	27.30	43.97	6.67	2.03	12.30	0.23	TRUE:FALSE
	Standard Deviation	0.00	0:00	21.65	27.05	7.83	3.44	15.09	0.00	61.29	1:01	23.11	34.90	6.39	2.76	12.52	0.00	3:27
	Minimum	300.00	5:00	5.00	11.00	0.00	0.00	0.00	0.00	47.00	0:47	4.00	4.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	86.00	119.00	26.00	15.00	61.00	6.00	300.00	5:00	84.00	136.00	23.00	11.00	50.00	4.00	10.00
Primary School Students	Average	300.00	5:00	26.89	42.33	6.00	3.22	17.00	0.00	280.78	4:40	18.89	46.11	7.56	3.22	11.56	0.33	TRUE:FALSE
	Standard Deviation	0.00	0:00	26.04	31.69	8.56	4.74	15.09	0.00	57.67	0:57	17.27	27.44	9.30	3.60	11.07	1.00	1:8
	Minimum	300.00	5:00	5.00	11.00	0.00	0.00	0.00	0.00	127.00	2:07	6.00	17.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	86.00	119.00	26.00	15.00	52.00	0.00	300.00	5:00	61.00	91.00	23.00	11.00	30.00	3.00	11.11
Secondary School Students	Average	300.00	5:00	32.57	41.95	8.52	1.29	18.71	0.52	280.19	4:40	30.90	43.05	6.29	1.52	12.62	0.19	TRUE:FALSE
	Standard Deviation	0.00	0:00	19.96	25.68	7.59	2.65	15.43	1.66	64.16	1:04	24.69	38.23	4.91	2.23	13.34	0.87	2:19
	Minimum	300.00	5:00	9.00	13.00	0.00	0.00	0.00	0.00	47.00	0:47	4.00	4.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	81.00	97.00	25.00	11.00	61.00	6.00	300.00	5:00	84.00	136.00	15.00	9.00	50.00	4.00	9.52
All Students that Found the Food	Average	300.00	5:00	32.67	38.33	14.67	2.33	8.67	0.00	103.67	1:43	8.67	9.67	7.00	0.33	0.33	1.00	
	Standard Deviation	0.00	0:00	9.24	17.62	11.06	1.15	8.08	0.00	49.33	0:49	3.06	6.43	6.56	0.58	0.58	1.73	
	Minimum	300.00	5:00	22.00	18.00	3.00	1.00	0.00	0.00	47.00	0:47	6.00	5.00	1.00	0.00	0.00	0.00	
	Maximum	300.00	5:00	38.00	49.00	25.00	3.00	16.00	0.00	137.00	2:17	12.00	17.00	14.00	1.00	1.00	3.00	
All Students that Did Not Find the Food	Average	300.00	5:00	30.67	42.48	7.00	1.81	19.26	0.41	300.00	5:00	29.37	47.78	6.63	2.22	13.63	0.15	
	Standard Deviation	0.00	0:00	22.72	28.12	7.27	3.62	15.40	1.47	0.00	0:00	23.46	34.70	6.50	2.85	12.51	0.77	
	Minimum	300.00	5:00	5.00	11.00	0.00	0.00	0.00	0.00	300.00	5:00	4.00	4.00	0.00	0.00	0.00	0.00	
	Maximum	300.00	5:00	86.00	119.00	26.00	15.00	61.00	6.00	300.00	5:00	84.00	136.00	23.00	11.00	50.00	4.00	
No Vision Students	Average	300.00	5:00	25.23	41.69	7.38	1.54	20.85	0.46	300.00	5:00	24.69	50.08	5.54	2.15	11.46	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	21.68	30.50	7.54	3.23	18.66	1.66	0.00	0:00	23.28	44.82	4.96	2.73	12.59	0.00	0:13
	Minimum	300.00	5:00	7.00	11.00	0.00	0.00	2.00	0.00	300.00	5:00	4.00	4.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	86.00	97.00	20.00	11.00	61.00	6.00	300.00	5:00	69.00	136.00	15.00	9.00	41.00	0.00	0.00
Low Vision Students	Average	300.00	5:00	35.18	42.35	8.06	2.12	16.18	0.29	265.35	4:25	29.29	39.29	7.53	1.94	12.94	0.41	TRUE:FALSE
	Standard Deviation	0.00	0:00	21.25	25.07	8.26	3.67	11.89	1.21	79.10	1:19	23.48	25.43	7.33	2.86	12.81	1.18	3:14
	Minimum	300.00	5:00	5.00	16.00	0.00	0.00	0.00	0.00	47.00	0:47	6.00	5.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	81.00	119.00	26.00	15.00	44.00	5.00	300.00	5:00	84.00	91.00	23.00	11.00	50.00	4.00	17.65
Students with Learning Difficulties	Average	300.00	5:00	15.57	29.29	9.86	2.71	19.57	0.00	300.00	5:00	13.57	40.71	7.00	2.43	9.14	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	8.92	22.53	7.60	4.07	20.39	0.00	0.00	0:00	10.39	39.58	6.48	3.10	9.63	0.00	0:7
	Minimum	300.00	5:00	7.00	11.00	0.00	0.00	0.00	0.00	300.00	5:00	4.00	4.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	34.00	76.00	20.00	11.00	61.00	0.00	300.00	5:00	29.00	115.00	15.00	9.00	29.00	0.00	0.00
Students without Learning Difficulties	Average	300.00	5:00	35.52	45.96	7.13	1.61	17.78	0.48	274.39	4:34	31.48	44.96	6.57	1.91	13.26	0.30	TRUE:FALSE
	Standard Deviation	0.00	0:00	22.34	27.54	7.95	3.29	13.63	1.59	69.22	1:09	24.42	34.26	6.51	2.71	13.31	1.02	3:20
	Minimum	300.00	5:00	5.00	16.00	0.00	0.00	0.00	0.00	47.00	0:47	5.00	5.00	0.00	0.00	0.00	0.00	Found (%)
	Maximum	300.00	5:00	86.00	119.00	26.00	15.00	52.00	6.00	300.00	5:00	84.00	136.00	23.00	11.00	50.00	4.00	13.04

Room	Living Room

No.	Student	Exploration								Food Finding										
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed	Diagnosis	Learning Difficulties
1	Participant 1	300	5:00	40	34	1	0	9	0	300	5:00	40	30	0	0	17	0	FALSE	Low Vision	TRUE
2	Participant 2	300	5:00	50	41	1	0	25	0	300	5:00	10	14	2	1	3	0	FALSE	Low Vision	FALSE
3	Participant 3	260	4:20	49	46	16	1	17	0	300	5:00	42	50	8	1	7	0	FALSE	Low Vision	FALSE
4	Participant 4	300	5:00	3	34	1	11	11	0	300	5:00	15	45	1	3	13	0	FALSE	No Vision	FALSE
5	Participant 5	300	5:00	104	27	0	0	41	0	300	5:00	10	24	6	0	40	0	FALSE	No Vision	FALSE
6	Participant 6	300	5:00	8	43	31	12	11	0	300	5:00	5	62	23	8	9	0	FALSE	Low Vision	FALSE
7	Participant 7	300	5:00	9	0	0	0	4	0	300	5:00	9	13	0	0	7	0	FALSE	No Vision	TRUE
8	Participant 8	300	5:00	32	63	0	0	18	0	300	5:00	28	111	0	0	9	0	FALSE	Low Vision	FALSE
9	Participant 9	300	5:00	20	17	9	11	9	0	300	5:00	45	29	4	3	30	0	FALSE	Low Vision	TRUE
10	Participant 10	300	5:00	117	26	0	0	41	0	300	5:00	117	28	0	0	43	0	FALSE	Low Vision	FALSE
11	Participant 11	300	5:00	65	72	0	0	20	0	300	5:00	55	50	0	0	23	0	FALSE	Low Vision	FALSE
12	Participant 12	300	5:00	19	42	2	0	5	0	300	5:00	20	26	4	1	1	0	FALSE	Low Vision	FALSE
13	Participant 13	300	5:00	53	41	13	0	12	0	157	2:37	28	20	10	0	2	0	TRUE	Low Vision	FALSE
14	Participant 14	300	5:00	69	62	0	0	29	0	300	5:00	89	81	0	0	29	0	FALSE	No Vision	FALSE
15	Participant 15	300	5:00	53	23	7	3	30	0	300	5:00	66	30	1	1	24	0	FALSE	Low Vision	FALSE
16	Participant 16	300	5:00	24	83	1	0	16	0	300	5:00	25	75	5	0	11	0	FALSE	Low Vision	FALSE
17	Participant 17	300	5:00	72	27	3	1	37	2	300	5:00	56	17	6	3	12	0	FALSE	Low Vision	FALSE
18	Participant 18	300	5:00	41	39	1	2	8	0	300	5:00	22	32	4	3	6	0	FALSE	No Vision	FALSE
19	Participant 19	300	5:00	47	156	18	0	2	0	300	5:00	30	102	5	5	4	0	FALSE	No Vision	FALSE
20	Participant 20	300	5:00	35	62	15	4	26	0	300	5:00	46	67	0	1	19	0	FALSE	No Vision	TRUE
21	Participant 21	300	5:00	64	30	7	2	17	0	300	5:00	54	31	8	0	13	0	FALSE	Low Vision	FALSE
22	Participant 22	300	5:00	62	86	1	0	19	0	300	5:00	17	139	0	0	14	0	FALSE	No Vision	FALSE
23	Participant 23	300	5:00	6	46	12	8	35	0	300	5:00	17	35	3	5	17	0	FALSE	No Vision	TRUE
24	Participant 24	300	5:00	53	29	3	7	16	0	300	5:00	37	22	9	4	8	0	FALSE	No Vision	FALSE
25	Participant 25	300	5:00	48	26	12	0	15	0	139	2:19	18	15	7	0	3	0	TRUE	No Vision	TRUE
26	Participant 26	300	5:00	30	21	26	0	1	0	300	5:00	35	21	21	3	1	0	FALSE	No Vision	FALSE
27	Participant 27	300	5:00	20	13	26	0	0	0	300	5:00	25	10	29	0	1	0	FALSE	Low Vision	FALSE
28	Participant 28	300	5:00	86	38	0	0	36	0	193	3:13	44	27	1	0	23	1	TRUE	Low Vision	FALSE
29	Participant 29	300	5:00	35	15	6	5	26	0	300	5:00	22	33	3	0	22	0	FALSE	No Vision	TRUE
30	Participant 30	300	5:00	56	72	2	1	12	0	300	5:00	64	81	3	0	10	0	FALSE	Low Vision	FALSE

Room	Living Room

Students	Summary	Exploration								Food Finding								
		Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Time Taken (s)	Time Taken (min)	Steps Taken	Turns Made	Tile Checked	Info Checked	Bumps	Penalties	Passed
All Students	Average	298.67	4:58	45.67	43.80	7.13	2.27	18.27	0.07	286.30	4:46	36.37	44.00	5.43	1.40	14.03	0.03	TRUE:FALSE
	Standard Deviation	7.30	0:07	27.55	29.82	8.90	3.74	11.98	0.00	42.42	0:42	24.93	32.21	7.16	2.04	11.20	0.00	3:27
	Minimum	260.00	4:20	3.00	0.00	0.00	0.00	0.00	0.00	139.00	2:19	5.00	10.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	117.00	156.00	31.00	12.00	41.00	2.00	300.00	5:00	117.00	139.00	29.00	8.00	43.00	1.00	10.00
Primary School Students	Average	295.56	4:55	35.00	33.89	6.56	3.89	16.11	0.00	300.00	5:00	22.67	42.00	4.89	1.78	15.00	0.00	TRUE:FALSE
	Standard Deviation	13.33	0:13	31.36	18.06	10.69	5.60	11.20	0.00	0.00	0:00	16.12	30.61	7.37	2.64	12.26	0.00	0:9
	Minimum	260.00	4:20	3.00	0.00	0.00	0.00	4.00	0.00	300.00	5:00	5.00	13.00	0.00	0.00	3.00	0.00	Found (%)
	Maximum	300.00	5:00	104.00	63.00	31.00	12.00	41.00	0.00	300.00	5:00	45.00	111.00	23.00	8.00	40.00	0.00	0.00
Secondary School Students	Average	300.00	5:00	50.24	48.05	7.38	1.57	19.19	0.10	280.43	4:40	42.24	44.86	5.67	1.24	13.62	0.05	TRUE:FALSE
	Standard Deviation	0.00	0:00	25.17	33.10	8.30	2.46	12.45	0.44	49.89	0:49	26.00	33.57	7.24	1.79	11.01	0.22	3:18
	Minimum	300.00	5:00	6.00	13.00	0.00	0.00	0.00	0.00	139.00	2:19	17.00	10.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	117.00	156.00	26.00	8.00	41.00	2.00	300.00	5:00	117.00	139.00	29.00	5.00	43.00	1.00	14.29
All Students that Found the Food	Average	300.00	5:00	62.33	35.00	8.33	0.00	21.00	0.00	163.00	2:43	30.00	20.67	6.00	0.00	9.33	0.33	
	Standard Deviation	0.00	0:00	20.65	7.94	7.23	0.00	13.08	0.00	27.50	0:27	13.11	6.03	4.58	0.00	11.85	0.58	
	Minimum	300.00	5:00	48.00	26.00	0.00	0.00	12.00	0.00	139.00	2:19	18.00	15.00	1.00	0.00	2.00	0.00	
	Maximum	300.00	5:00	86.00	41.00	13.00	0.00	36.00	0.00	193.00	3:13	44.00	27.00	10.00	0.00	23.00	1.00	
All Students that Did Not Find the Food	Average	298.52	4:58	43.81	44.78	7.00	2.52	17.96	0.07	300.00	5:00	37.07	46.59	5.37	1.56	14.56	0.00	
	Standard Deviation	7.70	0:07	27.89	31.25	9.17	3.87	12.08	0.38	0.00	0:00	25.97	32.93	7.45	2.10	11.24	0.00	
	Minimum	260.00	4:20	3.00	0.00	0.00	0.00	0.00	0.00	300.00	5:00	5.00	10.00	0.00	0.00	1.00	0.00	
	Maximum	300.00	5:00	117.00	156.00	31.00	12.00	41.00	2.00	300.00	5:00	117.00	139.00	29.00	8.00	43.00	0.00	
No Vision Students	Average	300.00	5:00	41.69	46.38	7.31	2.85	17.92	0.00	287.62	4:47	28.23	48.38	4.54	1.85	14.08	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	27.84	39.95	8.50	3.80	12.82	0.00	44.65	0:44	21.30	38.30	5.77	2.03	11.32	0.00	1:12
	Minimum	300.00	5:00	3.00	0.00	0.00	0.00	1.00	0.00	139.00	2:19	9.00	13.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	104.00	156.00	26.00	11.00	41.00	0.00	300.00	5:00	89.00	139.00	21.00	5.00	40.00	0.00	7.69
Low Vision Students	Average	297.65	4:57	48.71	41.82	7.00	1.82	18.53	0.12	285.29	4:45	42.59	40.65	6.12	1.06	14.00	0.06	TRUE:FALSE
	Standard Deviation	9.70	0:09	27.77	20.11	9.45	3.75	11.69	0.49	42.00	0:42	26.28	27.43	8.18	2.05	11.46	0.24	2:15
	Minimum	260.00	4:20	8.00	13.00	0.00	0.00	0.00	0.00	157.00	2:37	5.00	10.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	117.00	83.00	31.00	12.00	41.00	2.00	300.00	5:00	117.00	111.00	29.00	8.00	43.00	1.00	11.76
Students with Learning Difficulties	Average	300.00	5:00	27.57	28.57	7.86	4.00	17.71	0.00	277.00	4:37	28.14	31.71	2.43	1.29	16.43	0.00	TRUE:FALSE
	Standard Deviation	0.00	0:00	16.07	20.78	5.76	4.36	11.43	0.00	60.85	1:00	15.14	17.78	2.64	1.98	9.05	0.00	1:6
	Minimum	300.00	5:00	6.00	0.00	0.00	0.00	4.00	0.00	139.00	2:19	9.00	13.00	0.00	0.00	3.00	0.00	Found (%)
	Maximum	300.00	5:00	48.00	62.00	15.00	11.00	35.00	0.00	300.00	5:00	46.00	67.00	7.00	5.00	30.00	0.00	14.29
Students without Learning Difficulties	Average	298.26	4:58	51.17	48.43	6.91	1.74	18.43	0.09	289.13	4:49	38.87	47.74	6.35	1.43	13.30	0.04	TRUE:FALSE
	Standard Deviation	8.34	0:08	28.18	30.95	9.75	3.47	12.39	0.42	36.42	0:36	26.99	34.91	7.87	2.11	11.86	0.21	2:21
	Minimum	260.00	4:20	3.00	13.00	0.00	0.00	0.00	0.00	157.00	2:37	5.00	10.00	0.00	0.00	1.00	0.00	Found (%)
	Maximum	300.00	5:00	117.00	156.00	31.00	12.00	41.00	2.00	300.00	5:00	117.00	139.00	29.00	8.00	43.00	1.00	8.70

Appendix 10 - Data for Wire Net Test Results

Room	Hallway	No. of Items:	2

No.	Student	Item #1 Coat Hanger						Item #2 Shoe Rack						Passed Food Finding	Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)	Diagnosis	Learning Difficulties
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)						
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)							
1	Participant 1	TRUE	0	100	0	100	100	TRUE	0	100	0	100	100	TRUE	100.00	0	100.00	Low Vision	TRUE
2	Participant 2	FALSE	0	0	0	0	0	TRUE	2	60	1	80	70	TRUE	35.00	0	35.00	Low Vision	FALSE
3	Participant 3	TRUE	2	60	0	100	80	TRUE	0	100	1	80	90	FALSE	85.00	0	85.00	Low Vision	FALSE
4	Participant 4	TRUE	0	100	0	100	100	TRUE	0	100	1	80	90	FALSE	95.00	0	95.00	No Vision	FALSE
5	Participant 5	TRUE	5	0	0	100	50	TRUE	4	20	1	80	50	TRUE	50.00	0	50.00	No Vision	FALSE
6	Participant 6	TRUE	3	40	0	100	70	TRUE	0	100	1	80	90	TRUE	80.00	0	80.00	Low Vision	FALSE
7	Participant 7	TRUE	1	80	0	100	90	TRUE	1	80	1	80	80	FALSE	85.00	0	85.00	No Vision	TRUE
8	Participant 8	TRUE	1	80	0	100	90	FALSE	0	100	0	100	0	TRUE	45.00	0	45.00	Low Vision	FALSE
9	Participant 9	TRUE	1	80	0	100	90	TRUE	0	100	1	80	90	FALSE	90.00	0	90.00	Low Vision	TRUE
10	Participant 10	TRUE	3	40	0	100	70	TRUE	0	100	1	80	90	FALSE	80.00	0	80.00	Low Vision	FALSE
11	Participant 11	FALSE	0	0	0	0	0	TRUE	0	100	1	80	90	FALSE	45.00	0	45.00	Low Vision	FALSE
12	Participant 12	TRUE	0	100	0	100	100	TRUE	0	100	1	80	90	FALSE	95.00	0	95.00	Low Vision	FALSE
13	Participant 13	TRUE	0	100	0	100	100	TRUE	0	100	0	100	100	TRUE	100.00	0	100.00	Low Vision	FALSE
14	Participant 14	TRUE	0	100	0	100	100	TRUE	0	100	1	80	90	TRUE	95.00	0	95.00	No Vision	FALSE
15	Participant 15	TRUE	0	100	0	100	100	TRUE	0	100	1	80	90	TRUE	95.00	0	95.00	Low Vision	FALSE
16	Participant 16	TRUE	3	40	0	100	70	TRUE	0	100	1	80	90	FALSE	80.00	0	80.00	Low Vision	FALSE
17	Participant 17	TRUE	0	100	0	100	100	TRUE	0	100	1	80	90	TRUE	95.00	0	95.00	Low Vision	FALSE
18	Participant 18	TRUE	3	40	0	100	70	TRUE	1	80	1	80	80	TRUE	75.00	0	75.00	No Vision	FALSE
19	Participant 19	TRUE	0	100	0	100	100	TRUE	1	80	1	80	80	TRUE	90.00	0	90.00	No Vision	FALSE
20	Participant 20	TRUE	4	20	0	100	60	TRUE	0	100	2	60	80	TRUE	70.00	0	70.00	No Vision	TRUE
21	Participant 21	TRUE	3	40	0	100	70	TRUE	2	60	1	80	70	TRUE	70.00	0	70.00	Low Vision	FALSE
22	Participant 22	TRUE	4	20	0	100	60	TRUE	5	0	1	80	40	FALSE	50.00	0	50.00	No Vision	FALSE
23	Participant 23	FALSE	0	0	0	0	0	TRUE	4	20	1	80	50	FALSE	25.00	0	25.00	No Vision	TRUE
24	Participant 24	FALSE	0	0	0	0	0	TRUE	0	100	1	80	90	TRUE	45.00	0	45.00	No Vision	FALSE
25	Participant 25	FALSE	0	0	0	0	0	TRUE	0	100	1	80	90	TRUE	45.00	0	45.00	No Vision	TRUE
26	Participant 26	TRUE	0	100	0	100	100	TRUE	3	40	1	80	60	TRUE	80.00	0	80.00	No Vision	FALSE
27	Participant 27	TRUE	1	80	0	100	90	TRUE	0	100	1	80	90	TRUE	90.00	0	90.00	Low Vision	FALSE
28	Participant 28	TRUE	3	40	0	100	70	TRUE	0	100	1	80	90	TRUE	80.00	0	80.00	Low Vision	FALSE
29	Participant 29	TRUE	2	60	0	100	80	TRUE	1	80	0	100	90	FALSE	85.00	0	85.00	No Vision	TRUE
30	Participant 30	TRUE	0	100	0	100	100	TRUE	0	100	1	80	90	TRUE	95.00	0	95.00	Low Vision	FALSE

Room	Hallway		No. of Items:	2

Students	Summary	Item #1 Coat Hanger						Item #2 Shoe Rack						Summary		
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)				
All Students	TRUE:FALSE Ratio	25:5	Found (%)		83.33			29:1	Found (%)		96.67			Avg Item Found(%)		90.00
	Average	-	1.30	57.33	0.00	83.33	70.33	-	0.80	84.00	0.90	82.00	79.67	75.00	0.00	75.00
	Standard Deviation	-	1.58	39.21	0.00	37.90	35.18	-	1.42	28.48	0.40	8.05	21.09	21.77	0.00	21.77
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	60.00	0.00	25.00	0.00	25.00
	Maximum	-	5.00	100.00	0.00	100.00	100.00	-	5.00	100.00	2.00	100.00	100.00	100.00	0.00	100.00
Primary School Students	TRUE:FALSE Ratio	8:1	Found (%)		88.89			8:1	Found (%)		88.89			Avg Item Found(%)		88.89
	Average	-	1.44	60.00	0.00	88.89	74.44	-	0.78	84.44	0.78	84.44	73.33	73.89	0.00	73.89
	Standard Deviation	-	1.67	38.73	0.00	33.33	32.06	-	1.39	27.89	0.44	8.82	31.22	23.95	0.00	23.95
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	20.00	0.00	80.00	0.00	35.00	0.00	35.00
	Maximum	-	5.00	100.00	0.00	100.00	100.00	-	4.00	100.00	1.00	100.00	100.00	100.00	0.00	100.00
Secondary School Students	TRUE:FALSE Ratio	17:4	Found (%)		80.95			21:0	Found (%)		100.00			Avg Item Found(%)		90.48
	Average	-	1.24	56.19	0.00	80.95	68.57	-	0.81	83.81	0.95	80.95	82.38	75.48	0.00	75.48
	Standard Deviation	-	1.58	40.31	0.00	40.24	37.05	-	1.47	29.41	0.38	7.68	15.13	21.38	0.00	21.38
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	60.00	40.00	25.00	0.00	25.00
	Maximum	-	4.00	100.00	0.00	100.00	100.00	-	5.00	100.00	2.00	100.00	100.00	100.00	0.00	100.00
All Students that Found the Food	TRUE:FALSE Ratio	16:3	Found (%)		84.21			18:1	Found (%)		94.74			Avg Item Found(%)		89.47
	Average	-	1.21	60.00	0.00	84.21	72.11	-	0.68	86.32	0.89	82.11	78.95	75.53	0.00	75.53
	Standard Deviation	-	1.69	41.63	0.00	37.46	35.84	-	1.20	24.09	0.46	9.18	23.07	21.53	0.00	21.53
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	20.00	0.00	60.00	0.00	35.00	0.00	35.00
	Maximum	-	5.00	100.00	0.00	100.00	100.00	-	4.00	100.00	2.00	100.00	100.00	100.00	0.00	100.00
All Students that Did Not Find the Food	TRUE:FALSE Ratio	9:2	Found (%)		81.82			11:0	Found (%)		100.00			Avg Item Found(%)		90.91
	Average	-	1.45	52.73	0.00	81.82	67.27	-	1.00	80.00	0.91	81.82	80.91	74.09	0.00	74.09
	Standard Deviation	-	1.44	36.08	0.00	40.45	35.52	-	1.79	35.78	0.30	6.03	18.14	23.22	0.00	23.22
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	80.00	40.00	25.00	0.00	25.00
	Maximum	-	4.00	100.00	0.00	100.00	100.00	-	5.00	100.00	1.00	100.00	90.00	95.00	0.00	95.00
No Vision Students	TRUE:FALSE Ratio	10:3	Found (%)		76.92			13:0	Found (%)		100.00			Avg Item Found(%)		88.46
	Average	-	1.46	47.69	0.00	76.92	62.31	-	1.54	69.23	1.00	80.00	74.62	68.46	0.00	68.46
	Standard Deviation	-	1.90	43.62	0.00	43.85	39.40	-	1.81	36.16	0.41	8.16	18.08	22.86	0.00	22.86
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	60.00	40.00	25.00	0.00	25.00
	Maximum	-	5.00	100.00	0.00	100.00	100.00	-	5.00	100.00	2.00	100.00	90.00	95.00	0.00	95.00
Low Vision Students	TRUE:FALSE Ratio	15:2	Found (%)		88.24			16:1	Found (%)		94.12			Avg Item Found(%)		91.18
	Average	-	1.18	64.71	0.00	88.24	76.47	-	0.24	95.29	0.82	83.53	83.53	80.00	0.00	80.00
	Standard Deviation	-	1.33	35.02	0.00	33.21	31.41	-	0.66	13.28	0.39	7.86	22.90	20.16	0.00	20.16
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	60.00	0.00	80.00	0.00	35.00	0.00	35.00
	Maximum	-	3.00	100.00	0.00	100.00	100.00	-	2.00	100.00	1.00	100.00	100.00	100.00	0.00	100.00
Students with Learning Difficulties	TRUE:FALSE Ratio	5:2	Found (%)		71.43			7:0	Found (%)		100.00			Avg Item Found(%)		85.71
	Average	-	1.14	48.57	0.00	71.43	60.00	-	0.86	82.86	0.86	82.86	82.86	71.43	0.00	71.43
	Standard Deviation	-	1.46	41.40	0.00	48.80	42.82	-	1.46	29.28	0.69	13.80	16.04	27.04	0.00	27.04
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	20.00	0.00	60.00	50.00	25.00	0.00	25.00
	Maximum	-	4.00	100.00	0.00	100.00	100.00	-	4.00	100.00	2.00	100.00	100.00	100.00	0.00	100.00
Students without Learning Difficulties	TRUE:FALSE Ratio	20:3	Found (%)		86.96			22:1	Found (%)		95.65			Avg Item Found(%)		91.30
	Average	-	1.35	60.00	0.00	86.96	73.48	-	0.78	84.35	0.91	81.74	78.70	76.09	0.00	76.09
	Standard Deviation	-	1.64	39.08	0.00	34.44	32.98	-	1.44	28.89	0.29	5.76	22.62	20.50	0.00	20.50
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	80.00	0.00	35.00	0.00	35.00
	Maximum	-	5.00	100.00	0.00	100.00	100.00	-	5.00	100.00	1.00	100.00	100.00	100.00	0.00	100.00

Room	Laundry Room		No. of Items:	3

No.	Student		Item #1 Laundry Machine					Item #2 Pails					Item #3 Sink										
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Passed Food Finding	Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)	Diagnosis	Learning Difficulties
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)							
1	Participant 1	TRUE	0	100	0	100	100	TRUE	1	80	0	100	90	TRUE	0	100	0	100	100	FALSE	96.67	0	96.67	Low Vision	TRUE
2	Participant 2	TRUE	3	40	1	80	60	TRUE	3	40	0	100	70	TRUE	2	60	1	80	70	TRUE	66.67	0	66.67	Low Vision	FALSE
3	Participant 3	TRUE	5	0	1	80	40	TRUE	1	80	0	100	90	TRUE	4	20	1	80	50	FALSE	60.00	0	60.00	Low Vision	FALSE
4	Participant 4	TRUE	3	40	1	80	60	TRUE	2	60	0	100	80	TRUE	1	80	2	60	70	FALSE	70.00	0	70.00	No Vision	FALSE
5	Participant 5	TRUE	1	80	0	100	90	TRUE	1	80	0	100	90	TRUE	1	80	0	100	90	TRUE	90.00	0	90.00	No Vision	FALSE
6	Participant 6	TRUE	0	100	0	100	100	TRUE	1	80	0	100	90	TRUE	1	80	1	80	80	FALSE	90.00	0	90.00	Low Vision	FALSE
7	Participant 7	TRUE	5	0	1	80	40	TRUE	4	20	0	100	60	TRUE	0	100	1	80	90	FALSE	63.33	0	63.33	No Vision	TRUE
8	Participant 8	TRUE	4	20	1	80	50	TRUE	2	60	0	100	80	TRUE	0	100	1	80	90	TRUE	73.33	0	73.33	Low Vision	FALSE
9	Participant 9	TRUE	0	100	1	80	90	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	30.00	0	30.00	Low Vision	TRUE
10	Participant 10	TRUE	1	80	0	100	90	TRUE	3	40	0	100	70	TRUE	3	40	1	80	60	FALSE	73.33	0	73.33	Low Vision	FALSE
11	Participant 11	TRUE	4	20	0	100	60	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0	TRUE	46.67	0	46.67	Low Vision	FALSE
12	Participant 12	TRUE	0	100	0	100	100	FALSE	0	0	0	0	0	TRUE	4	20	1	80	50	FALSE	50.00	0	50.00	Low Vision	FALSE
13	Participant 13	TRUE	0	100	0	100	100	TRUE	1	80	0	100	90	TRUE	0	100	0	100	100	TRUE	96.67	0	96.67	Low Vision	FALSE
14	Participant 14	TRUE	1	80	1	80	80	TRUE	3	40	0	100	70	TRUE	0	100	2	60	80	TRUE	76.67	0	76.67	No Vision	FALSE
15	Participant 15	TRUE	3	40	1	80	60	TRUE	0	100	0	100	100	TRUE	0	100	3	40	70	FALSE	76.67	0	76.67	Low Vision	FALSE
16	Participant 16	TRUE	1	80	0	100	90	TRUE	0	100	0	100	100	TRUE	5	0	1	80	40	FALSE	76.67	0	76.67	Low Vision	FALSE
17	Participant 17	TRUE	0	100	1	80	90	TRUE	2	60	0	100	80	TRUE	2	60	1	80	70	TRUE	80.00	0	80.00	Low Vision	FALSE
18	Participant 18	TRUE	1	80	4	20	50	TRUE	1	80	0	100	90	TRUE	3	40	1	80	60	TRUE	66.67	0	66.67	No Vision	FALSE
19	Participant 19	TRUE	1	80	1	80	80	TRUE	3	40	0	100	70	TRUE	3	40	1	80	60	FALSE	70.00	0	70.00	No Vision	FALSE
20	Participant 20	TRUE	5	0	1	80	40	TRUE	5	0	0	100	50	TRUE	3	40	1	80	60	TRUE	50.00	0	50.00	No Vision	TRUE
21	Participant 21	TRUE	0	100	0	100	100	TRUE	3	40	0	100	70	TRUE	3	40	1	80	60	FALSE	76.67	0	76.67	Low Vision	FALSE
22	Participant 22	TRUE	4	20	1	80	50	FALSE	0	0	0	0	0	TRUE	4	20	1	80	50	FALSE	33.33	0	33.33	No Vision	FALSE
23	Participant 23	TRUE	3	40	0	100	70	TRUE	2	60	0	100	80	TRUE	4	20	1	80	50	TRUE	66.67	0	66.67	No Vision	TRUE
24	Participant 24	TRUE	2	60	1	80	70	TRUE	1	80	0	100	90	FALSE	0	0	0	0	0	FALSE	53.33	0	53.33	No Vision	FALSE
25	Participant 25	TRUE	0	100	1	80	90	TRUE	3	40	0	100	70	TRUE	1	80	0	100	90	TRUE	83.33	0	83.33	No Vision	TRUE
26	Participant 26	TRUE	0	100	0	100	100	TRUE	1	80	0	100	90	TRUE	0	100	1	80	90	TRUE	93.33	0	93.33	No Vision	FALSE
27	Participant 27	TRUE	5	0	1	80	40	TRUE	3	40	0	100	70	TRUE	3	40	0	100	70	TRUE	60.00	0	60.00	Low Vision	FALSE
28	Participant 28	TRUE	1	80	2	60	70	TRUE	0	100	0	100	100	TRUE	1	80	1	80	80	TRUE	83.33	0	83.33	Low Vision	FALSE
29	Participant 29	TRUE	1	80	0	100	90	FALSE	1	0	0	0	0	TRUE	2	60	0	100	80	FALSE	56.67	0	56.67	No Vision	TRUE
30	Participant 30	TRUE	0	100	1	80	90	TRUE	1	80	0	100	90	TRUE	0	100	1	80	90	TRUE	90.00	0	90.00	Low Vision	FALSE

Room	Laundry Room		No. of Items:	3

Students	Summary	Item #1 Laundry Machine						Item #2 Pails						Item #3 Sink						Summary		
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)				
All Students	TRUE:FALSE Ratio	30:0	Found (%)		100.00			26:4	Found (%)		86.67			27:3	Found (%)		90.00			Avg Item Found(%)		92.22
	Average	-	1.80	64.00	0.73	85.33	74.67	-	1.67	54.00	0.00	86.67	70.33	-	1.67	56.67	0.83	73.33	65.00	70.00	0.00	70.00
	Standard Deviation	-	1.85	36.92	0.83	16.55	21.45	-	1.32	32.01	0.00	34.57	30.45	-	1.63	36.04	0.70	27.96	27.26	17.46	0.00	17.46
	Minimum	-	0.00	0.00	0.00	20.00	40.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	30.00	0.00	30.00
	Maximum	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	96.67	0.00	96.67
Primary School Students	TRUE:FALSE Ratio	9:0	Found (%)		100.00			8:1	Found (%)		88.89			8:1	Found (%)		88.89			Avg Item Found(%)		92.59
	Average	-	2.33	53.33	0.67	86.67	70.00	-	1.67	55.56	0.00	88.89	72.22	-	1.00	68.89	0.78	73.33	71.11	71.11	0.00	71.11
	Standard Deviation	-	2.12	42.43	0.50	10.00	25.00	-	1.22	29.63	0.00	33.33	29.06	-	1.32	36.21	0.67	30.00	30.60	20.21	0.00	20.21
	Minimum	-	0.00	0.00	0.00	80.00	40.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	30.00	0.00	30.00
	Maximum	-	5.00	100.00	1.00	100.00	100.00	-	4.00	80.00	0.00	100.00	90.00	-	4.00	100.00	2.00	100.00	100.00	96.67	0.00	96.67
Secondary School Students	TRUE:FALSE Ratio	21:0	Found (%)		100.00			18:3	Found (%)		85.71			19:2	Found (%)		90.48			Avg Item Found(%)		92.06
	Average	-	1.57	68.57	0.76	84.76	76.67	-	1.67	53.33	0.00	85.71	69.52	-	1.95	51.43	0.86	73.33	62.38	69.52	0.00	69.52
	Standard Deviation	-	1.72	34.39	0.94	18.87	20.08	-	1.39	33.67	0.00	35.86	31.70	-	1.69	35.54	0.73	27.81	26.06	16.68	0.00	16.68
	Minimum	-	0.00	0.00	0.00	20.00	40.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	33.33	0.00	33.33
	Maximum	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	96.67	0.00	96.67
All Students that Found the Food	TRUE:FALSE Ratio	16:0	Found (%)		100.00			15:1	Found (%)		93.75			14:2	Found (%)		87.50			Avg Item Found(%)		93.75
	Average	-	1.75	65.00	0.94	81.25	73.13	-	1.88	56.25	0.00	93.75	75.00	-	1.25	62.50	0.69	73.75	68.13	72.08	0.00	72.08
	Standard Deviation	-	1.91	38.30	1.00	19.96	20.89	-	1.31	28.49	0.00	25.00	23.38	-	1.39	35.68	0.60	30.74	29.94	18.57	0.00	18.57
	Minimum	-	0.00	0.00	0.00	20.00	40.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	30.00	0.00	30.00
	Maximum	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00	-	4.00	100.00	2.00	100.00	100.00	96.67	0.00	96.67
All Students that Did Not Find the Food	TRUE:FALSE Ratio	14:0	Found (%)		100.00			11:3	Found (%)		78.57			13:1	Found (%)		92.86			Avg Item Found(%)		90.48
	Average	-	1.86	62.86	0.50	90.00	76.43	-	1.43	51.43	0.00	78.57	65.00	-	2.14	50.00	1.00	72.86	61.43	67.62	0.00	67.62
	Standard Deviation	-	1.83	36.67	0.52	10.38	22.74	-	1.34	36.55	0.00	42.58	37.16	-	1.79	36.58	0.78	25.55	24.45	16.46	0.00	16.46
	Minimum	-	0.00	0.00	0.00	80.00	40.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	33.33	0.00	33.33
	Maximum	-	5.00	100.00	1.00	100.00	100.00	-	4.00	100.00	0.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	96.67	0.00	96.67
No Vision Students	TRUE:FALSE Ratio	13:0	Found (%)		100.00			11:2	Found (%)		84.62			12:1	Found (%)		92.31			Avg Item Found(%)		92.31
	Average	-	2.08	58.46	0.92	81.54	70.00	-	2.08	44.62	0.00	84.62	64.62	-	1.69	58.46	0.85	75.38	66.92	67.18	0.00	67.18
	Standard Deviation	-	1.75	35.08	1.04	20.75	20.41	-	1.44	31.78	0.00	37.55	31.26	-	1.55	34.12	0.69	26.02	25.29	16.66	0.00	16.66
	Minimum	-	0.00	0.00	0.00	20.00	40.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	33.33	0.00	33.33
	Maximum	-	5.00	100.00	4.00	100.00	100.00	-	5.00	80.00	0.00	100.00	90.00	-	4.00	100.00	2.00	100.00	90.00	93.33	0.00	93.33
Low Vision Students	TRUE:FALSE Ratio	17:0	Found (%)		100.00			15:2	Found (%)		88.24			15:2	Found (%)		88.24			Avg Item Found(%)		92.16
	Average	-	1.59	68.24	0.59	88.24	78.24	-	1.35	61.18	0.00	88.24	74.71	-	1.65	55.29	0.82	71.76	63.53	72.16	0.00	72.16
	Standard Deviation	-	1.94	38.77	0.62	12.37	22.15	-	1.17	31.20	0.00	33.21	30.02	-	1.73	38.42	0.73	30.05	29.36	18.26	0.00	18.26
	Minimum	-	0.00	0.00	0.00	60.00	40.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	30.00	0.00	30.00
	Maximum	-	5.00	100.00	2.00	100.00	100.00	-	3.00	100.00	0.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	96.67	0.00	96.67
Students with Learning Difficulties	TRUE:FALSE Ratio	7:0	Found (%)		100.00			5:2	Found (%)		71.43			6:1	Found (%)		85.71			Avg Item Found(%)		85.71
	Average	-	2.00	60.00	0.57	88.57	74.29	-	2.29	28.57	0.00	71.43	50.00	-	1.43	57.14	0.43	77.14	67.14	63.81	0.00	63.81
	Standard Deviation	-	2.31	46.19	0.53	10.69	25.07	-	1.80	32.37	0.00	48.80	36.51	-	1.62	39.04	0.53	35.46	34.50	21.81	0.00	21.81
	Minimum	-	0.00	0.00	0.00	80.00	40.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	30.00	0.00	30.00
	Maximum	-	5.00	100.00	1.00	100.00	100.00	-	5.00	80.00	0.00	100.00	90.00	-	4.00	100.00	1.00	100.00	100.00	96.67	0.00	96.67
Students without Learning Difficulties	TRUE:FALSE Ratio	23:0	Found (%)		100.00			21:2	Found (%)		91.30			21:2	Found (%)		91.30			Avg Item Found(%)		94.20
	Average	-	1.74	65.22	0.78	84.35	74.78	-	1.48	61.74	0.00	91.30	76.52	-	1.74	56.52	0.96	72.17	64.35	71.88	0.00	71.88
	Standard Deviation	-	1.74	34.75	0.90	18.05	20.86	-	1.12	28.23	0.00	28.81	26.22	-	1.66	36.01	0.71	26.10	25.55	16.01	0.00	16.01
	Minimum	-	0.00	0.00	0.00	20.00	40.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	33.33	0.00	33.33
	Maximum	-	5.00	100.00	4.00	100.00	100.00	-	3.00	100.00	0.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	96.67	0.00	96.67

Room	Study Room		No. of Items:	5

No.	Student	Item #1 Bookrack 1						Item #2 Bookrack 2						Item #3 Chair					
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)	
1	Participant 1	TRUE	0	100	0	100	100	FALSE	0	0	0	0	0	TRUE	0	100	0	100	100
2	Participant 2	TRUE	2	60	0	100	80	TRUE	3	40	0	100	70	FALSE	0	0	0	0	0
3	Participant 3	TRUE	4	20	0	100	60	TRUE	5	0	0	100	50	TRUE	1	80	0	100	90
4	Participant 4	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0	TRUE	3	40	0	100	70
5	Participant 5	TRUE	3	40	0	100	70	FALSE	0	0	0	0	0	TRUE	4	20	0	100	60
6	Participant 6	TRUE	3	40	0	100	70	TRUE	5	0	0	100	50	TRUE	4	20	0	100	60
7	Participant 7	TRUE	4	20	0	100	60	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0
8	Participant 8	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0	TRUE	1	80	0	100	90
9	Participant 9	TRUE	2	60	0	100	80	TRUE	5	0	0	100	50	TRUE	2	60	0	100	80
10	Participant 10	TRUE	0	100	0	100	100	FALSE	0	0	0	0	0	TRUE	1	80	0	100	90
11	Participant 11	TRUE	1	80	0	100	90	FALSE	0	0	0	0	0	TRUE	2	60	0	100	80
12	Participant 12	TRUE	2	60	0	100	80	TRUE	2	60	0	100	80	TRUE	0	100	0	100	100
13	Participant 13	TRUE	0	100	0	100	100	FALSE	0	0	0	0	0	TRUE	0	100	0	100	100
14	Participant 14	TRUE	2	60	0	100	80	TRUE	5	0	0	100	50	TRUE	3	40	0	100	70
15	Participant 15	TRUE	2	60	0	100	80	TRUE	5	0	0	100	50	TRUE	3	40	0	100	70
16	Participant 16	TRUE	5	0	0	100	50	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0
17	Participant 17	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
18	Participant 18	TRUE	4	20	0	100	60	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
19	Participant 19	TRUE	3	40	0	100	70	TRUE	2	60	0	100	80	TRUE	5	0	0	100	50
20	Participant 20	TRUE	3	40	0	100	70	TRUE	4	20	0	100	60	TRUE	3	40	0	100	70
21	Participant 21	TRUE	1	80	0	100	90	TRUE	1	80	0	100	90	FALSE	0	0	0	0	0
22	Participant 22	TRUE	1	80	0	100	90	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
23	Participant 23	TRUE	1	80	0	100	90	FALSE	0	0	0	0	0	TRUE	3	40	0	100	70
24	Participant 24	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0
25	Participant 25	TRUE	2	60	0	100	80	TRUE	5	0	0	100	50	TRUE	0	100	0	100	100
26	Participant 26	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
27	Participant 27	TRUE	2	60	0	100	80	TRUE	4	20	0	100	60	TRUE	3	40	0	100	70
28	Participant 28	TRUE	1	80	0	100	90	TRUE	3	40	0	100	70	TRUE	1	80	0	100	90
29	Participant 29	TRUE	4	20	0	100	60	TRUE	4	20	0	100	60	TRUE	1	80	0	100	90
30	Participant 30	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	0	100	0	100	100

Item #4 Portable Air Conditioner						Item #5 Table											
Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Passed Food Finding	Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)	Diagnosis	Learning Difficulties
	Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)							
TRUE	0	100	0	100	100	TRUE	0	100	5	0	50	FALSE	70.00	0	70.00	Low Vision	TRUE
TRUE	5	0	0	100	50	TRUE	2	60	5	0	30	FALSE	46.00	0	46.00	Low Vision	FALSE
TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	FALSE	50.00	0	50.00	Low Vision	FALSE
TRUE	3	40	0	100	70	TRUE	0	100	2	60	80	FALSE	60.00	0	60.00	No Vision	FALSE
TRUE	4	20	0	100	60	TRUE	3	40	2	60	50	FALSE	48.00	0	48.00	No Vision	FALSE
TRUE	0	100	0	100	100	TRUE	2	60	5	0	30	FALSE	62.00	0	62.00	Low Vision	FALSE
TRUE	1	80	0	100	90	TRUE	1	80	4	20	50	FALSE	50.00	0	50.00	No Vision	TRUE
FALSE	0	0	0	0	0	TRUE	4	20	2	60	40	TRUE	42.00	0	42.00	Low Vision	FALSE
TRUE	4	20	0	100	60	TRUE	2	60	5	0	30	FALSE	60.00	0	60.00	Low Vision	TRUE
TRUE	5	0	0	100	50	TRUE	1	80	5	0	40	FALSE	56.00	0	56.00	Low Vision	FALSE
TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	FALSE	44.00	0	44.00	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	1	80	4	20	50	FALSE	62.00	0	62.00	Low Vision	FALSE
TRUE	0	100	0	100	100	TRUE	0	100	2	60	80	TRUE	76.00	0	76.00	Low Vision	FALSE
TRUE	5	0	0	100	50	TRUE	3	40	3	40	40	FALSE	58.00	0	58.00	No Vision	FALSE
TRUE	5	0	0	100	50	TRUE	1	80	4	20	50	FALSE	60.00	0	60.00	Low Vision	FALSE
TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	FALSE	36.00	1	16.00	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	4	20	5	0	10	FALSE	18.00	0	18.00	Low Vision	FALSE
TRUE	2	60	0	100	80	TRUE	2	60	5	0	30	FALSE	34.00	0	34.00	No Vision	FALSE
TRUE	5	0	0	100	50	TRUE	4	20	5	0	10	FALSE	52.00	0	52.00	No Vision	FALSE
TRUE	3	40	0	100	70	TRUE	2	60	3	40	50	FALSE	64.00	0	64.00	No Vision	TRUE
TRUE	2	60	0	100	80	TRUE	4	20	5	0	10	FALSE	54.00	0	54.00	Low Vision	FALSE
TRUE	5	0	0	100	50	TRUE	2	60	5	0	30	FALSE	34.00	0	34.00	No Vision	FALSE
TRUE	0	100	0	100	100	TRUE	3	40	5	0	20	FALSE	56.00	0	56.00	No Vision	TRUE
TRUE	2	60	0	100	80	TRUE	2	60	4	20	40	FALSE	44.00	0	44.00	No Vision	FALSE
TRUE	5	0	0	100	50	TRUE	0	100	5	0	50	FALSE	66.00	0	66.00	No Vision	TRUE
TRUE	0	100	0	100	100	TRUE	0	100	2	60	80	FALSE	36.00	0	36.00	No Vision	FALSE
TRUE	5	0	0	100	50	TRUE	4	20	5	0	10	FALSE	54.00	0	54.00	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	0	100	5	0	50	FALSE	60.00	0	60.00	Low Vision	FALSE
TRUE	2	60	0	100	80	TRUE	1	80	3	40	60	FALSE	70.00	0	70.00	No Vision	TRUE
TRUE	0	100	1	80	90	TRUE	0	100	5	0	50	FALSE	48.00	0	48.00	Low Vision	FALSE

Room	Study Room		No. of Items:	5

Students	Summary	Item #1 Bookrack 1						Item #2 Bookrack 2						Item #3 Chair					
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)	
All Students	TRUE:FALSE Ratio	28:2	Found (%)		93.33			17:13	Found (%)		56.67			21:9	Found (%)		70.00		
	Average	-	2.10	51.33	0.00	93.33	72.33	-	2.17	13.33	0.00	56.67	35.00	-	1.33	43.33	0.00	70.00	56.67
	Standard Deviation	-	1.47	30.48	0.00	25.37	23.88	-	2.18	23.68	0.00	50.40	32.77	-	1.56	38.63	0.00	46.61	39.86
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	0.00	100.00	100.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	100.00	0.00	100.00	100.00
Primary School Students	TRUE:FALSE Ratio	9:0	Found (%)		100.00			5:4	Found (%)		55.56			7:2	Found (%)		77.78		
	Average	-	2.44	51.11	0.00	100.00	75.56	-	2.56	4.44	0.00	55.56	30.00	-	1.67	44.44	0.00	77.78	61.11
	Standard Deviation	-	1.24	24.72	0.00	0.00	12.36	-	2.51	13.33	0.00	52.70	29.15	-	1.66	37.12	0.00	44.10	37.23
	Minimum	-	0.00	20.00	0.00	100.00	60.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	4.00	100.00	0.00	100.00	100.00	-	5.00	40.00	0.00	100.00	70.00	-	4.00	100.00	0.00	100.00	100.00
Secondary School Students	TRUE:FALSE Ratio	19:2	Found (%)		90.48			12:9	Found (%)		57.14			14:7	Found (%)		66.67		
	Average	-	1.95	51.43	0.00	90.48	70.95	-	2.00	17.14	0.00	57.14	37.14	-	1.19	42.86	0.00	66.67	54.76
	Standard Deviation	-	1.56	33.21	0.00	30.08	27.55	-	2.07	26.30	0.00	50.71	34.66	-	1.54	40.14	0.00	48.30	41.67
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	0.00	100.00	100.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	100.00	0.00	100.00	100.00
All Students that Found the Food	TRUE:FALSE Ratio	2:0	Found (%)		100.00			0:2	Found (%)		0.00			2:0	Found (%)		100.00		
	Average	-	1.00	80.00	0.00	100.00	90.00	-	0.00	0.00	0.00	0.00	0.00	-	0.50	90.00	0.00	100.00	95.00
	Standard Deviation	-	1.41	28.28	0.00	0.00	14.14	-	0.00	0.00	0.00	0.00	0.00	-	0.71	14.14	0.00	0.00	7.07
	Minimum	-	0.00	60.00	0.00	100.00	80.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	80.00	0.00	100.00	90.00
	Maximum	-	2.00	100.00	0.00	100.00	100.00	-	0.00	0.00	0.00	0.00	0.00	-	1.00	100.00	0.00	100.00	100.00
All Students that Did Not Find the Food	TRUE:FALSE Ratio	26:2	Found (%)		92.86			17:11	Found (%)		60.71			19:9	Found (%)		67.86		
	Average	-	2.18	49.29	0.00	92.86	71.07	-	2.32	14.29	0.00	60.71	37.50	-	1.39	40.00	0.00	67.86	53.93
	Standard Deviation	-	1.47	30.05	0.00	26.23	24.09	-	2.18	24.26	0.00	49.73	32.50	-	1.59	37.71	0.00	47.56	39.85
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	0.00	100.00	100.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	100.00	0.00	100.00	100.00
No Vision Students	TRUE:FALSE Ratio	12:1	Found (%)		92.31			7:6	Found (%)		53.85			8:5	Found (%)		61.54		
	Average	-	2.62	40.00	0.00	92.31	66.15	-	2.31	7.69	0.00	53.85	30.77	-	1.69	27.69	0.00	61.54	44.62
	Standard Deviation	-	1.45	27.08	0.00	27.74	23.29	-	2.36	17.39	0.00	51.89	30.68	-	1.84	33.20	0.00	50.64	38.65
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	80.00	0.00	100.00	90.00	-	5.00	60.00	0.00	100.00	80.00	-	5.00	100.00	0.00	100.00	100.00
Low Vision Students	TRUE:FALSE Ratio	16:1	Found (%)		94.12			10:7	Found (%)		58.82			13:4	Found (%)		76.47		
	Average	-	1.71	60.00	0.00	94.12	77.06	-	2.06	17.65	0.00	58.82	38.24	-	1.06	55.29	0.00	76.47	65.88
	Standard Deviation	-	1.40	30.82	0.00	24.25	23.92	-	2.11	27.28	0.00	50.73	34.86	-	1.30	39.07	0.00	43.72	39.38
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	0.00	100.00	100.00	-	5.00	80.00	0.00	100.00	90.00	-	4.00	100.00	0.00	100.00	100.00
Students with Learning Difficulties	TRUE:FALSE Ratio	7:0	Found (%)		100.00			5:2	Found (%)		71.43			6:1	Found (%)		85.71		
	Average	-	2.29	54.29	0.00	100.00	77.14	-	3.29	5.71	0.00	71.43	38.57	-	1.29	60.00	0.00	85.71	72.86
	Standard Deviation	-	1.50	29.92	0.00	0.00	14.96	-	2.29	9.76	0.00	48.80	26.73	-	1.38	36.51	0.00	37.80	34.50
	Minimum	-	0.00	20.00	0.00	100.00	60.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	4.00	100.00	0.00	100.00	100.00	-	5.00	20.00	0.00	100.00	60.00	-	3.00	100.00	0.00	100.00	100.00
Students without Learning Difficulties	TRUE:FALSE Ratio	21:2	Found (%)		91.30			12:11	Found (%)		52.17			15:8	Found (%)		65.22		
	Average	-	2.04	50.43	0.00	91.30	70.87	-	1.83	15.65	0.00	52.17	33.91	-	1.35	38.26	0.00	65.22	51.74
	Standard Deviation	-	1.49	31.26	0.00	28.81	26.10	-	2.08	26.26	0.00	51.08	34.87	-	1.64	38.57	0.00	48.70	40.75
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	0.00	100.00	100.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	100.00	0.00	100.00	100.00

Item #4 Portable Air Conditioner					
Item Found	Placement		Size		Total Item Acc (%)
	Diff	Acc (%)	Diff	Acc (%)	
26:4	Found (%)		86.67		
-	2.60	34.67	0.03	86.00	60.33
-	2.19	41.00	0.18	34.50	30.57
-	0.00	0.00	0.00	0.00	0.00
-	5.00	100.00	1.00	100.00	100.00
8:1	Found (%)		88.89		
-	2.44	40.00	0.00	88.89	64.44
-	2.19	42.43	0.00	33.33	31.27
-	0.00	0.00	0.00	0.00	0.00
-	5.00	100.00	0.00	100.00	100.00
18:3	Found (%)		85.71		
-	2.67	32.38	0.05	84.76	58.57
-	2.24	41.22	0.22	35.72	30.87
-	0.00	0.00	0.00	0.00	0.00
-	5.00	100.00	1.00	100.00	100.00
1:1	Found (%)		50.00		
-	0.00	50.00	0.00	50.00	50.00
-	0.00	70.71	0.00	70.71	70.71
-	0.00	0.00	0.00	0.00	0.00
-	0.00	100.00	0.00	100.00	100.00
25:3	Found (%)		89.29		
-	2.79	33.57	0.04	88.57	61.07
-	2.15	40.02	0.19	31.47	28.46
-	0.00	0.00	0.00	0.00	0.00
-	5.00	100.00	1.00	100.00	100.00
13:0	Found (%)		100.00		
-	2.85	43.08	0.00	100.00	71.54
-	1.86	37.28	0.00	0.00	18.64
-	0.00	0.00	0.00	100.00	50.00
-	5.00	100.00	0.00	100.00	100.00
13:4	Found (%)		76.47		
-	2.41	28.24	0.06	75.29	51.76
-	2.45	43.62	0.24	43.32	35.40
-	0.00	0.00	0.00	0.00	0.00
-	5.00	100.00	1.00	100.00	100.00
7:0	Found (%)		100.00		
-	2.14	57.14	0.00	100.00	78.57
-	1.95	39.04	0.00	0.00	19.52
-	0.00	0.00	0.00	100.00	50.00
-	5.00	100.00	0.00	100.00	100.00
19:4	Found (%)		82.61		
-	2.74	27.83	0.04	81.74	54.78
-	2.28	39.88	0.21	38.57	31.46
-	0.00	0.00	0.00	0.00	0.00
-	5.00	100.00	1.00	100.00	100.00

Item #5 Table					
Item Found	Placement		Size		Total Item Acc (%)
	Diff	Acc (%)	Diff	Acc (%)	
27:3	Found (%)		90.00		
-	1.60	58.00	3.67	16.67	37.33
-	1.48	33.77	1.69	23.54	22.88
-	0.00	0.00	0.00	0.00	0.00
-	4.00	100.00	5.00	60.00	80.00
8:1	Found (%)		88.89		
-	1.56	57.78	3.33	22.22	40.00
-	1.42	33.83	1.87	29.06	21.79
-	0.00	0.00	0.00	0.00	0.00
-	4.00	100.00	5.00	60.00	80.00
19:2	Found (%)		90.48		
-	1.62	58.10	3.81	14.29	36.19
-	1.53	34.59	1.63	21.11	23.76
-	0.00	0.00	0.00	0.00	0.00
-	4.00	100.00	5.00	60.00	80.00
2:0	Found (%)		100.00		
-	2.00	60.00	2.00	60.00	60.00
-	2.83	56.57	0.00	0.00	28.28
-	0.00	20.00	2.00	60.00	40.00
-	4.00	100.00	2.00	60.00	80.00
25:3	Found (%)		89.29		
-	1.57	57.86	3.79	13.57	35.71
-	1.43	33.26	1.69	21.12	22.18
-	0.00	0.00	0.00	0.00	0.00
-	4.00	100.00	5.00	60.00	80.00
13:0	Found (%)		100.00		
-	1.77	64.62	3.69	26.15	45.38
-	1.30	26.02	1.25	25.01	20.66
-	0.00	20.00	2.00	0.00	10.00
-	4.00	100.00	5.00	60.00	80.00
14:3	Found (%)		82.35		
-	1.47	52.94	3.65	9.41	31.18
-	1.62	38.69	2.00	20.15	23.15
-	0.00	0.00	0.00	0.00	0.00
-	4.00	100.00	5.00	60.00	80.00
7:0	Found (%)		100.00		
-	1.29	74.29	4.29	14.29	44.29
-	1.11	22.25	0.95	19.02	13.97
-	0.00	40.00	3.00	0.00	20.00
-	3.00	100.00	5.00	40.00	60.00
20:3	Found (%)		86.96		
-	1.70	53.04	3.48	17.39	35.22
-	1.58	35.48	1.83	25.08	24.84
-	0.00	0.00	0.00	0.00	0.00
-	4.00	100.00	5.00	60.00	80.00

Summary		
Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)
Avg Item Found(%)		79.33
52.33	0.03	51.67
12.75	0.18	14.08
18.00	0.00	16.00
76.00	1.00	76.00
Avg Item Found(%)		82.22
54.22	0.00	54.22
9.13	0.00	9.13
42.00	0.00	42.00
70.00	0.00	70.00
Avg Item Found(%)		78.10
51.52	0.05	50.57
14.14	0.22	15.81
18.00	0.00	16.00
76.00	1.00	76.00
Avg Item Found(%)		70.00
59.00	0.00	59.00
24.04	0.00	24.04
42.00	0.00	42.00
76.00	0.00	76.00
Avg Item Found(%)		80.00
51.86	0.04	51.14
12.23	0.19	13.69
18.00	0.00	16.00
70.00	1.00	70.00
Avg Item Found(%)		81.54
51.69	0.00	51.69
12.13	0.00	12.13
34.00	0.00	34.00
70.00	0.00	70.00
Avg Item Found(%)		77.65
52.82	0.06	51.65
13.55	0.24	15.78
18.00	0.00	16.00
76.00	1.00	76.00
Avg Item Found(%)		91.43
62.29	0.00	62.29
7.43	0.00	7.43
50.00	0.00	50.00
70.00	0.00	70.00
Avg Item Found(%)		75.65
49.30	0.04	48.43
12.57	0.21	14.13
18.00	0.00	16.00
76.00	1.00	76.00

Room	Bedroom		No. of Items:	4

No.	Student	Item #1 Bed						Item #2 Closet						Item #3 Potted Plant					
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)	
1	Participant 1	TRUE	1	80	3	40	60	TRUE	0	100	1	80	90	TRUE	5	0	0	100	50
2	Participant 2	TRUE	3	40	5	0	20	TRUE	1	80	1	80	80	FALSE	0	0	0	0	0
3	Participant 3	TRUE	1	80	5	0	40	TRUE	2	60	1	80	70	TRUE	5	0	0	100	50
4	Participant 4	TRUE	1	80	5	0	40	TRUE	4	20	1	80	50	TRUE	3	40	0	100	70
5	Participant 5	TRUE	1	80	3	40	60	TRUE	5	0	1	80	40	TRUE	4	20	0	100	60
6	Participant 6	TRUE	0	100	5	0	50	TRUE	2	60	1	80	70	FALSE	0	0	0	0	0
7	Participant 7	TRUE	4	20	5	0	10	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
8	Participant 8	TRUE	5	0	5	0	0	TRUE	4	20	1	80	50	TRUE	5	0	0	100	50
9	Participant 9	TRUE	4	20	5	0	10	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50
10	Participant 10	TRUE	5	0	5	0	0	TRUE	2	60	1	80	70	TRUE	4	20	0	100	60
11	Participant 11	TRUE	2	60	5	0	30	TRUE	1	80	1	80	80	TRUE	5	0	0	100	50
12	Participant 12	TRUE	2	60	5	0	30	TRUE	0	100	2	60	80	FALSE	0	0	0	0	0
13	Participant 13	TRUE	1	80	0	100	90	TRUE	0	100	0	100	100	TRUE	0	100	0	100	100
14	Participant 14	TRUE	1	80	5	0	40	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50
15	Participant 15	TRUE	4	20	4	20	20	FALSE	0	0	0	0	0	TRUE	2	60	0	100	80
16	Participant 16	FALSE	0	0	0	0	0	TRUE	4	20	0	100	60	TRUE	5	0	0	100	50
17	Participant 17	TRUE	5	0	5	0	0	TRUE	5	0	1	80	40	FALSE	0	0	0	0	0
18	Participant 18	FALSE	0	0	0	0	0	TRUE	3	40	1	80	60	FALSE	0	0	0	0	0
19	Participant 19	TRUE	3	40	5	0	20	TRUE	4	20	1	80	50	TRUE	2	60	0	100	80
20	Participant 20	TRUE	1	80	5	0	40	TRUE	4	20	5	0	10	TRUE	3	40	0	100	70
21	Participant 21	TRUE	5	0	5	0	0	FALSE	0	0	0	0	0	TRUE	3	40	0	100	70
22	Participant 22	TRUE	0	100	5	0	50	FALSE	0	0	0	0	0	TRUE	1	80	0	100	90
23	Participant 23	TRUE	4	20	5	0	10	TRUE	5	0	1	80	40	TRUE	5	0	0	100	50
24	Participant 24	TRUE	0	100	5	0	50	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
25	Participant 25	TRUE	3	40	5	0	20	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0
26	Participant 26	TRUE	1	80	3	40	60	TRUE	1	80	0	100	90	FALSE	0	0	0	0	0
27	Participant 27	TRUE	3	40	5	0	20	FALSE	0	0	0	0	0	TRUE	2	60	0	100	80
28	Participant 28	TRUE	3	40	5	0	20	TRUE	3	40	4	20	30	TRUE	3	40	0	100	70
29	Participant 29	TRUE	2	60	5	0	30	TRUE	4	20	1	80	50	TRUE	5	0	0	100	50
30	Participant 30	TRUE	2	60	5	0	30	TRUE	0	100	0	100	100	TRUE	0	100	0	100	100

Item #4 Side Table											
Item Found	Placement		Size		Total Item Acc (%)	Passed Food Finding	Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)	Diagnosis	Learning Difficulties
	Diff	Acc (%)	Diff	Acc (%)							
TRUE	4	20	0	100	60	TRUE	65.00	0	65.00	Low Vision	TRUE
TRUE	1	80	0	100	90	TRUE	47.50	0	47.50	Low Vision	FALSE
TRUE	2	60	0	100	80	FALSE	60.00	0	60.00	Low Vision	FALSE
TRUE	3	40	0	100	70	FALSE	57.50	0	57.50	No Vision	FALSE
TRUE	5	0	0	100	50	TRUE	52.50	0	52.50	No Vision	FALSE
FALSE	0	0	0	0	0	TRUE	30.00	0	30.00	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	2.50	0	2.50	No Vision	TRUE
TRUE	5	0	0	100	50	FALSE	37.50	0	37.50	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	27.50	0	27.50	Low Vision	TRUE
TRUE	5	0	0	100	50	FALSE	45.00	0	45.00	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	40.00	0	40.00	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	27.50	0	27.50	Low Vision	FALSE
TRUE	1	80	0	100	90	TRUE	95.00	0	95.00	Low Vision	FALSE
TRUE	5	0	0	100	50	FALSE	47.50	0	47.50	No Vision	FALSE
FALSE	0	0	0	0	0	TRUE	25.00	0	25.00	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	27.50	0	27.50	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	10.00	0	10.00	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	15.00	0	15.00	No Vision	FALSE
FALSE	0	0	0	0	0	FALSE	37.50	0	37.50	No Vision	FALSE
TRUE	2	60	0	100	80	FALSE	50.00	0	50.00	No Vision	TRUE
TRUE	5	0	0	100	50	FALSE	30.00	0	30.00	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	35.00	0	35.00	No Vision	FALSE
TRUE	0	100	0	100	100	FALSE	50.00	0	50.00	No Vision	TRUE
TRUE	2	60	0	100	80	TRUE	32.50	0	32.50	No Vision	FALSE
FALSE	0	0	0	0	0	TRUE	25.00	0	25.00	No Vision	TRUE
FALSE	0	0	0	0	0	FALSE	37.50	0	37.50	No Vision	FALSE
TRUE	5	0	0	100	50	FALSE	37.50	0	37.50	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	30.00	0	30.00	Low Vision	FALSE
TRUE	4	20	0	100	60	FALSE	47.50	0	47.50	No Vision	TRUE
TRUE	0	100	1	80	90	TRUE	80.00	0	80.00	Low Vision	FALSE

Room	Bedroom		No. of Items:	4

Students	Summary	Item #1 Bed						Item #2 Closet						Item #3 Potted Plant					
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)	
All Students	TRUE:FALSE	28:1	Found (%)		93.33			24:6	Found (%)		80.00			21:9	Found (%)		70.00		
	Average	-	2.23	48.67	4.27	8.00	28.33	-	2.20	36.00	0.83	63.33	49.67	-	2.40	22.00	0.00	70.00	46.00
	Standard Devi	-	1.70	34.31	1.57	21.40	22.76	-	1.97	37.29	1.15	38.63	32.43	-	2.14	32.10	0.00	46.61	33.79
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	90.00	-	5.00	100.00	5.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00
Primary School Students	TRUE:FALSE	9:0	Found (%)		100.00			8:1	Found (%)		88.89			6:3	Found (%)		66.67		
	Average	-	2.22	55.56	4.56	8.89	32.22	-	2.56	37.78	0.78	73.33	55.56	-	3.00	6.67	0.00	66.67	36.67
	Standard Devi	-	1.79	35.75	0.88	17.64	22.79	-	2.01	38.01	0.44	28.28	26.51	-	2.35	14.14	0.00	50.00	28.28
	Minimum	-	0.00	0.00	3.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	40.00	60.00	-	5.00	100.00	1.00	100.00	90.00	-	5.00	40.00	0.00	100.00	70.00
Secondary School Students	TRUE:FALSE	19:1	Found (%)		90.48			16:5	Found (%)		76.19			15:6	Found (%)		71.43		
	Average	-	2.24	45.71	4.14	7.62	26.67	-	2.05	35.24	0.86	59.05	47.14	-	2.14	28.57	0.00	71.43	50.00
	Standard Devi	-	1.70	34.14	1.80	23.22	23.09	-	1.99	37.90	1.35	42.18	34.95	-	2.06	35.54	0.00	46.29	35.78
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	90.00	-	5.00	100.00	5.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00
All Students that Found the Food	TRUE:FALSE	14:0	Found (%)		100.00			11:3	Found (%)		78.57			9:5	Found (%)		64.29		
	Average	-	2.07	58.57	4.29	14.29	36.43	-	1.71	44.29	0.71	64.29	54.29	-	1.79	28.57	0.00	64.29	46.43
	Standard Devi	-	1.64	32.78	1.44	28.75	24.37	-	2.02	43.09	1.07	40.14	36.73	-	2.15	39.78	0.00	49.72	39.54
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	90.00	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00
All Students that Did Not Find the Food	TRUE:FALSE	14:1	Found (%)		87.50			13:3	Found (%)		81.25			12:4	Found (%)		75.00		
	Average	-	2.38	40.00	4.25	2.50	21.25	-	2.63	28.75	0.94	62.50	45.63	-	2.94	16.25	0.00	75.00	45.63
	Standard Devi	-	1.78	34.25	1.73	10.00	19.28	-	1.89	30.96	1.24	38.56	28.74	-	2.05	23.35	0.00	44.72	29.20
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	80.00	5.00	40.00	60.00	-	5.00	100.00	5.00	100.00	90.00	-	5.00	60.00	0.00	100.00	80.00
No Vision Students	TRUE:FALSE	12:1	Found (%)		92.31			10:3	Found (%)		76.92			8:5	Found (%)		61.54		
	Average	-	1.62	60.00	4.31	6.15	33.08	-	2.85	20.00	0.85	60.00	40.00	-	2.15	18.46	0.00	61.54	40.00
	Standard Devi	-	1.45	32.66	1.49	15.02	19.74	-	1.99	25.82	1.34	42.43	29.72	-	2.12	27.64	0.00	50.64	34.88
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	4.00	100.00	5.00	40.00	60.00	-	5.00	80.00	5.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00
Low Vision Students	TRUE:FALSE	16:0	Found (%)		94.12			14:3	Found (%)		82.35			13:4	Found (%)		76.47		
	Average	-	2.71	40.00	4.24	9.41	24.71	-	1.71	48.24	0.82	65.88	57.06	-	2.59	24.71	0.00	76.47	50.59
	Standard Devi	-	1.76	33.91	1.68	25.61	24.78	-	1.86	40.66	1.01	36.58	33.31	-	2.21	35.73	0.00	43.72	33.25
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	90.00	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00
Students with Learning Difficulties	TRUE:FALSE	7:0	Found (%)		100.00			6:1	Found (%)		85.71			5:2	Found (%)		71.43		
	Average	-	2.71	45.71	4.71	5.71	25.71	-	2.86	28.57	1.14	62.86	45.71	-	3.29	5.71	0.00	71.43	38.57
	Standard Devi	-	1.38	27.60	0.76	15.12	19.02	-	2.19	38.05	1.77	43.86	33.09	-	2.36	15.12	0.00	48.80	27.34
	Minimum	-	1.00	20.00	3.00	0.00	10.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	4.00	80.00	5.00	40.00	60.00	-	5.00	100.00	5.00	100.00	90.00	-	5.00	40.00	0.00	100.00	70.00
Students without Learning Difficulties	TRUE:FALSE	21:1	Found (%)		91.30			18:5	Found (%)		78.26			16:7	Found (%)		69.57		
	Average	-	2.09	49.57	4.13	8.70	29.13	-	2.00	38.26	0.74	63.48	50.87	-	2.13	26.96	0.00	69.57	48.26
	Standard Devi	-	1.78	36.62	1.74	23.22	24.10	-	1.91	37.62	0.92	37.97	32.88	-	2.05	34.44	0.00	47.05	35.76
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	90.00	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00

Item #4 Side Table						Summary		
Item Found	Placement		Size		Total Item Acc (%)	Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)
	Diff	Acc (%)	Diff	Acc (%)				
16:14	Found (%)		53.33			Avg Item Found(%)		74.17
-	1.63	20.67	0.03	52.67	36.67	40.17	0.00	40.17
-	2.08	33.83	0.18	50.24	37.26	19.26	0.00	19.26
-	0.00	0.00	0.00	0.00	0.00	2.50	0.00	2.50
-	5.00	100.00	1.00	100.00	100.00	95.00	0.00	95.00
6:3	Found (%)		66.67			Avg Item Found(%)		80.56
-	2.22	22.22	0.00	66.67	44.44	42.22	0.00	42.22
-	2.11	30.73	0.00	50.00	35.75	19.90	0.00	19.90
-	0.00	0.00	0.00	0.00	0.00	2.50	0.00	2.50
-	5.00	80.00	0.00	100.00	90.00	65.00	0.00	65.00
10:11	Found (%)		47.62			Avg Item Found(%)		71.43
-	1.38	20.00	0.05	46.67	33.33	39.29	0.00	39.29
-	2.06	35.78	0.22	50.33	38.25	19.42	0.00	19.42
-	0.00	0.00	0.00	0.00	0.00	10.00	0.00	10.00
-	5.00	100.00	1.00	100.00	100.00	95.00	0.00	95.00
6:8	Found (%)		42.86			Avg Item Found(%)		71.43
-	0.93	24.29	0.07	41.43	32.86	42.50	0.00	42.50
-	1.64	37.77	0.27	49.90	40.84	23.47	0.00	23.47
-	0.00	0.00	0.00	0.00	0.00	10.00	0.00	10.00
-	5.00	100.00	1.00	100.00	90.00	95.00	0.00	95.00
10:6	Found (%)		62.50			Avg Item Found(%)		76.56
-	2.25	17.50	0.00	62.50	40.00	38.13	0.00	38.13
-	2.27	30.88	0.00	50.00	34.83	15.18	0.00	15.18
-	0.00	0.00	0.00	0.00	0.00	2.50	0.00	2.50
-	5.00	100.00	0.00	100.00	100.00	60.00	0.00	60.00
7:6	Found (%)		53.85			Avg Item Found(%)		71.15
-	1.62	21.54	0.00	53.85	37.69	37.69	0.00	37.69
-	2.02	33.13	0.00	51.89	38.55	15.96	0.00	15.96
-	0.00	0.00	0.00	0.00	0.00	2.50	0.00	2.50
-	5.00	100.00	0.00	100.00	100.00	57.50	0.00	57.50
9:8	Found (%)		52.94			Avg Item Found(%)		76.47
-	1.65	20.00	0.06	51.76	35.88	42.06	0.00	42.06
-	2.18	35.36	0.24	50.53	37.43	21.74	0.00	21.74
-	0.00	0.00	0.00	0.00	0.00	10.00	0.00	10.00
-	5.00	100.00	1.00	100.00	90.00	95.00	0.00	95.00
4:3	Found (%)		57.14			Avg Item Found(%)		78.57
-	1.43	28.57	0.00	57.14	42.86	38.21	0.00	38.21
-	1.90	38.05	0.00	53.45	42.31	21.00	0.00	21.00
-	0.00	0.00	0.00	0.00	0.00	2.50	0.00	2.50
-	4.00	100.00	0.00	100.00	100.00	65.00	0.00	65.00
12:11	Found (%)		52.17			Avg Item Found(%)		72.83
-	1.70	18.26	0.04	51.30	34.78	40.76	0.00	40.76
-	2.16	32.98	0.21	50.39	36.42	19.16	0.00	19.16
-	0.00	0.00	0.00	0.00	0.00	10.00	0.00	10.00
-	5.00	100.00	1.00	100.00	90.00	95.00	0.00	95.00

Room	Kitchen		No. of Items:	8

No.	Student	Item #1 Cabinet						Item #2 Chair 1						Item #3 Chair 2						Item #4 Chair 3					
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)	
1	Participant 1	FALSE	0	0	0	0	0	TRUE	1	80	0	100	90	TRUE	1	80	0	100	90	TRUE	3	40	0	100	70
2	Participant 2	TRUE	5	0	2	60	30	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
3	Participant 3	TRUE	3	40	2	60	50	TRUE	3	40	0	100	70	TRUE	5	0	0	100	50	TRUE	4	20	0	100	60
4	Participant 4	TRUE	5	0	2	60	30	TRUE	2	60	0	100	80	TRUE	4	20	0	100	60	FALSE	0	0	0	0	0
5	Participant 5	TRUE	5	0	2	60	30	TRUE	1	80	0	100	90	TRUE	3	40	0	100	70	TRUE	1	80	0	100	90
6	Participant 6	TRUE	0	100	1	80	90	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
7	Participant 7	TRUE	5	0	2	60	30	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
8	Participant 8	TRUE	5	0	5	0	0	TRUE	4	20	0	100	60	TRUE	3	40	0	100	70	TRUE	2	60	0	100	80
9	Participant 9	TRUE	5	0	1	80	40	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
10	Participant 10	TRUE	3	40	2	60	50	TRUE	2	60	0	100	80	TRUE	1	80	0	100	90	FALSE	0	0	0	0	0
11	Participant 11	TRUE	0	100	1	80	90	TRUE	4	20	0	100	60	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
12	Participant 12	TRUE	2	60	0	100	80	TRUE	3	40	0	100	70	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
13	Participant 13	TRUE	0	100	1	80	90	TRUE	1	80	0	100	90	TRUE	2	60	0	100	80	TRUE	3	40	0	100	70
14	Participant 14	TRUE	4	20	1	80	50	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
15	Participant 15	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0
16	Participant 16	FALSE	0	0	0	0	0	TRUE	3	40	0	100	70	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0
17	Participant 17	FALSE	0	0	0	0	0	TRUE	3	40	0	100	70	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
18	Participant 18	FALSE	0	0	0	0	0	TRUE	1	80	0	100	90	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
19	Participant 19	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
20	Participant 20	TRUE	5	0	1	80	40	TRUE	2	60	0	100	80	TRUE	2	60	0	100	80	TRUE	3	40	0	100	70
21	Participant 21	TRUE	5	0	2	60	30	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
22	Participant 22	FALSE	0	0	0	0	0	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
23	Participant 23	TRUE	4	20	1	80	50	TRUE	1	80	0	100	90	TRUE	1	80	0	100	90	TRUE	5	0	0	100	50
24	Participant 24	TRUE	5	0	2	60	30	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
25	Participant 25	TRUE	1	80	2	60	70	TRUE	1	80	0	100	90	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0
26	Participant 26	TRUE	2	60	2	60	60	TRUE	1	80	0	100	90	TRUE	3	40	0	100	70	FALSE	0	0	0	0	0
27	Participant 27	FALSE	0	0	0	0	0	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
28	Participant 28	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
29	Participant 29	TRUE	2	60	3	40	50	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
30	Participant 30	FALSE	0	0	0	0	0	TRUE	1	80	0	100	90	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0

Item #5 Oven						Item #6 Sink						Item #7 Stove Counter						Item #8 Table											
Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Passed Food Finding	Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)	Diagnosis	Learning Difficulties
	Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)							
TRUE	0	100	0	100	100	TRUE	5	0	0	100	50	TRUE	0	100	0	100	100	TRUE	1	80	2	60	70	FALSE	71.25	0	71.25	Low Vision	TRUE
TRUE	3	40	0	100	70	FALSE	0	0	0	0	0	TRUE	3	40	2	60	50	TRUE	3	40	3	40	40	FALSE	33.75	0	33.75	Low Vision	FALSE
TRUE	4	20	0	100	60	TRUE	4	20	1	80	50	FALSE	0	0	0	0	0	TRUE	3	40	2	60	50	TRUE	48.75	0	48.75	Low Vision	FALSE
TRUE	5	0	0	100	50	TRUE	1	80	1	80	80	TRUE	5	0	0	100	50	TRUE	4	20	3	40	30	FALSE	47.50	0	47.50	No Vision	FALSE
TRUE	4	20	0	100	60	TRUE	3	40	1	80	60	TRUE	5	0	3	40	20	TRUE	0	100	3	40	70	FALSE	61.25	0	61.25	No Vision	FALSE
TRUE	1	80	0	100	90	TRUE	0	100	0	100	100	TRUE	1	80	2	60	70	TRUE	0	100	5	0	50	FALSE	50.00	0	50.00	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	3	40	4	20	30	FALSE	17.50	0	17.50	No Vision	TRUE
TRUE	3	40	0	100	70	TRUE	1	80	0	100	90	TRUE	1	80	2	60	70	TRUE	3	40	3	40	40	FALSE	60.00	0	60.00	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	2	60	1	80	70	TRUE	3	40	4	20	30	FALSE	27.50	0	27.50	Low Vision	TRUE
TRUE	5	0	1	80	40	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	TRUE	1	80	3	40	60	FALSE	52.50	0	52.50	Low Vision	FALSE
TRUE	5	0	0	100	50	TRUE	3	40	0	100	70	TRUE	5	0	2	60	30	TRUE	0	100	2	60	80	FALSE	47.50	0	47.50	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	1	80	0	100	90	FALSE	30.00	0	30.00	Low Vision	FALSE
TRUE	0	100	0	100	100	TRUE	0	100	0	100	100	TRUE	0	100	0	100	100	TRUE	1	80	0	100	90	TRUE	90.00	0	90.00	Low Vision	FALSE
TRUE	0	100	0	100	100	TRUE	3	40	1	80	60	TRUE	5	0	3	40	20	TRUE	3	40	2	60	50	FALSE	41.25	0	41.25	No Vision	FALSE
TRUE	5	0	1	80	40	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	3	40	2	60	50	FALSE	30.00	0	30.00	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	4	20	2	60	40	TRUE	0	100	4	20	60	FALSE	31.25	0	31.25	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	4	20	1	80	50	TRUE	4	20	2	60	40	TRUE	3	40	5	0	20	FALSE	22.50	0	22.50	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	5	0	3	40	20	TRUE	2	60	5	0	30	FALSE	17.50	0	17.50	No Vision	FALSE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	4	20	3	40	30	FALSE	0	0	0	0	0	FALSE	3.75	0	3.75	No Vision	FALSE
TRUE	5	0	2	60	30	TRUE	4	20	4	20	20	TRUE	5	0	3	40	20	TRUE	1	80	3	40	60	FALSE	50.00	0	50.00	No Vision	TRUE
FALSE	0	0	0	0	0	TRUE	5	0	0	100	50	TRUE	5	0	2	60	30	TRUE	3	40	4	20	30	FALSE	17.50	0	17.50	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	1	80	2	60	70	TRUE	5	0	3	40	20	TRUE	4	20	2	60	40	FALSE	26.25	0	26.25	No Vision	FALSE
TRUE	3	40	0	100	70	TRUE	3	40	1	80	60	TRUE	5	0	1	80	40	TRUE	3	40	4	20	30	FALSE	60.00	0	60.00	No Vision	TRUE
FALSE	0	0	0	0	0	TRUE	0	100	1	80	90	TRUE	4	20	3	40	30	FALSE	0	0	0	0	0	FALSE	18.75	0	18.75	No Vision	FALSE
FALSE	0	0	0	0	0	TRUE	2	60	1	80	70	TRUE	4	20	3	40	30	TRUE	5	0	4	20	10	FALSE	43.75	0	43.75	No Vision	TRUE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	1	80	2	60	70	TRUE	1	80	0	100	90	FALSE	47.50	0	47.50	No Vision	FALSE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	1	80	5	0	40	TRUE	15.00	0	15.00	Low Vision	FALSE
TRUE	1	80	3	40	60	TRUE	1	80	0	100	90	TRUE	5	0	2	60	30	TRUE	1	80	0	100	90	FALSE	46.25	0	46.25	Low Vision	FALSE
TRUE	2	60	0	100	80	TRUE	1	80	1	80	80	FALSE	0	0	0	0	0	TRUE	1	80	0	100	90	FALSE	37.50	0	37.50	No Vision	TRUE
FALSE	0	0	0	0	0	TRUE	0	100	0	100	100	TRUE	3	40	2	60	50	TRUE	1	80	2	60	70	FALSE	38.75	0	38.75	Low Vision	FALSE

Room	Kitchen		No. of Items:	8

Students	Summary	Item #1 Cabinet						Item #2 Chair 1						Item #3 Chair 2						Item #4 Chair 3					
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)	
All Students	TRUE:FALSE Ratio	22:8	Found (%)		73.33			25:5	Found (%)		83.33			13:17	Found (%)		43.33			7:23	Found (%)		23.33		
	Average	-	2.53	22.67	1.17	50.00	36.33	-	1.97	44.00	0.00	83.33	63.67	-	1.13	20.67	0.00	43.33	32.00	-	0.70	9.33	0.00	23.33	16.33
	Standard Deviation	-	2.24	35.13	1.18	35.91	29.77	-	1.52	31.69	0.00	37.90	31.46	-	1.59	29.93	0.00	50.40	38.27	-	1.42	20.83	0.00	43.02	30.68
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00
Primary School Students	TRUE:FALSE Ratio	8:1	Found (%)		88.89			8:1	Found (%)		88.89			5:4	Found (%)		55.56			4:5	Found (%)		44.44		
	Average	-	3.67	15.56	1.89	51.11	33.33	-	1.89	51.11	0.00	88.89	70.00	-	1.78	20.00	0.00	55.56	37.78	-	1.11	22.22	0.00	44.44	33.33
	Standard Deviation	-	2.18	34.32	1.36	30.18	26.93	-	1.17	26.67	0.00	33.33	27.84	-	1.99	28.28	0.00	52.70	37.34	-	1.54	30.73	0.00	52.70	40.31
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	80.00	90.00	-	4.00	80.00	0.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00	-	4.00	80.00	0.00	100.00	90.00
Secondary School Students	TRUE:FALSE Ratio	14:7	Found (%)		66.67			17:4	Found (%)		80.95			8:13	Found (%)		38.10			3:18	Found (%)		14.29		
	Average	-	2.05	25.71	0.86	49.52	37.62	-	2.00	40.95	0.00	80.95	60.95	-	0.86	20.95	0.00	38.10	29.52	-	0.52	3.81	0.00	14.29	9.05
	Standard Deviation	-	2.13	35.86	0.96	38.79	31.45	-	1.67	33.75	0.00	40.24	33.15	-	1.35	31.29	0.00	49.76	39.30	-	1.36	12.03	0.00	35.86	23.00
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	3.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	40.00	0.00	100.00	70.00
All Students that Found the Food	TRUE:FALSE Ratio	2:1	Found (%)		66.67			3:0	Found (%)		100.00			2:1	Found (%)		66.67			2:1	Found (%)		66.67		
	Average	-	1.00	46.67	1.00	46.67	46.67	-	2.00	60.00	0.00	100.00	80.00	-	2.33	20.00	0.00	66.67	43.33	-	2.33	20.00	0.00	66.67	43.33
	Standard Deviation	-	1.73	50.33	1.00	41.63	45.09	-	1.00	20.00	0.00	0.00	10.00	-	2.52	34.64	0.00	57.74	40.41	-	2.08	20.00	0.00	57.74	37.86
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	1.00	40.00	0.00	100.00	70.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	3.00	100.00	2.00	80.00	90.00	-	3.00	80.00	0.00	100.00	90.00	-	5.00	60.00	0.00	100.00	80.00	-	4.00	40.00	0.00	100.00	70.00
All Students that Did Not Find the Food	TRUE:FALSE Ratio	20:7	Found (%)		74.07			22:5	Found (%)		81.48			11:16	Found (%)		40.74			5:22	Found (%)		18.52		
	Average	-	2.70	20.00	1.19	50.37	35.19	-	1.96	42.22	0.00	81.48	61.85	-	1.00	20.74	0.00	40.74	30.74	-	0.52	8.15	0.00	18.52	13.33
	Standard Deviation	-	2.25	33.28	1.21	36.11	28.60	-	1.58	32.50	0.00	39.58	32.59	-	1.47	30.12	0.00	50.07	38.62	-	1.25	20.95	0.00	39.58	29.09
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00
No Vision Students	TRUE:FALSE Ratio	10:3	Found (%)		76.92			10:3	Found (%)		76.92			6:7	Found (%)		46.15			3:10	Found (%)		23.08		
	Average	-	2.92	18.46	1.38	49.23	33.85	-	1.38	49.23	0.00	76.92	63.08	-	1.15	23.08	0.00	46.15	34.62	-	0.69	9.23	0.00	23.08	16.15
	Standard Deviation	-	2.14	28.82	0.96	30.13	22.93	-	1.33	35.23	0.00	43.85	37.50	-	1.46	29.26	0.00	51.89	39.50	-	1.55	23.97	0.00	43.85	31.76
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	80.00	3.00	80.00	70.00	-	5.00	80.00	0.00	100.00	90.00	-	4.00	80.00	0.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00
Low Vision Students	TRUE:FALSE Ratio	12:5	Found (%)		70.59			15:2	Found (%)		88.24			7:10	Found (%)		41.18			4:13	Found (%)		23.53		
	Average	-	2.24	25.88	1.00	50.59	38.24	-	2.41	40.00	0.00	88.24	64.12	-	1.12	18.82	0.00	41.18	30.00	-	0.71	9.41	0.00	23.53	16.47
	Standard Deviation	-	2.33	39.85	1.32	40.69	34.68	-	1.54	29.15	0.00	33.21	27.17	-	1.73	31.20	0.00	50.73	38.41	-	1.36	18.86	0.00	43.72	30.81
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00	-	4.00	60.00	0.00	100.00	80.00
Students with Learning Difficulties	TRUE:FALSE Ratio	6:1	Found (%)		85.71			6:1	Found (%)		85.71			4:3	Found (%)		57.14			3:4	Found (%)		42.86		
	Average	-	3.14	22.86	1.43	57.14	40.00	-	1.29	60.00	0.00	85.71	72.86	-	0.86	40.00	0.00	57.14	48.57	-	1.57	11.43	0.00	42.86	27.14
	Standard Deviation	-	2.12	33.52	0.98	29.28	21.60	-	0.76	28.28	0.00	37.80	32.51	-	0.90	38.30	0.00	53.45	45.62	-	2.07	19.52	0.00	53.45	34.50
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	80.00	3.00	80.00	70.00	-	2.00	80.00	0.00	100.00	90.00	-	2.00	80.00	0.00	100.00	90.00	-	5.00	40.00	0.00	100.00	70.00
Students without Learning Difficulties	TRUE:FALSE Ratio	16:7	Found (%)		69.57			19:4	Found (%)		82.61			9:14	Found (%)		39.13			4:19	Found (%)		17.39		
	Average	-	2.35	22.61	1.09	47.83	35.22	-	2.17	39.13	0.00	82.61	60.87	-	1.22	14.78	0.00	39.13	26.96	-	0.43	8.70	0.00	17.39	13.04
	Standard Deviation	-	2.29	36.33	1.24	38.01	32.17	-	1.64	31.61	0.00	38.76	31.32	-	1.76	25.02	0.00	49.90	35.35	-	1.08	21.60	0.00	38.76	29.45
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00	-	5.00	80.00	0.00	100.00	90.00	-	4.00	80.00	0.00	100.00	90.00

Item #5 Oven						Item #6 Sink						Item #7 Stove Counter						Item #8 Table						Summary		
Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)
	Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)				
16:14	Found (%)		53.33			20:10	Found (%)		66.67			28:2	Found (%)		93.33			28:2	Found (%)		93.33			Avg Item Found(%)		66.25
-	1.53	22.67	0.23	48.67	35.67	-	1.53	36.00	0.50	56.67	46.33	-	2.87	22.67	1.53	49.33	36.00	-	1.83	56.67	2.53	42.67	49.67	39.50	0.00	39.50
-	2.03	35.52	0.68	48.05	37.57	-	1.83	39.09	0.86	43.65	37.64	-	2.15	33.52	1.22	31.40	28.11	-	1.44	31.11	1.72	33.52	26.71	18.81	0.00	18.81
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	3.75	0.00	3.75
-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	5.00	100.00	90.00	90.00	0.00	90.00
7:2	Found (%)		77.78			6:3	Found (%)		66.67			7:2	Found (%)		77.78			9:0	Found (%)		100.00			Avg Item Found(%)		75.00
-	2.22	33.33	0.00	77.78	55.56	-	1.56	35.56	0.33	60.00	47.78	-	1.89	40.00	1.11	55.56	47.78	-	2.22	55.56	3.22	35.56	45.56	46.39	0.00	46.39
-	1.99	36.06	0.00	44.10	35.04	-	1.94	40.96	0.50	45.83	39.62	-	2.03	41.23	1.17	37.12	34.56	-	1.48	29.63	0.97	19.44	15.90	17.30	0.00	17.30
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	20.00	2.00	0.00	30.00	17.50	0.00	17.50
-	5.00	100.00	0.00	100.00	100.00	-	5.00	100.00	1.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	-	4.00	100.00	5.00	60.00	70.00	71.25	0.00	71.25
9:12	Found (%)		42.86			14:7	Found (%)		66.67			17:4	Found (%)		80.95			19:2	Found (%)		90.48			Avg Item Found(%)		60.12
-	1.24	18.10	0.33	36.19	27.14	-	1.52	36.19	0.57	55.24	45.71	-	3.29	15.24	1.71	46.67	30.95	-	1.67	57.14	2.24	45.71	51.43	36.55	0.00	36.55
-	2.02	35.16	0.80	45.00	36.08	-	1.83	39.30	0.98	43.77	37.76	-	2.10	27.50	1.23	29.21	24.06	-	1.43	32.43	1.89	38.02	30.38	19.05	0.00	19.05
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	3.75	0.00	3.75
-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	5.00	100.00	90.00	90.00	0.00	90.00
2:1	Found (%)		66.67			2:1	Found (%)		66.67			1:2	Found (%)		33.33			3:0	Found (%)		100.00			Avg Item Found(%)		70.83
-	1.33	40.00	0.00	66.67	53.33	-	1.33	40.00	0.33	60.00	50.00	-	0.00	33.33	0.00	33.33	33.33	-	1.67	66.67	2.33	53.33	60.00	51.25	0.00	51.25
-	2.31	52.92	0.00	57.74	50.33	-	2.31	52.92	0.58	52.92	50.00	-	0.00	57.74	0.00	57.74	57.74	-	1.15	23.09	2.52	50.33	26.46	37.56	0.00	37.56
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	1.00	40.00	0.00	0.00	40.00	15.00	0.00	15.00
-	4.00	100.00	0.00	100.00	100.00	-	4.00	100.00	1.00	100.00	100.00	-	0.00	100.00	0.00	100.00	100.00	-	3.00	80.00	5.00	100.00	90.00	90.00	0.00	90.00
14:13	Found (%)		51.85			18:9	Found (%)		66.67			23:4	Found (%)		85.19			25:2	Found (%)		92.59			Avg Item Found(%)		63.89
-	1.56	20.74	0.26	46.67	33.70	-	1.56	35.56	0.52	56.30	45.93	-	3.19	21.48	1.70	51.11	36.30	-	1.85	55.56	2.56	41.48	48.52	38.19	0.00	38.19
-	2.04	33.96	0.71	47.72	36.60	-	1.83	38.56	0.89	43.69	37.24	-	2.02	31.34	1.17	28.47	24.98	-	1.49	32.03	1.67	32.31	26.99	16.38	0.00	16.38
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	3.75	0.00	3.75
-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	5.00	100.00	90.00	71.25	0.00	71.25
6:7	Found (%)		46.15			9:4	Found (%)		69.23			11:2	Found (%)		84.62			11:2	Found (%)		84.62			Avg Item Found(%)		63.46
-	1.46	16.92	0.15	43.08	30.00	-	1.38	41.54	1.00	49.23	45.38	-	3.69	10.77	2.08	43.08	26.92	-	2.08	43.08	2.31	38.46	40.77	36.35	0.00	36.35
-	2.07	31.46	0.55	49.56	37.19	-	1.45	36.02	1.08	37.96	35.50	-	1.97	22.53	1.32	26.89	18.88	-	1.71	34.49	1.80	34.12	30.13	17.98	0.00	17.98
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	3.75	0.00	3.75
-	5.00	100.00	2.00	100.00	100.00	-	4.00	100.00	4.00	80.00	90.00	-	5.00	80.00	3.00	100.00	70.00	-	5.00	100.00	5.00	100.00	90.00	61.25	0.00	61.25
10:7	Found (%)		58.82			11:6	Found (%)		64.71			13:4	Found (%)		76.47			17:0	Found (%)		100.00			Avg Item Found(%)		65.44
-	1.59	27.06	0.29	52.94	40.00	-	1.65	31.76	0.12	62.35	47.06	-	2.24	31.76	1.12	54.12	42.94	-	1.65	67.06	2.71	45.88	56.47	41.91	0.00	41.91
-	2.06	38.69	0.77	47.93	38.41	-	2.12	41.87	0.33	47.90	40.27	-	2.11	38.12	0.99	34.47	32.36	-	1.22	24.43	1.69	33.74	22.34	19.61	0.00	19.61
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	40.00	0.00	0.00	20.00	15.00	0.00	15.00
-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	1.00	100.00	100.00	-	5.00	100.00	2.00	100.00	100.00	-	3.00	100.00	5.00	100.00	90.00	90.00	0.00	90.00
4:3	Found (%)		57.14			5:2	Found (%)		71.43			5:2	Found (%)		71.43			7:0	Found (%)		100.00			Avg Item Found(%)		71.43
-	1.43	28.57	0.29	51.43	40.00	-	2.14	28.57	1.00	51.43	40.00	-	2.29	25.71	1.14	48.57	37.14	-	2.43	51.43	3.00	40.00	45.71	43.93	0.00	43.93
-	1.99	39.76	0.76	50.14	42.82	-	1.95	32.37	1.41	42.98	33.17	-	2.36	39.52	1.35	39.76	36.84	-	1.51	30.24	1.53	30.55	28.20	18.49	0.00	18.49
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	1.00	0.00	0.00	20.00	10.00	17.50	0.00	17.50
-	5.00	100.00	2.00	100.00	100.00	-	5.00	80.00	4.00	100.00	80.00	-	5.00	100.00	3.00	100.00	100.00	-	5.00	80.00	4.00	100.00	90.00	71.25	0.00	71.25
12:11	Found (%)		52.17			15:8	Found (%)		65.22			19:4	Found (%)		82.61			21:2	Found (%)		91.30			Avg Item Found(%)		62.50
-	1.57	20.87	0.22	47.83	34.35	-	1.35	38.26	0.35	58.26	48.26	-	3.04	21.74	1.65	49.57	35.65	-	1.65	58.26	2.39	43.48	50.87	38.15	0.00	38.15
-	2.09	34.89	0.67	48.52	36.78	-	1.80	41.30	0.57	44.69	39.39	-	2.10	32.43	1.19	29.46	25.91	-	1.40	31.86	1.78	34.98	26.78	19.11	0.00	19.11
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	3.75	0.00	3.75
-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	2.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	-	4.00	100.00	5.00	100.00	90.00	90.00	0.00	90.00

Room	Living Room		No. of Items:	7

No.	Student	Item #1 Bookrack						Item #2 Potted Plant 1						Item #3 Potted Plant 2						Item #4 Shelf					
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)	
1	Participant 1	TRUE	4	20	1	80	50	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	TRUE	4	20	0	100	60
2	Participant 2	FALSE	0	0	0	0	0	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
3	Participant 3	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	TRUE	3	40	0	100	70
4	Participant 4	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	TRUE	5	0	0	100	50
5	Participant 5	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	TRUE	5	0	1	80	40
6	Participant 6	TRUE	1	80	0	100	90	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	5	0	1	80	40
7	Participant 7	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
8	Participant 8	TRUE	5	0	0	100	50	TRUE	4	20	0	100	60	TRUE	0	100	0	100	100	TRUE	5	0	2	60	30
9	Participant 9	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0
10	Participant 10	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	TRUE	5	0	0	100	50
11	Participant 11	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	5	0	0	100	50
12	Participant 12	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
13	Participant 13	TRUE	0	100	0	100	100	TRUE	0	100	0	100	100	TRUE	0	100	0	100	100	TRUE	1	80	0	100	90
14	Participant 14	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
15	Participant 15	FALSE	0	0	0	0	0	TRUE	5	0	2	60	30	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
16	Participant 16	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	1	80	1	80	80
17	Participant 17	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	TRUE	4	20	1	80	50
18	Participant 18	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	TRUE	5	0	0	100	50
19	Participant 19	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	2	60	1	80	70
20	Participant 20	TRUE	5	0	5	0	0	TRUE	0	100	3	40	70	FALSE	0	0	0	0	0	TRUE	4	20	4	20	20
21	Participant 21	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	TRUE	5	0	1	80	40
22	Participant 22	FALSE	0	0	0	0	0	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
23	Participant 23	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	TRUE	5	0	1	80	40
24	Participant 24	FALSE	0	0	0	0	0	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	TRUE	5	0	1	80	40
25	Participant 25	TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
26	Participant 26	TRUE	3	40	0	100	70	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0
27	Participant 27	TRUE	4	20	0	100	60	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	4	20	1	80	50
28	Participant 28	TRUE	5	0	5	0	0	TRUE	5	0	3	40	20	FALSE	0	0	0	0	0	TRUE	0	100	4	20	60
29	Participant 29	TRUE	2	60	0	100	80	TRUE	3	40	0	100	70	TRUE	3	40	0	100	70	FALSE	0	0	0	0	0
30	Participant 30	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	1	80	0	100	90

Item #5 Side Table						Item #6 Sofa						Item #7 Table											
Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Passed Food Finding	Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)	Diagnosis	Learning Difficulties
	Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)							
TRUE	2	60	0	100	80	TRUE	1	80	2	60	70	TRUE	4	20	4	20	20	FALSE	54.29	0	54.29	Low Vision	TRUE
FALSE	0	0	0	0	0	TRUE	2	60	0	100	80	TRUE	1	80	5	0	40	FALSE	28.57	0	28.57	Low Vision	FALSE
TRUE	5	0	0	100	50	TRUE	5	0	0	100	50	TRUE	4	20	3	40	30	FALSE	50.00	0	50.00	Low Vision	FALSE
TRUE	5	0	0	100	50	TRUE	3	40	3	40	40	TRUE	5	0	5	0	0	FALSE	34.29	0	34.29	No Vision	FALSE
TRUE	4	20	0	100	60	TRUE	5	0	0	100	50	TRUE	4	20	5	0	10	FALSE	37.14	0	37.14	No Vision	FALSE
TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	TRUE	1	80	5	0	40	FALSE	31.43	0	31.43	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	5	0	5	0	0	FALSE	0.00	0	0.00	No Vision	TRUE
TRUE	5	0	0	100	50	TRUE	5	0	1	80	40	TRUE	5	0	5	0	0	FALSE	47.14	0	47.14	Low Vision	FALSE
TRUE	5	0	0	100	50	TRUE	5	0	2	60	30	TRUE	5	0	5	0	0	FALSE	32.86	0	32.86	Low Vision	TRUE
TRUE	5	0	0	100	50	TRUE	3	40	0	100	70	TRUE	3	40	5	0	20	FALSE	41.43	0	41.43	Low Vision	FALSE
TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	21.43	0	21.43	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	2	60	4	20	40	TRUE	5	0	2	60	30	FALSE	10.00	0	10.00	Low Vision	FALSE
TRUE	0	100	0	100	100	TRUE	1	80	0	100	90	TRUE	1	80	4	20	50	TRUE	90.00	0	90.00	Low Vision	FALSE
TRUE	5	0	0	100	50	TRUE	4	20	1	80	50	TRUE	4	20	4	20	20	FALSE	17.14	0	17.14	No Vision	FALSE
TRUE	3	40	0	100	70	TRUE	5	0	2	60	30	TRUE	5	0	5	0	0	FALSE	18.57	0	18.57	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	3	40	5	0	20	FALSE	14.29	0	14.29	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	1	80	0	100	90	TRUE	5	0	5	0	0	FALSE	34.29	0	34.29	Low Vision	FALSE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	TRUE	5	0	5	0	0	FALSE	21.43	0	21.43	No Vision	FALSE
FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	10.00	0	10.00	No Vision	FALSE
TRUE	5	0	4	20	10	TRUE	5	0	2	60	30	TRUE	5	0	2	60	30	FALSE	22.86	0	22.86	No Vision	TRUE
TRUE	5	0	0	100	50	TRUE	3	40	1	80	60	TRUE	5	0	5	0	0	FALSE	35.71	0	35.71	Low Vision	FALSE
TRUE	5	0	0	100	50	TRUE	0	100	0	100	100	TRUE	5	0	3	40	20	FALSE	31.43	0	31.43	No Vision	FALSE
TRUE	3	40	0	100	70	TRUE	3	40	1	80	60	TRUE	5	0	5	0	0	FALSE	45.71	0	45.71	No Vision	TRUE
FALSE	0	0	0	0	0	TRUE	1	80	1	80	80	TRUE	5	0	5	0	0	FALSE	24.29	0	24.29	No Vision	FALSE
TRUE	5	0	0	100	50	TRUE	2	60	0	100	80	FALSE	0	0	0	0	0	TRUE	25.71	0	25.71	No Vision	TRUE
TRUE	0	100	1	80	90	TRUE	1	80	0	100	90	TRUE	4	20	5	0	10	FALSE	37.14	0	37.14	No Vision	FALSE
FALSE	0	0	0	0	0	TRUE	2	60	1	80	70	TRUE	4	20	5	0	10	FALSE	27.14	0	27.14	Low Vision	FALSE
FALSE	0	0	0	0	0	TRUE	5	0	4	20	10	TRUE	3	40	2	60	50	TRUE	20.00	0	20.00	Low Vision	FALSE
TRUE	5	0	0	100	50	FALSE	0	0	0	0	0	FALSE	0	0	0	0	0	FALSE	38.57	0	38.57	No Vision	TRUE
TRUE	5	0	1	80	40	TRUE	2	60	0	100	80	TRUE	0	100	5	0	50	FALSE	37.14	0	37.14	Low Vision	FALSE

Room	Living Room		No. of Items:	7

Students	Summary	Item #1 Bookrack						Item #2 Potted Plant 1						Item #3 Potted Plant 2						Item #4 Shelf					
		Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)
			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)	
All Students	TRUE:FALSE Ratio	20:10	Found (%)		66.67			19:11	Found (%)		63.33			7:23	Found (%)		23.33			20:10	Found (%)		66.67		
	Average	-	2.80	10.67	0.37	59.33	35.00	-	2.63	10.67	0.27	58.00	34.33	-	0.77	8.00	0.00	23.33	15.67	-	2.47	17.33	0.63	54.00	35.67
	Standard Deviation	-	2.35	25.59	1.27	49.41	31.49	-	2.43	27.66	0.83	47.66	29.79	-	1.77	26.05	0.00	43.02	30.81	-	2.26	30.51	1.07	43.36	29.79
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00	-	5.00	100.00	4.00	100.00	90.00
Primary School Students	TRUE:FALSE Ratio	7:2	Found (%)		77.78			7:2	Found (%)		77.78			4:5	Found (%)		44.44			6:3	Found (%)		66.67		
	Average	-	3.33	11.11	0.11	75.56	43.33	-	3.44	8.89	0.00	77.78	43.33	-	1.67	11.11	0.00	44.44	27.78	-	3.00	6.67	0.44	57.78	32.22
	Standard Deviation	-	2.29	26.67	0.33	43.33	27.84	-	2.19	20.28	0.00	44.10	26.46	-	2.50	33.33	0.00	52.70	36.32	-	2.35	14.14	0.73	45.22	26.82
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	80.00	1.00	100.00	90.00	-	5.00	60.00	0.00	100.00	80.00	-	5.00	100.00	0.00	100.00	100.00	-	5.00	40.00	2.00	100.00	70.00
Secondary School Students	TRUE:FALSE Ratio	13:8	Found (%)		61.90			12:9	Found (%)		57.14			3:18	Found (%)		14.29			14:7	Found (%)		66.67		
	Average	-	2.57	10.48	0.48	52.38	31.43	-	2.29	11.43	0.38	49.52	30.48	-	0.38	6.67	0.00	14.29	10.48	-	2.24	21.90	0.71	52.38	37.14
	Standard Deviation	-	2.40	25.78	1.50	51.18	32.91	-	2.49	30.71	0.97	47.59	30.90	-	1.24	23.09	0.00	35.86	27.47	-	2.23	34.59	1.19	43.58	31.49
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00	-	5.00	100.00	4.00	100.00	90.00
All Students that Found the Food	TRUE:FALSE Ratio	3:0	Found (%)		100.00			2:1	Found (%)		66.67			1:2	Found (%)		33.33			2:1	Found (%)		66.67		
	Average	-	3.33	33.33	1.67	66.67	50.00	-	1.67	33.33	1.00	46.67	40.00	-	0.00	33.33	0.00	33.33	33.33	-	0.33	60.00	1.33	40.00	50.00
	Standard Deviation	-	2.89	57.74	2.89	57.74	50.00	-	2.89	57.74	1.73	50.33	52.92	-	0.00	57.74	0.00	57.74	57.74	-	0.58	52.92	2.31	52.92	45.83
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	-	0.00	100.00	0.00	100.00	100.00	-	1.00	100.00	4.00	100.00	90.00
All Students that Did Not Find the Food	TRUE:FALSE Ratio	17:10	Found (%)		62.96			17:10	Found (%)		62.96			6:21	Found (%)		22.22			18:9	Found (%)		66.67		
	Average	-	2.74	8.15	0.22	58.52	33.33	-	2.74	8.15	0.19	59.26	33.70	-	0.85	5.19	0.00	22.22	13.70	-	2.70	12.59	0.56	55.56	34.07
	Standard Deviation	-	2.35	20.20	0.97	49.59	29.74	-	2.41	23.04	0.68	48.19	27.76	-	1.85	20.45	0.00	42.37	27.62	-	2.25	24.27	0.89	43.09	28.32
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	80.00	5.00	100.00	90.00	-	5.00	100.00	3.00	100.00	80.00	-	5.00	100.00	0.00	100.00	100.00	-	5.00	80.00	4.00	100.00	90.00
No Vision Students	TRUE:FALSE Ratio	8:5	Found (%)		61.54			8:5	Found (%)		61.54			2:11	Found (%)		15.38			7:6	Found (%)		53.85		
	Average	-	2.69	7.69	0.38	53.85	30.77	-	2.54	10.77	0.23	56.92	33.85	-	0.62	3.08	0.00	15.38	9.23	-	2.38	6.15	0.62	41.54	23.85
	Standard Deviation	-	2.39	19.22	1.39	51.89	30.95	-	2.50	29.00	0.83	49.56	28.73	-	1.56	11.09	0.00	37.55	22.90	-	2.43	17.10	1.12	44.32	25.34
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	60.00	5.00	100.00	80.00	-	5.00	100.00	3.00	100.00	70.00	-	5.00	40.00	0.00	100.00	70.00	-	5.00	60.00	4.00	100.00	70.00
Low Vision Students	TRUE:FALSE Ratio	12:5	Found (%)		70.59			11:6	Found (%)		64.71			5:12	Found (%)		29.41			13:4	Found (%)		76.47		
	Average	-	2.88	12.94	0.35	63.53	38.24	-	2.71	10.59	0.29	58.82	34.71	-	0.88	11.76	0.00	29.41	20.59	-	2.53	25.88	0.65	63.53	44.71
	Standard Deviation	-	2.39	29.95	1.22	48.60	32.45	-	2.44	27.49	0.85	47.68	31.45	-	1.96	33.21	0.00	46.97	35.61	-	2.18	35.89	1.06	41.37	30.44
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00	-	5.00	100.00	4.00	100.00	90.00
Students with Learning Difficulties	TRUE:FALSE Ratio	6:1	Found (%)		85.71			5:2	Found (%)		71.43			4:3	Found (%)		57.14			3:4	Found (%)		42.86		
	Average	-	3.71	11.43	0.86	68.57	40.00	-	2.57	20.00	0.43	62.86	41.43	-	2.57	5.71	0.00	57.14	31.43	-	1.86	5.71	0.71	28.57	17.14
	Standard Deviation	-	1.98	22.68	1.86	47.41	29.44	-	2.51	38.30	1.13	48.21	29.68	-	2.51	15.12	0.00	53.45	30.24	-	2.34	9.76	1.50	42.98	24.30
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	60.00	5.00	100.00	80.00	-	5.00	100.00	3.00	100.00	70.00	-	5.00	40.00	0.00	100.00	70.00	-	5.00	20.00	4.00	100.00	60.00
Students without Learning Difficulties	TRUE:FALSE Ratio	14:9	Found (%)		60.87			14:9	Found (%)		60.87			3:20	Found (%)		13.04			17:6	Found (%)		73.91		
	Average	-	2.52	10.43	0.22	56.52	33.48	-	2.65	7.83	0.22	56.52	32.17	-	0.22	8.70	0.00	13.04	10.87	-	2.65	20.87	0.61	61.74	41.30
	Standard Deviation	-	2.43	26.88	1.04	50.69	32.56	-	2.46	23.92	0.74	48.49	30.14	-	1.04	28.81	0.00	34.44	29.99	-	2.25	33.83	0.94	41.30	29.43
	Minimum	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00
	Maximum	-	5.00	100.00	5.00	100.00	100.00	-	5.00	100.00	3.00	100.00	100.00	-	5.00	100.00	0.00	100.00	100.00	-	5.00	100.00	4.00	100.00	90.00

Item #5 Side Table						Item #6 Sofa						Item #7 Table						Summary		
Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Item Found	Placement		Size		Total Item Acc (%)	Room Item Acc (%)	Extra Item Penalty	Final Accuracy (%)
	Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)			Diff	Acc (%)	Diff	Acc (%)				
20:10	Found (%)		66.67			23:7	Found (%)		76.67			26:4	Found (%)		86.67			Avg Item Found(%)		64.29
-	2.73	12.00	0.20	62.67	37.33	-	2.20	32.67	0.83	60.00	46.33	-	3.37	19.33	3.80	10.67	15.00	31.33	0.00	31.33
-	2.38	28.09	0.76	47.48	30.95	-	1.92	34.63	1.21	40.34	33.47	-	1.96	29.47	1.81	20.16	17.57	16.73	0.00	16.73
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	5.00	60.00	50.00	90.00	0.00	90.00
7:2	Found (%)		77.78			7:2	Found (%)		77.78			9:0	Found (%)		100.00			Avg Item Found(%)		74.60
-	3.44	8.89	0.00	77.78	43.33	-	2.89	20.00	0.89	60.00	40.00	-	3.78	24.44	4.67	6.67	15.56	35.08	0.00	35.08
-	2.19	20.28	0.00	44.10	26.46	-	2.20	31.62	1.17	40.00	27.39	-	1.64	32.83	0.71	14.14	17.40	15.94	0.00	15.94
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	1.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00
-	5.00	60.00	0.00	100.00	80.00	-	5.00	80.00	3.00	100.00	80.00	-	5.00	80.00	5.00	40.00	40.00	54.29	0.00	54.29
13:8	Found (%)		61.90			16:5	Found (%)		76.19			17:4	Found (%)		80.95			Avg Item Found(%)		59.86
-	2.43	13.33	0.29	56.19	34.76	-	1.90	38.10	0.81	60.00	49.05	-	3.19	17.14	3.43	12.38	14.76	29.73	0.00	29.73
-	2.44	31.20	0.90	48.42	32.96	-	1.76	35.16	1.25	41.47	36.04	-	2.09	28.49	2.01	22.34	18.06	17.18	0.00	17.18
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	10.00	0.00	10.00
-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	5.00	60.00	50.00	90.00	0.00	90.00
2:1	Found (%)		66.67			3:0	Found (%)		100.00			2:1	Found (%)		66.67			Avg Item Found(%)		71.43
-	1.67	33.33	0.00	66.67	50.00	-	2.67	46.67	1.33	73.33	60.00	-	1.33	40.00	2.00	26.67	33.33	45.24	0.00	45.24
-	2.89	57.74	0.00	57.74	50.00	-	2.08	41.63	2.31	46.19	43.59	-	1.53	40.00	2.00	30.55	28.87	38.87	0.00	38.87
-	0.00	0.00	0.00	0.00	0.00	-	1.00	0.00	0.00	20.00	10.00	-	0.00	0.00	0.00	0.00	0.00	20.00	0.00	20.00
-	5.00	100.00	0.00	100.00	100.00	-	5.00	80.00	4.00	100.00	90.00	-	3.00	80.00	4.00	60.00	50.00	90.00	0.00	90.00
18:9	Found (%)		66.67			20:7	Found (%)		74.07			24:3	Found (%)		88.89			Avg Item Found(%)		63.49
-	2.85	9.63	0.22	62.22	35.93	-	2.15	31.11	0.78	58.52	44.81	-	3.59	17.04	4.00	8.89	12.96	29.79	0.00	29.79
-	2.35	23.77	0.80	47.50	29.25	-	1.94	34.34	1.09	40.35	32.86	-	1.89	28.12	1.71	18.67	15.40	13.09	0.00	13.09
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-	5.00	100.00	4.00	100.00	90.00	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	5.00	60.00	50.00	54.29	0.00	54.29
9:4	Found (%)		69.23			9:4	Found (%)		69.23			10:3	Found (%)		76.92			Avg Item Found(%)		58.24
-	2.85	12.31	0.38	61.54	36.92	-	1.85	32.31	0.62	56.92	44.62	-	3.62	4.62	3.38	9.23	6.92	26.59	0.00	26.59
-	2.41	28.91	1.12	47.93	30.93	-	1.95	37.00	0.96	43.09	36.66	-	2.10	8.77	2.14	19.35	10.32	12.69	0.00	12.69
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-	5.00	100.00	4.00	100.00	90.00	-	5.00	100.00	3.00	100.00	100.00	-	5.00	20.00	5.00	60.00	30.00	45.71	0.00	45.71
11:6	Found (%)		64.71			14:3	Found (%)		82.35			16:1	Found (%)		94.12			Avg Item Found(%)		68.91
-	2.65	11.76	0.06	63.53	37.65	-	2.47	32.94	1.00	62.35	47.65	-	3.18	30.59	4.12	11.76	21.18	34.96	0.00	34.96
-	2.42	28.34	0.24	48.60	31.92	-	1.91	33.87	1.37	39.30	31.92	-	1.88	34.73	1.50	21.28	19.65	18.82	0.00	18.82
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	10.00	0.00	10.00
-	5.00	100.00	1.00	100.00	100.00	-	5.00	80.00	4.00	100.00	90.00	-	5.00	100.00	5.00	60.00	50.00	90.00	0.00	90.00
6:1	Found (%)		85.71			5:2	Found (%)		71.43			5:2	Found (%)		71.43			Avg Item Found(%)		69.39
-	3.57	14.29	0.57	74.29	44.29	-	2.29	25.71	1.00	51.43	38.57	-	3.43	2.86	3.00	11.43	7.14	31.43	0.00	31.43
-	1.99	25.07	1.51	44.29	29.36	-	2.14	34.09	1.00	38.05	32.37	-	2.37	7.56	2.31	22.68	12.54	17.67	0.00	17.67
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-	5.00	60.00	4.00	100.00	80.00	-	5.00	80.00	2.00	100.00	80.00	-	5.00	20.00	5.00	60.00	30.00	54.29	0.00	54.29
14:9	Found (%)		60.87			18:5	Found (%)		78.26			21:2	Found (%)		91.30			Avg Item Found(%)		62.73
-	2.48	11.30	0.09	59.13	35.22	-	2.17	34.78	0.78	62.61	48.70	-	3.35	24.35	4.04	10.43	17.39	31.30	0.00	31.30
-	2.47	29.43	0.29	48.80	31.75	-	1.90	35.27	1.28	41.47	34.15	-	1.87	31.88	1.61	19.88	18.39	16.85	0.00	16.85
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	10.00	0.00	10.00
-	5.00	100.00	1.00	100.00	100.00	-	5.00	100.00	4.00	100.00	100.00	-	5.00	100.00	5.00	60.00	50.00	90.00	0.00	90.00