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The Design and Development of Motion Detection Edutainment Maths for Use with Slow learners' children

By

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Thesis submitted to The University of Nottingham for the degree of Doctor of Philosophy, August 2021

Acknowledgement

First praise is to Allah, the first without a first before him and the last without a last behind him, the Almighty, on whom ultimately we depend for sustenance and guidance. In the first place I would like to record my gratitude to Dr. Marina Ng for her supervision, advice, and guidance from the very early stage of this research as well as giving me extraordinary experiences throughout the work. Above all and the most needed, she provided me unflinching encouragement and support in various ways. I am indebted to her more than she knows. I would also like to thank my Co-supervisor Dr. Tomas Maul for his help during the project. His truly scientist intuition has made him as a constant oasis of ideas and passions in science and knowledge, which exceptionally inspire and enrich my growth as a student and a researcher want to be.

Where would I be without my family? My parents deserve special mention for their inseparable support and prayers. My Father, lovely Bahman, in the first place is the person who put the fundament my learning character, showing me the joy of intellectual pursuit ever since I was a child. My Mother, sweet Marzi, is the one who sincerely raised me with her caring and gently love. I hope I made you both proud. Words fail me to express my appreciation to my wife, Zahra whose dedication, love and persistent confidence in me, has taken the load off my shoulder. I owe her for being unselfishly let her intelligence, passions, and ambitions collide with mine. Finally, I would like to thank everybody who was important to the successful realization of thesis, as well as expressing my apology that I could not mention personally one by one.

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Abstract

This research is aimed to examine game-based motion detection technology in helping slow learners' children to improve and enhance their levels of attention and concentration while learning mathematics. The study also aims to explore that game-based motion detection engage slow learners' children while learning mathematics. Additionally, the current study examined the role of game-based motion detection in improving the attention and concentration of slow learners' children as compared to normal healthy students, in terms of learning mathematics and the educational outcomes of such classes

Slow learners are considering a wide different range of students who are not performing well in their study. These group could be including ADHD, Autism, impulsive students, inattention and many more. In this research, I have designed and developed a motion-based mathematic game using Kinect Xbox to test and check the effectiveness and efficiency of slow learners' students in compare with normal students.

For the above purpose, the game has been designed based on several learning theories such as Mayer Principles of learning, Kolb's Learning style and Piaget Theory for K5 and grade 6-8 years old. In experiment design, I have used System Usability Scale (SUS) to rate the features and PACES, Physical Activity Enjoyment Scale have been used for experimentation of the participants.

For testing, both qualitative and quantitative model have been accomplished. Qualitative model was based on the feedback from expert teachers who are observing the students and quantitative model was based on demographic analysis, normality test, reliability analysis and validity test.

The outcome illustrates the value of game-based instruction, in specific physical activities and their impact on children's mathematics. The current study findings highlighted the suitability, needfulness, attention, and enhanced learning through game based instructional design for slow learners. The study answers the advantages of using game based instructional design for the slow learner students.

Chapter 1. Introduction

1.1 Project Background

Slow learning in children induce difficulties in terms of the reception, interpolation, processing, or storing information. Burt in 1937 utilizes the word “education backwardness” or “slow learners” to define students who find it strenuous to cope up with task which demands a certain level of intelligence (Burt, C., 1937). Such students face serious difficulties with their academics and their scholastic performance is below average (Kirk, S.A. and Bateman, B., 1962). Kirk further elaborated that slow learners are not mentally retarded or disabled and can acquire a few degrees of success in academics but is below average as compared to the children from the same age group. Such students are unable to deal with complex mathematical equations, numerical operations, logic, and reasoning and have a low pace to process thus referred to as exhibiting the “Slow learning process” (SLP). Children with SLP do not require special schools to endure their academics but special attention in normal school and get blend with the population with the assistance of special training and adaptive curriculum with their growing age (Vasudevan, A., 2017).

According to a survey conducted in America, over 1.5 million exhibit learning disabilities while 6.5 million require special assistance in accomplishing school tasks and objective learnings out of the total 50 million school students (the United States. Congress). Continuous pressure to get through the peers and school instructions followed by the regret of perpetual failures lead them to lose confidence and motivation and ultimately cause them to drop out (Kaznowski, K., 2004). Three main factors influencing SLP in children encompass limited intelligence level, inadequate education system, and scarcity in adaptability toward the social environment. The school framework is designed with the assumption that children of the same age exhibit the same mental growth along with physical growth thus pursuing equal intelligence level and mental development (Dottrens, Robert., 1962). However, mental development and intellectual growth are directly dependent on experience and exposure toward the complexity along with growing age (Shaffer, D.D.R. and Kipp, K., 2010). Some physiatrists define the slow learning stage with the assistance of mental age in comparison to the physical age. For example, a child of 10 years old may look like other children but he is unable to grasp the intellectual concepts unlike the other students of the same age which ensures that his attainment age of brain is less than the other (Chauhan, S., 2011).

A study conducted for the revelation of educational backwardness claim that students with intelligent quotient range from 80 to 90 find numeric interpolation, reasoning, writing, and reading a stumbling block during academic conduct thus classified as slow learners (Jensen, A.R., 1980). Later on, Kelly presented that individuals with the intelligent quotient ranged from 75 to 80 present slow learners while learning disability exhibit when these ranges exceed 85 to 115 (Kelly, N., 2005). Thus, slow learners do not fit in the requirement for special school but require targeted approaches for the flourishment of the process for the skill attainment and grasping concepts. Multiple characteristics are exhibited by slow learners for their primary identification encloses difficulties in pertaining focus over a particular task, reading with consistency, poor logic and reasoning, inability toward the long term goals accomplishment and struggle with comprehending abstract ideas (Brennan, W.K., 2018).

Learning disorder is classified depending on the academic interventions and the factors affecting the learning process which include; a) Difficulty in reading refer to dyslexia which provokes obstacles in recognizing letter and words, understanding of ideas and interpolation of words, speed and fluency in reading and engaging vocabulary in speech. b) Dyscalculia induce barrier while interpolating numeric problems or solving mathematical equations, organizing concepts, or defining time. c) Dysgraphia invokes difficulties in writing along with spelling and in organizing ideas on paper. d) Dyspraxia provides the sensory integration disorder which affects the motor skills of the students thus disturbing the balance and coordination between eyes and hands. e) Dysphasia or Aphasia define language hurdles during speech affecting fluency (Kemp, G., Smith, M., and Segal, J., 2017). Other disorders that directly affect the learning process include; i) Auditory processing disorder hinders the auditory processing skill or receptive language which ultimately affects the reading, writing, and learning process, especially during child growth. ii) Visual processing disorder induces difficulty during interpolating differences in shapes and affects visual perception while reading or performing any activity which involves motor skills. iii) ADHD induces slow learning due to the inability to concentrate or focus on a particular task due to the existence of inattentiveness, hyperactivity, and impulsivity in children (Semrud-Clikeman, M. and Bledsoe, J., 2011). The summary of types of learning disorders has been shown in Figure 1.1.

Types of Learning Disorders		
Dyslexia	**Reading Difficulty**	Problems with reading, spelling and speaking
Dyscalculia	**Mathematical difficulty**	Problem doing mathematics, understanding time, money use
Dysgraphia	**Writing difficulty**	Problem with handwriting, spelling, organizing ideas
Dyspraxia	**Sensory Integration Disorder**	Difficulty with motor skills, balance coordination
Dysphasia/ Aphasia	**Difficulty with language**	Problems in spoken language, poor reading comprehension
Auditory Processing Disorder	**- Difficulty hearing differences between sounds**	Problems with reading, comprehension, language
Visual Processing Disorder	**Difficulty interpreting visual information**	Problems with reading, math, maps, charts, symbols, pictures
Others	**ADHD/ADD or Autism**	Problems with staying focused, following instructions

Figure 1.1 Types of Learning Disorders

Attention Deficit Hyperactivity Disorder (ADHD) is the most commonly studied and diagnosed psychiatric disorder in children, affecting about 3 to 5 percent of children globally (Craig et al., 2020). It can occur in two distinct forms: one that is mainly a learning difficulty and another that mainly affects behavior (Selikowitz 2009), however, these are not mutually exclusive. The disorder is primarily characterized by the existence of attentional problems and hyperactivity while symptoms start to germinate before seven years of age (Biederman.J 1998).

ADHD, also known as attention deficit disorder (ADD) or hyperkinetic disorder appears to be similar to a disorder described by Hippocrates, (460 to 370 BC). The name Attention Deficit Disorder was first introduced in 1980 in DSM-III, the third edition of the 'Diagnostic and Statistical Manual of Mental Disorders' used in psychiatry. In 1994 the definition was altered to include three groups within ADHD: the predominantly hyperactive-impulsive type; the predominantly inattentive type; and the combined type. ADHD usually appears in childhood but can be diagnosed in adults. Figure 1.2 shows the common types of disabilities that affect the learning process in children directly or indirectly which also include ADHD (Quinn, P 1994).

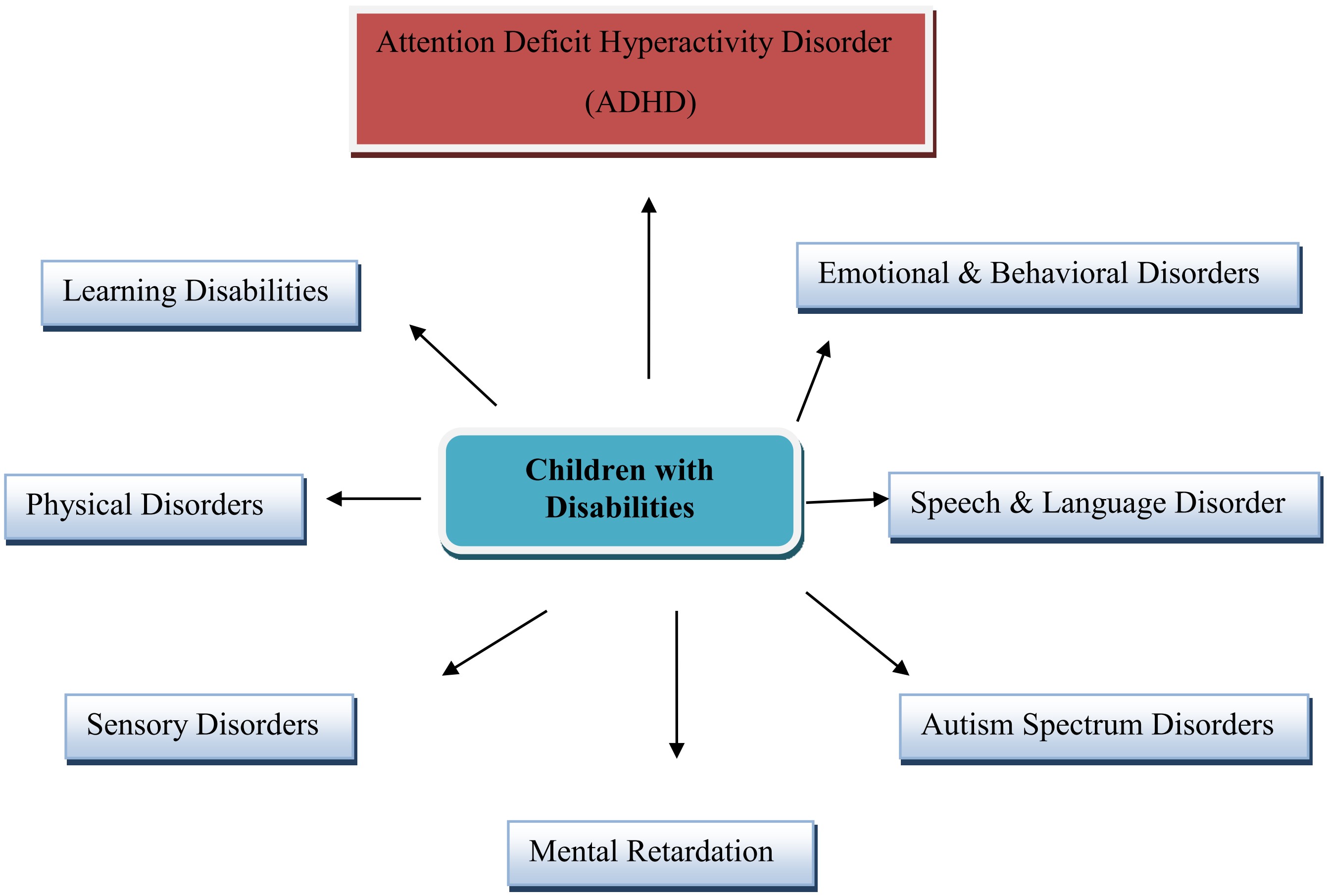

Figure 1.2 List of Disabilities in Children

Many behavior characteristics of students with ADHD provoke slow learning which is either influence by personal disorder or the outer environment. Apart from the existence of disorder, children with emotional inadequacy such as anxiety or depression are more likely to face academic failures due to the slow learning process. The impulsive or hyperactive nature of the children with ADHD prevents them from accompanying long-term goals because they are unable to focus on a particular task thus causing slow learning (Rajkumar, M.R. and Hema, G., 2017). A study conducted over 119 students with an average age of 11 years for the revelation of impact of ADHD and it was found that learning disorder or educational backwardness was more common in 86 students with ADHD presenting the percentile around 70 which may demand the acquisition of special education (Mayes, S.D.,et al., 2000). Approximately 14% of students range from 3 to 21 years of age in the United States received special education or related services in the 2006-2007 school year (National Center for Education Statistics 2008).

1.2 Characteristics of Attention Deficit Hyperactivity Disorder (ADHD)

ADHD is a neurobiological disorder and individuals with ADHD usually diagnose with three traits in their behavior as shown in figure 1.3, which affects their learning ability that encloses poor pulse control, the pattern of impulsiveness along with hyperactivity, and distraction (Cooper, J., 2001). These symptoms may coexist and it is estimated that ADHD affects around 2 to 4% of college students (Epstein, M.H., 2002). Doctors and physicians also use ADD (Attention deficit disorder) instead of ADHD to define above mention state. However, majority of the past researcher focus on the impulsiveness and inattention (Conway, 2020; Craig et al., 2020; Hsu et al., 2021). Inline, Vekety et al. (2021) in their study combined the impulsive and hyperactive. Considering the mix results in the past studies, the current study focused on the two main dimensions of ADHD.

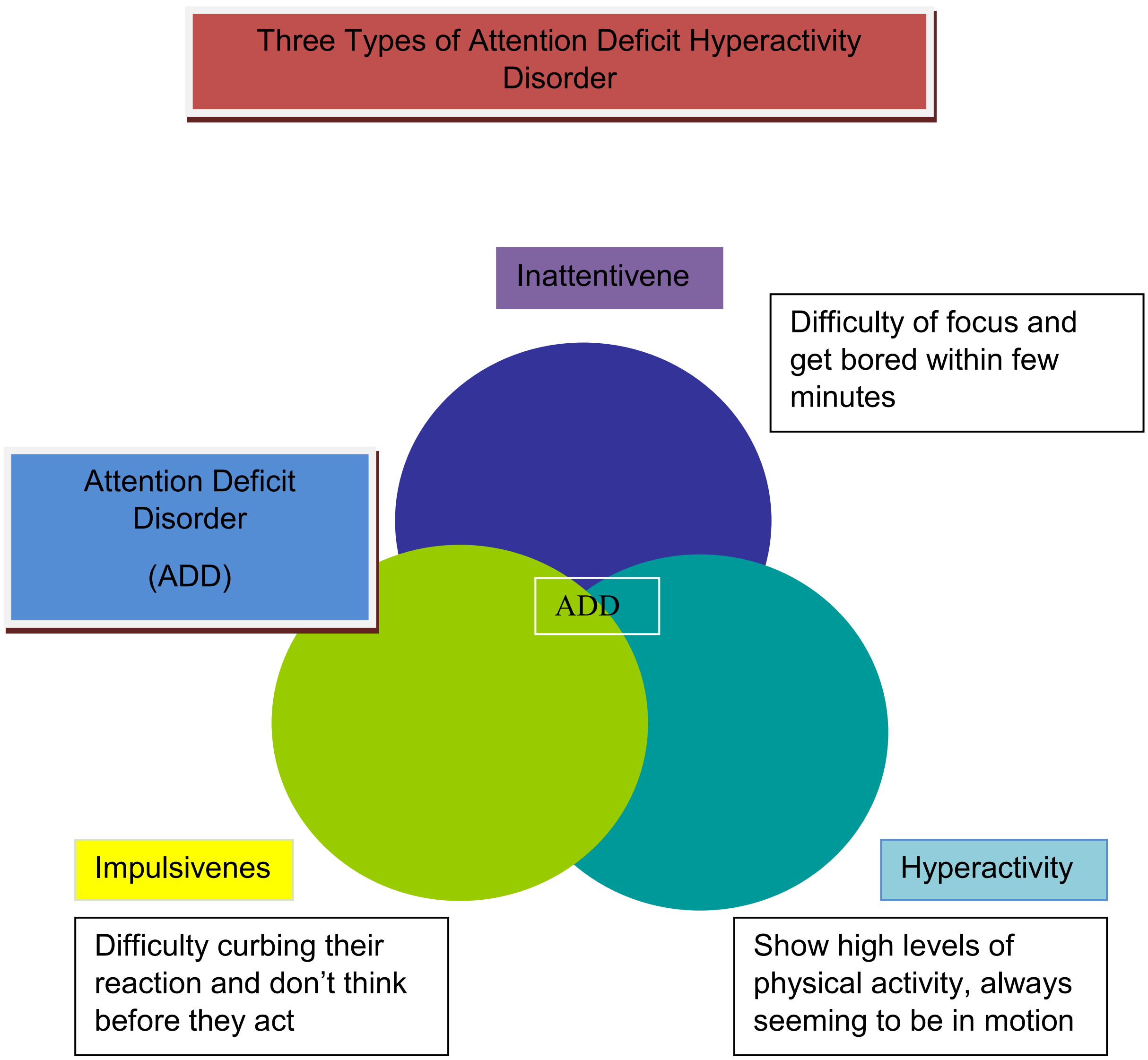

Figure 1.3 Types of ADHD

Based on figure 1.3, three types of ADHD include inattentiveness, impulsiveness, and hyperactivity which each individual part cause slow learning process.

1.2.1 Inattentiveness

Children presenting with the inattention variant of the disorder have difficulty focusing on any one thing and may get bored with a particular task only after a few minutes. One study found that problems in sustaining attention were the most common type of attentional problem in slow learners' children (Tsal, Shalve, & Mevorach 2005) and are usually slow learners.

The symptoms for inattention include:

- Fails to give close attention to the details or makes careless mistakes in school work.
- Difficulty in sustaining attention during tasks or play.
- Does not seem to listen when directly spoken to them.
- Does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace.
- Difficulty in organizing tasks and activities.
- Avoids or dislikes tasks that require sustained mental effort.
- Easily distracted.
- Often forgetful in daily activities

1.2.2 Impulsiveness

Impulsive behavior in slow learners children is often displayed in the form of apparent impatience, as in blurting out answers in class when they have been instructed to 'raise your hand and wait to be called upon to answer' (Lesley Hughes & Paul Cooper 2007). Those observing such impulsive behavior may complain that the child has a careless and unfocused approach towards classroom activities (Sonuga-barke 1992, Taylor 1995, Lesley 2007). Teachers might find that by providing children with clear instruction, and ensuring that they understand what is being asked of them (even if this means repeating the instructions), they are better able to engage with the task and are therefore more focused (Lesley Hughes & Paul Cooper 2007).

Impulsive children have difficulty curbing their reactions and do not do well with a good job of thinking before they act. The symptoms for impulsive slow learners are as follows:

- Blurts out answers before questions have been completed.
- Has difficulty in awaiting turn.
- Interrupts or intrudes on others (butts into conversations or games)

Depending on the characteristics that slow learners children, they can be diagnosed as (1) slow learners with predominantly inattention, (2) slow learners with predominantly impulsivity, or (3) slow learners with both inattention and impulsivity (Santrock 2009). Slow learners people are often dismissed as incompetent, disorganized, aggressive, disruptive, lazy, untrustworthy, neglectful, selfish, accident-prone, and antisocial.

1.3 Impact of Technology on Slow learners

There are two types of technology that can be used to improve the education of students with disabilities which are including instructional technology and assistive technology (Blackhurst 1997). Instructional technology encompasses various types of hardware and software combined with innovative teaching methods, to accommodate student's learning needs in the classroom. Examples include complex hypermedia programs in which computers are used to control and guide the students in real-time, to enhance learning. Assistive technology consists of various services and devices to help students with disabilities function within the learning environment. In this research, the combination of the two methods will be used as hybrid technology.

Learning style is of great importance as it defines the way of interpolating complex information, retaining the new concepts, and define the ways for the concentration

(Dunn, R., 2000). Slow learners' children show consistent academic underachievement, limited educational performance, and learning problems due to the limited ability to concentrate and impulsiveness (Power, T.J., Werba, B.E, et al, 2006). Therefore, investigating the learning style of the slow learners' children is necessary to provide the bridge between a student's intelligence and its ability to pertain academic knowledge. Early-stage detection of slow learners and the adoption of adequate learning styles and techniques improve their performance and speed up their learning process thus ensuring better performance for future academic endeavors. In the learning environment where kids labeled slow learners have the opportunity to engage in movement, hands-on learning, cooperative learning, arts education, project-based learning, or other innovative designs, their behavior is much less likely to be problematic (Eddowes, Aldridge, & Culpepper 1994; Jacob, O'Leary, & Rosenblad 1978; Zentall 1980 & 1993). Therefore, our study focus on a kinesthetic-based learning model that provides a better understanding of their behavior and enabling them to concentrate which ultimately improves their performance.

Integrating technology for the improvement of learnings proves to be beneficial not only for ordinary students but also for students with special needs. In general, technology is incorporated in two ways which are mentioned below:

1.3.1 Instructional Applications

Software and hardware designed for use with traditional students are also being utilized with considerable success with students who have special needs. Mobile computers such as tablets also hold promising results for use with special needs; preliminary research provides evidence that the use of mobile computing devices in inclusive classes can improve the engagement of students with special needs and help in lessening the achievement gap between students with special needs and regular students (Swan 2005). Many factors of technology involved while assisting the affected slow learners' children or special needs with technology. Information conveying method which includes the demonstration of graphics, animations, color and sound over computers engage slow learners' children for a longer time thus helping them to concentrate over particular goal while mitigating the effect of impulsivity and inattentiveness which ultimately improve their academic performance (Parmelee, D.X. and Fisher, J.G., 1999). Another study reveals that computers allow in maintaining focus, retaining patience, promoting learning discoveries, and assisting them to develop problem-solving skills while keeping them motivated (Xu, C., Reid, R. and Steckelberg, A., 2002). In (Solomonidou, C., Garagouni-Areou, F., and Zafiropoulou, M., 2004), the author presented that the particular characteristics of the software-based programming improve their behavior towards learning as they can pay more attention when subjected to the pictorial transferring of information, videos, and short narrated items. On the contrary, Children exhibit difficulty when interacted with long narrations, text, or videos thus providing evidence for the effectiveness of instructional application towards slow learners (Solomonidou, C., Garagouni-Areou, F. and Zafiropoulou, M., 2004).

1.3.2 Assistive Technology

Assistive technologies are software and hardware designed specifically to help students with special needs. For example, printers can produce large print or Braille. Tactile devices that scan a page and translate the text into vibrating, tactile displays also can be used with children who are visually impaired. Telecommunication technologies for the deaf allow children with hearing impairments to communicate with people over the phone. The internet gives children with a disability who are homebound access to educational opportunities. Many children with physical disabilities cannot use traditional devices such as a keyboard and mouse. Touch Screens and voice-controlled devices are alternatives that allow them to use a computer (Santrock 2009). Considering Inattentiveness due to ADHD or SLP provides the roots for poor academic performance. Many researchers suggested that relevant auditory stimulation can be enhanced by reducing awareness of background noises in classrooms. Assistive technologies which include FM system and Sound Field Amplification Systems (SFASs) prove to be effective in the cross-cultural environment of the classroom especially for slow learners' children (Maag, J.W. and Anderson, J.M.). Such systems provide the amplification of the voice of the educationist which is transmitted over a semi-closed headset worn by the students which reduces the noise inputs and disturbance of the background. Similarly, brain training to improve the learning process focus on the utilization of games and software systems that enhance focus and cognitive skills, also considered as a non-pharmaceutical alternative in treating slow learners' children (Wegrzyn, S.C., et al, 2012). These assistive technologies not only mitigate the effect of impulsivity and inattentiveness (Retalis, S., Korpa, T et al, 2014) but also improve memory and focus (de la Guía, E., Lozano, et al, 2015).

1.4 Research Theoretical Framework

The purpose of this research was to examine game-based motion detection technology in helping slow learners' children to improve and enhance their levels of attention and concentration while learning mathematics. Additionally, the study explored that game-based motion detection that engage slow learners' children while learning mathematics. Moreover, the study examined the role of game-based motion detection in improving the attention and concentration of slow learners' children as compared to normal healthy students, in terms of learning mathematics and the educational outcomes of such classes. For this purpose, a research theoretical framework was designed which is shown in figure 1.4. This research theoretical framework is based on slow learners as a general form of learning disabilities. Mayer principles of learning were selected with three principles which encompass a) modality principle which demands the implication of visual and audio mode to transfer information which effectively expands the working memory while reducing cognitive load thus proves to be effective for slow learners with predominantly inattention, b) redundancy principle suggests that redundant material or presenting single information in more than one format disturb the learning process and c) multimedia principle state that visual assistance along with audio enhances the learning capacity as compared to the text-only thus providing effective remedies for slow learners with predominantly impulsivity and slow learners with both inattention and impulsivity.

As shown in Figure 1.4, slow learners are based on two groups of people which include inattention and impulsiveness. In this research three principles of Mayer have been considered while implementing the proposed study which are Modality, Redundancy, and Multimedia principles (Mayer, 2005). The Mayer Principles of Learning were also considered during the study conducted by Kolb for learning styles while presenting experimental learning theory (Kolb, 1984) which details the four learning styles of children such as feeling, watching, thinking, and doing, that will be considered in this research for motion detection mathematics game. Also, to better develop the contents of motion detection game for slow learners' children, the Piaget learning theory (Piaget J 1983) has applied for both preoperational (3-7 years old) and concrete operational stages (7-11 years old). Piaget was the first to conduct a systematic study and claim that intelligence is not a fixed trait but a process of cognitive development that occurs due to the biological maturation and exposure to the environment. Piaget's theory provides the framework for the development of cognition during growth while demonstrating how a child builds a mental model of the world. Finally, to enhance the attention of slow learners' children, the Gagnes Learning theory (Gagne 1985) has been used which concerns using visualization to gain learner's attention and also enhance the content presentation. Gagne considers five major categories of learning while presenting the human approach toward learning which include verbal information, cognitive skills, motor skills, intellectual and behavior. He introduces nine steps for the learning process which include acquiring attention, introducing the learner with an objective, simulating the previous knowledge, demonstrating the stimulus, providing the learning guidance, prompting performance, providing feedback, analyzing performance, and enhancing retention while transferring the learning outcome.

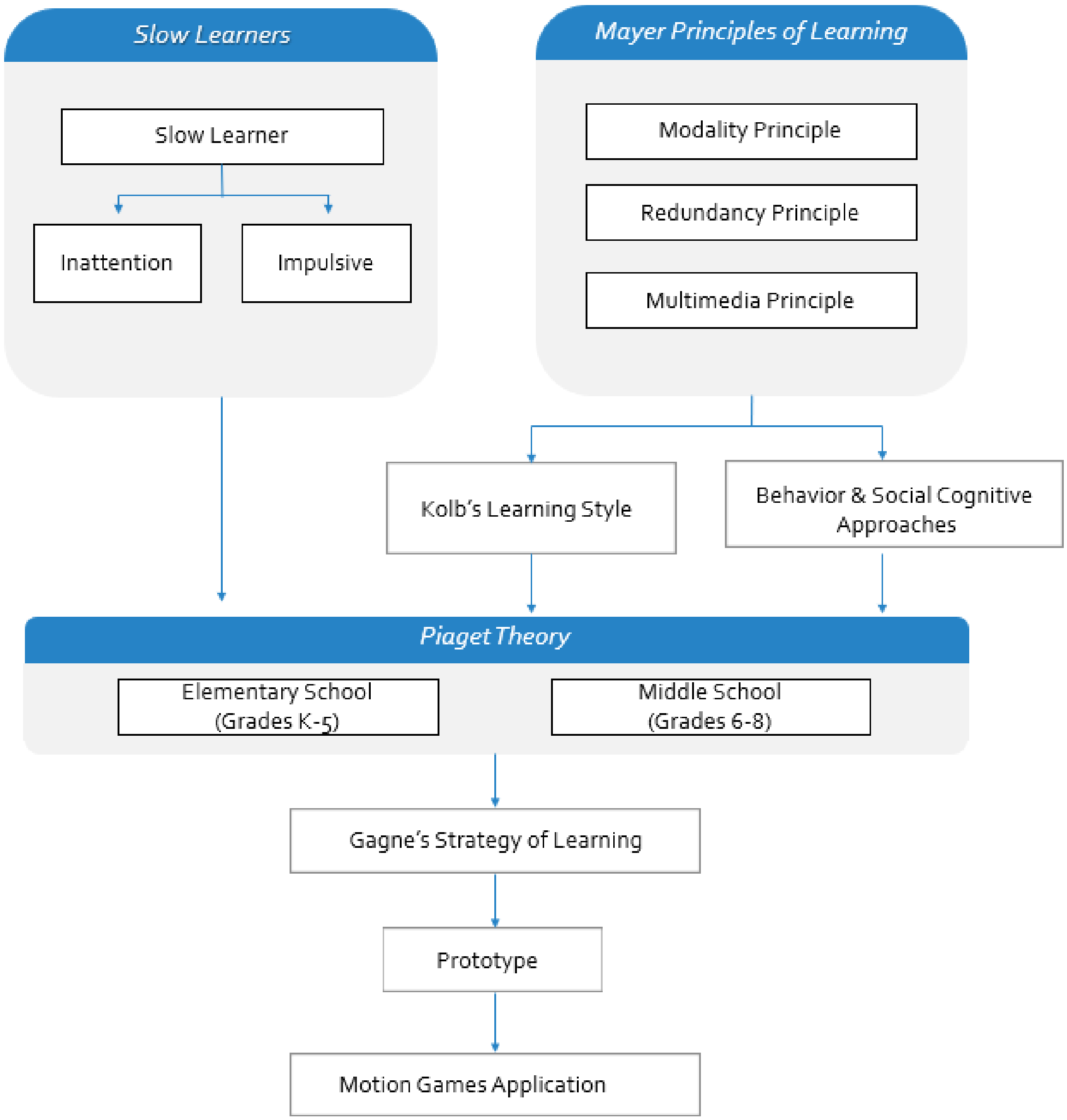

Figure 1.4 Research Theoretical Framework for MAR-Kid

1.5 Problem Statement

1.5.1 Slow Learners and existing technologies

Features of this type of slow learners' children include inattention, easy distractibility, disorganization, procrastination, forgetfulness, and lethargy-fatigue, but with fewer or no symptoms of hyperactivity or impulsiveness affiliated with the other slow learners subtypes (Quinn 1994). Slow learners' children may be at greater risk of academic failures and early withdrawal from school (Triolo, 1998). Teachers and parents may make incorrect assumptions about the behaviors and attitudes of slow learners' children, and may provide them with frequent and erroneous negative feedback (e.g. "you're irresponsible", "you're immature", "you're lazy", "you don't care/show any effort", "you just aren't trying", etc. (Kelly 2006). If these children progress into adulthood undiagnosed or untreated, their inattentiveness, ongoing frustrations, and poor self-image frequently create numerous and severe problems in maintaining healthy relationships, succeeding in postsecondary schooling, or succeeding in the workplace. These problems can compound frustrations and low self-esteem and will often lead to the development of secondary pathologies including anxiety disorders, sexual promiscuity, mood disorders, and substance abuse (Triolo 1998).

Multiple technologies are available in the literature to assist inattentiveness or slow learning in children whether its software integrated application, tablet technology, or motion-based physical involvement. For instance, Huang (2016) presented the idea of animating the education system while providing a reality-based environment to the students, and Hsiao et al. (2013) proposed a manipulative augmented reality system to support the simulation at the classroom, museum, and home to assist different fields of science learning. In another study, augmented reality was integrated to boost mathematical learning while providing informal learning (Sommerauer, P. and Müller, O., 2014). Similarly, (Li, P. L., Wang, J. C., et al. 2014) demonstrated the design of motion-sensing computer games which were incorporated with the physical education curriculum to assist the learning for slow learners or accompanying learning disability. Paraskeva, F., et al. (2010) proposed multiplayer online games as an educational tool that shield and assist the challenges encountered in the traditional educational curriculum. Also, research was conducted at the primary level in which interaction between slow learners and teachers was established in English class which highlighted the gap for the adoption of advanced technology for learning (Qian, J. 2008). Similarly, Saridak et al (2008) demonstrated digital game-based learnings with digital screens as an interactive media for students with learning disabilities.

According to the study, students with learning disabilities find it strenuous to grasp mathematical concepts (Metikasari, S., 2019), and to overcome the challenges, multiple technologies have been integrated to assist the subject deliverables. For instance, Armstrong and Gutica (2020) presented computer technologies as a rationale for their use in the teaching of mathematics in school while Yarmohamadi Vasel et al. (2014) proposed a game-based learning approach for teachers to deliver mathematical concepts at lower secondary school but what is clearly missing in the literature is bridging the mathematical concept with interactive technologies considering the needs and IQ level of targeted students. Mathematics demands a continuous process of practices spans around the different stages i-e from simple to complex with IQ scores from different bands. On contrary, students with learning disabilities or slow learners face challenges when they encountered mathematical problems that enclose inattentiveness due to unattractive mode of learning, confusion due to lack of practices, and impulsiveness due to lack of engagement. This thesis tends to address these problems and bridge the educational gap in the era of mathematics considering slow learners' weaknesses and subject requirement by providing an iterative process of mathematics with ascending IQ level along with the interactive media for enhancing engagement and amusement.

This research is concerned with slow learners’ children who shows symptoms of inattention & impulsivity and developing an edutainment application based on motion detection game to improve and enhance the level of attention and concentration for these students.

1.6 Research Variables

In this research, the main dependent variable is "educational achievement/educational performance" in slow learners' children. Besides, there are three independent variables proposed in this research, which are as follows:

a. Independent Variables (Contents): Prior Mathematical Ability / Achievement

b. Independent Variables (Technology): Motion Detection Game Learning / Normal learning

c. Independent Variables (Gender): Boys / Girls

We access the mathematical intellectual capabilities of the students prior to the use of technology. Then we introduce technology and teach the students with the help of technology aid and again measure the mathematical intellectual capabilities of the students.

1.7 Research Question

RQ1:

- There are some educational technologies such as Augmented Reality, Motion Detection, and Mobile technology which have been found to help students to enhance their learning ability (learning attention; Phelan (1995). **Does a game-based motion detection technology help slow learners' children to improve and enhance their levels of attention and concentration while learning mathematics?**

RQ2:

- One of the main issues for slow learners' children is the period during which they can concentrate during the learning process. **How can game-based motion detection engage slow learners' children while learning mathematics?**

RQ3:

- **To what degree can game-based motion detection improve the attention and concentration of slow learners' children as compared to normal healthy students, in terms of learning mathematics and the educational outcomes of such classes?**

1.8 Research Objectives

- **RO1: To explore that a game-based motion detection technology helps slow learners' children to improve and enhance their levels of attention and concentration while learning mathematics**
- To design and develop a motion detection edutainment application for mathematics, based on learning theories and learning strategies developed for students with inattention and impulsive disorders, to improve and enhance levels of attention and concentration.
- To develop the prototype of a motion game for slow learners' children based on Mayer principles of learning integrated with Kolb's learning style by applying real-time game-based motion detection technology.

RO2: To evaluate the role of game-based motion detection engage slow learners' children while learning mathematics.

- To evaluate and test the content design based on motion detection game on the selected elementary school (grades k-5) for learning mathematics for slow learners' children.
- To investigate the effective learning of game-based motion detection application for slow learners' children on mathematical achievement.

RO3: To examine that game-based motion detection improve the attention and concentration of slow learners' children as compared to normal

healthy students, in terms of learning mathematics and the educational outcomes of such classes.

- To compare the outcomes for slow learners' children with normal healthy students in terms of mathematical achievement.

1.9 Research Scope

The research hypothesis is that Edutainment can increase mathematical achievement in slow learners' children. To test this hypothesis, we took a sample (slow learners' children from elementary school (grades K-5) and middle school (6 to 8 years old)). To confirm our hypothesis, we observed and compared the results from the following four groups:

1) slow learners' children who receive Edutainment.

2) Normal students who receive Edutainment.

This way we can test whether Edutainment works for slow learners' children and compare it whether Edutainment improves learning more generally as well as investigating whether or not this form of motion detection game is more effective for slow learners' children than normal healthy children.

1.10 Procedure

The procedure of research conceptual framework designed for this research is based on four stages as indicated in Figure 1.5. As indicated in the framework, Stage I includes the analysis process. In the analysis process, several steps were taken such as initial analysis, specifications requirement, literature review, interviews, research question, which cause the subsequent steps such as objectives of the research, research organization, research scope, and final formulation of the Software Requirement Specifications (SRS).

Stage II involved the design process and development of the system. In the design process, aspects such as model and storyboard of the development of MAR-Kid were conducted to ascertain the Software Design Specifications (SDS). At the progress stage, the process of the system was divided into three parts namely, motion detection, real-time interaction, and Microsoft Kinect Xbox.

Stage III involved the implementation. At this stage, the development of the prototype involved two parts namely, software and hardware used. The software included modeling software, programming software, and other special software related to AR. The hardware included the equipment and facilities that were used in the research such as Kinect Xbox and the widescreen.

Stage IV involved evaluation and testing. At this stage, the designed system went through pilot system testing and also usability testing, concentrating on the strengths and weaknesses of the system.

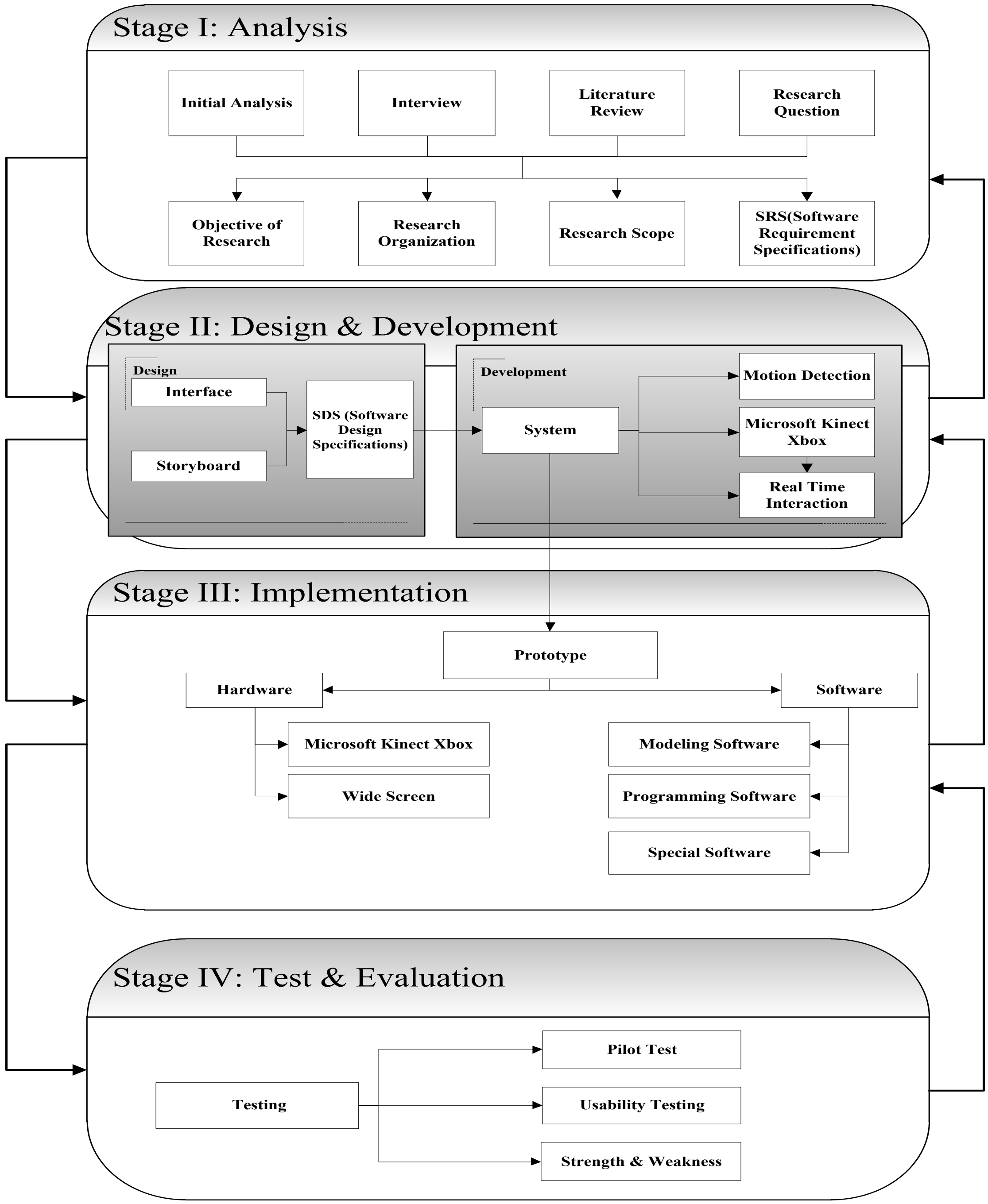

Figure 1.5 Procedure for Research Conceptual Framework for MAR-Kid

1.11 Conclusion

Slow learning children requires special attention so that they can compete with quick learners. Technology can play its role in this domain as well as it is improving our lives in many ways. The prime objective of this thesis is to validate our hypothesis that uses technologies such as motion detection can help to improve and enhance the attention of slow learners' children, concerning a combination of learning theories as well as learning strategies. This research is also concerned with an instructional design model for lecturers to apply effective learning techniques for the slow learners' children. We believe that technology can expedite the learning process in the pupil who are slow learners.

Chapter 2 Literature Review

2.0 Over View of the Chapter

These chapters review the past literature on the Slow Learners, Game Development, Kinetic Motion based model and the context of the study. Relevant theories will be elaborated and the theoretical framework will be constructed based on the theories and gaps in the literature. The chapter also discusses the relationship between the endogenous and exogenous variables. The prepositions were developed at the end of the study. Lastly, summary of the whole chapter will be presented.

2.1 Slow Learners

Slow learners refer to the children with limited intelligence and first demonstrated as education “backwardness” or “slow learners” by Burt in 1937 (Burt, C., 1937) which was narrated to describe the children who find it strenuous to cope up with activities which demand a certain level of intelligence. Kirman further elaborated the term while claiming such students face difficulties with their academics as compared to the other children of the same age group (Kirman, B.H., 1975). Such children have limited ability to deal with symbolic or abstract studies such as language or numeric interpolation and are slightly different from normal students in grasping concepts. Complex assignments or games seem to be burdensome for them which causes them to get easily distracted thus leading to the slow learning process (SLP). Students with SLP need special attention and require continuous encouragement to endorse them for the accomplishment of specific goals since children with SLP are slow to catch up.

Different terms and conditions are referred to for the identification of the SLP state. Some psychologists define this state with the assistance of mental age corresponding to the physical age. For that instance, a child who is 10 years old may look like other children in his appearance but he is unable to attain concepts ensuring that his attainment age of brain is below phrased as a slow learner (Chauhan, S., 2011). According to a study, students with intelligent quotient range from 80 to 90 attain absurdities while interpolating the complex scenario during any activity especially reading, writing, and mathematical or numeric interpolation, are usually classified as slow learners (Jensen, A.R., 1980). Learning difficulties are categorized based on academic difficulties, physical age, and intellectuals. Students with the problem in reading is usually termed as dyslexia in which student is unable to recognize letters or words and has the limited ability to interpolate them. Dysgraphia refers to the students with the difficulty in writing, organizing thoughts on paper, or coherency in writing (Borus, A., 2019). In Dyscalculia, students struggle with numeric interpolation and mathematical operations. Other types encompass dyspraxia in which student face difficulties while executing motor skills and aphasia/dysphasia refer to the obstacles in acquiring language (Moll, K., Göbel, S.M. and Snowling, M.J., 2015).

Many factors are involved in the behavioral characteristics of slow learners either influenced by the outer environment or personal disability. Limited intellectual ability, illness, poor parenting, and incompatible environment are general factors that induce slow learning in children. Students exhibiting anxiety, depression, or emotional disorders find it strenuous to concentrate on the goals with consistency thus providing the barrier in the learning process. The existence of slow learning in such children also provokes learning problems. According to a survey, dyslexia is identified as a slow learning factor, and the overlap of ADHD with dyslexia was found to be 35% (Lagae, L., 2008). In another search, a study is conducted over 119 students with a mean age of 11 years and it was found that learning disability or education backwardness was more common in 86 children with ADHD which present 69.8 percent as compared to the children without ADHD (39.4 %) (Mayes, S.D., et al, 2000).

Newcomer et al. (1995) demonstrated that anxiety and depression are more common in children with Learning Disabilities (LD)/SLP. Hyperactivity and impulsivity have also been identified in students exhibiting slow learning (Sripriya, S. and Lenin, M.S.). Hyperactivity in children was first documented in 1902 by Sir George Still (Bradley, 1937) in which he studied the group of children and find out that few children couldn’t control their behavior, unlike typical children. In the beginning, it was named minimal brain dysfunction. In the Diagnostic and Statistical Manual of Mental Disorders, Second Edition (DSM–II; American Psychiatric Association [APA], 1968), it was named hyperkinetic reaction of childhood disorder for the emphasis on the hyperactivity as the key deficit. In 1980, the DSM–III published the name attention deficit disorder (ADD; APA, 1980) and provided the first empirical-based set of diagnostic criteria. Within this diagnosis, hyperactivity and inattention were given as primary deficits (Cormier, 2008). The DSM–IV (APA, 1994) classified three types of attention disorders which enclose: a) combined type, which carries all symptoms of inattention, impulsivity, and hyperactivity; b) predominately inattentive type, in which attention is the primary issue; and c) predominately hyperactive-impulsive type, in which hyperactive and impulsivity symptoms persist (Corbett, Constantine, Hendren, Rocke, & Ozonoff, 2009). As clinical research advanced, it becomes clear that the hyperactivity and the impulsiveness seen in children diagnosed as behaving ADD with hyperactivity were highly related to each other. Longitudinal research also reveals that inattention and hyperactivity-impulsivity dimensions follow different developmental courses (i.e., inattention remains relatively constant while hyperactivity-impulsivity declines substantially with increasing age) and the two dimensions differ concerning their association with comorbid disorders (i.e., hyperactivity-impulsivity is more strongly correlated with oppositional and antisocial behaviors whereas inattention is more closely associated with affective disorders (Lahey et al., 1994). ADD may induce slow learning in children while affecting their ability to process information which provokes learning difficulties and computation analysis during the educational curriculum (Rajkumar, M.R. and Hema, G., 2017).

ADHD is a developmental disorder, which is associated with childhood. These kinds of slow learners often have difficulties in sustaining attention, have an extensive or inappropriate level of motor activity, and have problems in inhibiting their behavior (Barkley,1990). The core symptoms are inattention, hyperactivity, and impulsivity (American Psychiatric Association, 1994). It occurs in about 8% of children (Farone, Sergeant, et al, 2003). According to Schilling and colleagues (2003), slow learners' children have a difficult time in their academic setting because of sensory-motor problems such as difficulty sitting and paying attention and failure to complete assignments, which leads to educational underperformance due to their limited ability to learn which is commonly referred as slow learning. slow learners' children experience a wide range of secondary behavioral and emotional problems at school. According to Schilling et al. (2003), slow learners' children are thirty-three percent more likely to drop out of school as compare to their class fellows who are not slow learners.

McGough and McCracken (2000) showed that the hyperactive-impulsive slow learners is the least prevalent of the three subtypes. Children diagnosed with the hyperactivity-impulsive subtype tend to show symptoms at an earlier age and tend to have more significant symptoms. A diagnosis of hyperactivity-combined type is often seen when academic demands are increased, and sustained attention is needed. Hyperactivity inattention is the most common of the three subtypes, accounting for 40% to 50% of all slow learners' children (McGough & McCracken, 2000).

Slow learners' children do not usually get along well with their peers. According to an estimation, over 50% had significant problems in their peer relationships. Research shows that the inattentive, disruptive, immature, and provocative behavior of slow learners' children quickly bring out a pattern of controlling and directive behavior from their peers when they must work together**.** Slow learners' children are often insufficiently self-conscious. A slow learners' child is likely to have social problems because he alienates other children by butting in, taking their things, failing to wait for his or her turn, and in general, acting without having first considered the feeling of others (Lahey, Schaughency, et al., 1987). Lynam (1996) argues that slow learners' children and who are also antisocial in their personalities are at a high risk of becoming psychopathic in adulthood and chronic offenders. A key for understanding the antisocial behavior of slow learners' children is poor behavioral control (Barkley, 1997), which also appears to influence how they cope with interrogation (Gudjonsson, Young & Bramham, 2007) and court proceedings (Gudjonsson & Young, 2006). The rate of prevalence of adult slow learners at age 25 was 1.2% if a narrow definition of the persistence of symptoms was used, but this increased to 4.7% of those in partial remission are included (Farone et al., 2006).

Because of their disruptive behavior, slow learners' children are more likely to be suspended or expelled from school. Weiss et al. (2003) prevail that conduct disorder and aggressiveness are far more common with slow learners' children (Barkley et al., 1990; Barkley, DuPaul, & McMurray, 1991; Faraone, Biederman, Wever, & Russell, 1998; Edelbrock, Costello, & Kessler, 1984; Goodyear & Hynd, 1992; Lahey et al., 1987; Morgan, Hynd, Riccio, & Hall, 1996; Nigg, 2000; Weiss et al., 2003). Conversely, slow learners' children are somewhat more prone to internalizing disorders such as anxiety or depression or at least show a marked absence of externalizing disorders and tend to be more socially isolated or withdrawn than children with ADHD (Barkley et al., 1990, 1991; Faraone, Biederman, Wever, & Russell, 1998; Edelbrock, Costello, & Kessler, 1984; Goodyear & Hynd ADHD Faraone et al., 1998; Warner–Rogers, Taylor, Taylor, & Sandberg, 2000; Weiss et al., 2003; Willcutt & Pennington, 2000). Slow learners' children exhibit serious problems with mental mathematical calculations because of their inability to process the information comparative to those of the same age group (Carlson, Lahey, & Neeper, 1986; Hynd et al., 1991; Marshall, Hynd, Handwerk, & Hall, 1997; Morgan et al., 1996; Lahey et al., 1987; Morgan, Hynd, Riccio, & Hall, 1996; Nigg, 2000; Weiss et al., 2003)

ADD also induces Slow Learning Processing (SLP) which is not a mental disability but limited intelligence to interpolate critical reasoning (Aiello, B., 1977). Students with SLP face educationally backwardness due to their limited ability unlike other students of the same age group. The term 'backwardness' or 'slow learners' was first defined by (Bun, 1937) which is referred to as the students whose academic performance is below average as compared to the students with the same age group (Brousseau, V. and Kirman, A., 1992). A child with a limited learning process can attain an average level of academic success at a slower rate as compared to the same age fellows and therefore, can be accumulated in normal school but with special supervision to accompanying them with their slow learnings (Kirk, 1962). The students with borderline mental retardation also tend to learn at a low pace but with the help of special training and adaptive curriculum, they can cope up with the environment with their growing age and get blend in with the normal population at their adulthood. S Metikasari presents the study to prevail the mathematical learning difficulties associated with slow learners and analysis was made on a Pythagoras theorem by deploying a qualitative approach (Metikasari, S., 2019). Results demonstrated that the difficulty with mathematics is directly influenced by a procedural memory deficit, semantic memory deficit, and visuospatial deficit.

Slow learning is estimated to affect between three to five percent of school-age children (APA, 1994). However, referral source (clinic versus epidemiological sample) and method of selection (single versus multiple raters and requirements for scale elevation) impact prevalence rates (Barkley, 1998; Carlson & Mann, 2000). The estimation for slow learners is even wider. According to a survey, 1.5 million children have a learning disability in America and 6.5 million students need special assistance in learning out of the total school population of 50 million (United States. Congress). Pliska in 2000 demonstrated that slow learners' children often also meet diagnostic criteria for learning, conduct, anxiety, major depressive, or oppositional defiant disorders (Pliska, 2000). In (Tannock, 1998), the author while summarizing comorbidity rates, reports a 40% to 90% co-occurrence between slow learning and conduct and oppositional disorders: a 25% co-occurrence between slow learners and anxiety disorders, and a 20% overlap of slow learning and learning disorders. Thus, in a classroom of 20 children, chances are that at least one child has slow learners and may have associated co-morbid areas of difficulty.

Several studies have investigated the prevalence of slow learning among adult prison inmates (Dalteg, Lingren, & Levander, 1999; Eyestone & Howell, 1994; Gudjonsson, Sigurdsson, Einarsson, Bragason, & Newton, 2008; Matsumoto et al., 2005; Rasmussen, Almvik, & Levander, 2001; Rösler et al., 2004; Vitelli, 1995, 1998; Young et al., 2009). These studies use different methodologies in assessing childhood and adult slow learners' symptoms. However, the results from these studies indicate that childhood slow learner among adult prison inmates ranges from 24% to 67% and adult slow learners ranges from 23% to 45%. These numbers indicate that slow learning is more common among offenders than the public, highlighting the role of antisocial personality disorder, which requires further investigation. Anxiety and depression are common co-morbid problems in adults' slow learners. irrespective of the presence or absence of personality disorder (Brassett-Grundy & Butler, 2004).

Students with SLP face continuous pressure to cope up with peers and school instructions along with the regret of continuous failure leads them to drop out due to the lack of motivation and low confidence (Kaznowski, K., 2004). Such students are unable to interpolate logic and find difficulties with the basic numeric computations which require a certain level of IQ to get addressed which leads them to lose interest (Rajkumar, M.R. and Hema, G., 2017). Three main reasons behind the SLP include limited intelligence level, flaws in the education system, and scarcity for adaptability in the social and family environment. School infrastructure assumes that the physical age guarantees equal mental development, intelligence level, and capability for which conducting the same curriculum with a proficient level of intelligence becomes challenging for the students with SLP (Dottrens, Robert. , 1962).

Research into the personality of people with SLP symptoms has been limited. However, several studies have investigated the relationship between the 'Big Five' model of personality and SLP (Nigg et al., 2002; Parker, Majeski, & Collin, 2004; Ranseen, Campbell, & Baer, 1998). Nigg et al. (2002) point out that the strongest Theoretical links with SLP are with the conscientiousness (low score), neuroticism (high score), and agreeableness (low score) dimensions and found empirical evidence to support which provide the foundations for the presence of SLP in the children exhibiting slow learning. Ranseen et al. (1998) only found a significant relationship with the conscientiousness dimension. Parker et al. found that these symptoms, whether operationalized as continuous or categorical variables, were significantly associated with all the five factors, but most strongly with the conscientiousness and agreeableness dimensions. Extraversion was positively associated with the hyperactivity/impulsivity SLP items and negatively with the inattention items, whereas there was greater consistency in the relationship with the other 'Big Five' dimensions.

SLP in general is a developmental disorder of self-control. It consists of problems with attention span, impulse control, and activity level. These problems are reflected in impairment in a child's will or capacity to control behavior relative to the passage of time to keep future goals and consequences in mind. SLP is a real developmental disorder and while conducting study scientists must show that 1) it arises early in child development 2) it clearly distinguishes these children from normal children or those who do not have the disorder.3) it is relatively pervasive or occurs across many different situations not necessarily all of them, 4) it affects a child's ability to function successfully in meeting the typical demands when kept in front of children of that age 5) it is relatively persistent over time or development 6) it is not readily accounted for by purely environmental or social causes 7) it is related to abnormalities in brain functioning or development which is defined as a failure or deficit in the natural functioning of a mental ability that accurses in all normal human and 8) it is associated with other biological factors that can affect brain functioning or development (i-e, genetics, injuries, and toxins, etc). The children just described also illustrated how SLP represents a significant impairment in the ability to inhibit their behavior. In its early history a distinctly recognizable phenomenon (1902), SLP was seen as a problem in how children learn to willfully inhibit their behavior and to adhere to rules of social conduct not simply social etiquette, but fundamental morals of the time.

On the other hand, adolescence diagnosed with SLP demonstrates greater deficits in some executive functions such as vigilance, inhibition, working memory, sense of time, and interference control (Barkley, 2004). Cox et al. (2007) found in the United States, approximately 8-10 percent of the school-age population are diagnosed with SLP. The researchers found children with this disorder can have impaired function in multiple settings, including but not limited to home, work, and school. Individuals diagnosed with SLP have trouble in these multiple settings with completing their activities of daily living (ADL) and instrumental activities of daily living (IADL). According to the Occupational Therapy Practice Framework, having SLP limits people in their areas of occupation such as dressing, eating, formal education, work, leisure participation, social participation with family and friends, and community mobility (American Occupational Therapy Association, 2008).

Evidence has accumulated to indicate that adults with SLP, like slow learners' children, have impaired performance on a range of neuropsychological tests including measures of attention, impulsivity, and executive functioning (see Bridgett & Walker, 2006; Hervey, Epstein, & Curry, 2004; Schoechlin & Engel, 2005). Several meta-analyses have investigated the neuropsychological profile of adults with SLP which have predominantly reported that overall cognitive ability is significantly lower among adults with SLP than normal participants (Bridgett & Walker, 2006). More specifically, Hervey et al. (2004) found that attention appears to be the primary domain most closely associated with adulthood SLP and Schoechlin and Engel's (2005) meta-analysis found the highest effect sizes for adults with SLP on measures of focused attention, sustained attention and problem solving with working memory. Simple alertness tasks that rely on basic psychomotor reaction time were less impaired than more complex attention tasks.

Slow learners' children have been found to attain lower academic levels than their peers (Frazier, Youngstrom, Glutting, & Watkins, 2007). Children with this category may possess SLP leading to limited cognitive abilities. This trend also applies to children who are severely inattentive, hyperactive, and impulsive but do not have a formal diagnosis of the disorder (McGee, Prior, Williams, Smart, & Sanson, 2002; Merrell & Tymms, 2001).

2.1.1. Types of Slow Learning

Individuals with SLP find difficulties in the learning process as they are unable to focus on goals and get distracted frequently are usually defined as slow learners. Slow learning term is mostly used by educationists for defining the student with less ability to interpolate information or with limited intelligence (Martin, R. and Martin, W., 1965). Children with slow learning pose difficulties in understanding different information that requires a certain intelligence level like mathematics and hence, not a mental disability or learning disability. Such children may not perform well while solving Pythagoras theorem or any algebraic equation but they perform well in different curricular activities with their interest or with less IQ requirement. According to the survey, individuals with an IQ range of 75 to 80 are said to be slow learners while learning disabilities provoke an average IQ range from 85 to 115 (Kelly, N., 2005). Thus, such children don't fit in for the requirement of a special education system but special attention and targeted approaches in a normal school assist them with the grasping of knowledge and focus. A normal school is an institution created to train high school graduates to be teachers by educating them in the norms of pedagogy and curriculum. And the normal students refer to the children studying in the school without any mental or physical ailment.

Slow learners exhibit the scarcity in manipulating similarities or differences, familiarities, logic, and reasoning, discovering relationship, and critical thinking which induce social impacts like insecurity, fantasy, deterioration, or sometimes show the trait of an introvert (Vasudevan, 2017). Apart from ADD/ADHD short attention span which doesn't let slow learners for engaged goals, multiple reasons have been reported which include eyesight weakness or other health problems especially long term diseases, inattentive parents, violence, and being ignored or exhibiting partiality which hinder not only their confidence level but builds obstacles for growth and development (Vijay, M.M., 2020).

Early-stage detection of slow learning is necessary from the psychological point of view especially for the student with extreme education backwardness followed by poor manipulation and retarded speech. Although students with these attributes go to school but eventually drop out if their educationist needs remain unaddressed. Early-stage identifications lead to effective interventions thus mitigating the stagnation for a longer run. Multiple techniques have been introduced for the detection of slow learning since the identification of such students is difficult as they behave similarly to the other students but with limited intelligence. Chintamani Kar reveals seven steps for the identification (Kāra, C., 1992). Later on, G.L.Reddy introduced three effective steps in the identification of slow learners which encloses: a) Initial identification phase; b)

Scientific/Medical confirmation phase; c) Counter check phase. During the initial assessment, he defines techniques for indicating slow learners based on social behavior which encompasses observation techniques, educational assessment, and a child's social history in family or toward society norms (Reddy, G.L., 1997).

Latest technologies have made a lot easier for the assessment of slow learner among students which prove to be a turning point for such individuals and educational institutes. According to a survey, one out of 20 students from a class is affected by slow learning, and considering the identification process for so many students of any institute is quite hectic and therefore be ignored. However, the advancement in technology led the identification process easier by developing interactive algorithms and software for the analysis of students. Data mining algorithms have been introduced by (Mhetre, V. and Nagar, M., 2017) where education-based data collection helps to predict student behavior. Education Data Mining (EDM) incorporate different classification techniques along with student educational background and scored marks in previous educational curriculum for the identification of slow learner.

According to a survey, SLP is a cost strenuous disorder that intrudes on the expenses of medications, curative education, and therapies that demonstrate the direct cost (Karande, S., Ramadoss, et al., 2019). According to the author, expenditures involved tuitions, treatments, and curative educations present 57.38%, 16.18%, 10.30% of direct cos involved respectively. These expenditures can be mitigated with the early detection and diagnosis of SLP in children.

There are generally three major types of learning styles for students which are:

i) Visual Learning Style

Visual learning prefers a visual approach for learning and is likely to extract information from pictures, videos, or diagrams as compared to verbal communication and organize their thoughts in pictorial form.

ii) Auditory Learning Style

Auditory learners infer information through verbal communication and listening to the speech. They interpolate the concept by focusing on the pitch, tone, and speed at which information is delivered and memorize by reading out loud the content. Information in written form is less effective for them (Gilakjani, A.P., 2012).

iii) Kinesthetic Learning Style

Children with this style of learning prefer to learn with the assistance of physical objects, like to move around while learning, and enjoy regular breaks (Oxford, R.L., 2001).

2.1.2 Slow Learners & Impulsivity

According to the DSM-IV-TR (2000), impulsivity “manifests itself as impatience, difficulty in delaying responses, blurting out answers before questions have been completed, difficulty in waiting for one’s turn, and frequently interrupting” (p. 86). Like inattention, impulsivity is prevalent in academic, occupational, and/or social situations (DSM-IV-TR). Impulsivity, as defined, was measured by the restless-impulsive subscale on the Connors’ Global Index-Parent and Connors’ Global Index-Teacher (Connors, 1997). The concept of impulsivity covers a wide range of actions that have negative consequences, are spontaneous, unplanned, often risky, and inadequate for the context (Evenden, 1999).

Impulsivity is a multidimensional construct (Plutchik & van Praag, 1995) involving different definitions and paradigms. Impulsivity is of different types which are determined based on different forms of impulsive behaviors (Evenden, 1999). Based on this, multiple instruments or revealing techniques have been developed to measure impulsivity. Behavioral tasks or self-administered questionnaires are the two fundamental techniques to determine the category of impulsivity. Different studies have pointed out the poor correlation between measures obtained using these two types of instruments, indicating that they could be measuring different aspects of the impulsivity construct (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). This overview of impulsivity research places special emphasis on the reasoning underlying previous investigations of the impulsivity construct in the hope of gaining a better understanding of the application of this work to studies of hyperactive children or slow learners. Impulsivity constitutes one of the core facets of SLP (American Psychiatric Association APA, 2000). The concept of impulsivity covers a wide range of actions that have negative consequences, are spontaneous, unplanned, often risky, and inadequate for the context (Evenden, 1999).

Analysis of data from children in elementary schools has revealed that inattention is particularly related to academic underachievement (effect size= −1.07 at age 7), hyperactivity/impulsivity has less of a negative association (effect size=−0.58), (Merrell & Tymms, 2001). Karmos, Scher, Miller, and Bardo (1981) found that impulsivity alone is negatively related to reading and mathematics. Vigil-Colet and Morales-Vives (2005) note that impulsivity is inversely related to intelligence, particularly crystallized intelligence and positively linked to academic failure.

Unlike the symptoms of inattention and distractibility, symptoms of hyperactivity and impulsivity often vary from childhood to adulthood (Weiss, Hechtman, & Weiss, 1999). Whereas slow learners' children will often fidget, inappropriately runabout, or leave their seats in classroom settings, and usually appear to be "on the go" (APA, 1994), adults with SLP exhibit less global motor output (Hill & Schoener, 1996). Although some adults with SLP display fidgetiness, most will report only a subjective sense of needing to be on the go or a preference for doing things at a frenetic pace (Weiss, Hechtman, & Weiss, 1999).

Recent findings suggest that many of the attentional problems experienced by these children are a function of their impulsivity. For example, impulsive and disruptive behavior patterns exhibited by these children may lead to peer difficulties (Ekerim-Akbulut et al., 2020; Evans et al., 2015; Valero et al., 2021). Aggressive and antisocial behavior has also been linked to impulsivity (Azevedo et al., 2020; Hofhansel et al., 2020). Despite a concerted research effort, impulsivity in general or exhibited by slow learners' children is still inadequately understood. A vast array of behaviors, which may or may not be related to each other, have been subsumed under this term in previous research: meanings abound with no clear consensus. The inability to define this construct adequately has impeded our knowledge of the workings of this essential characteristic of hyperactivity. Previous attempts to operationalize and measure impulsivity have yielded equivocal results. To date, most of the researches were exploratory, there is little evidence that quantitative or mix method studies have been conducted to articulate the underlying processes that result in the impulsive behavior of hyperactive children (Vekety et al., 2021).

Previous research has also been impeded by the fact that impulsive behavior, as measured by behavioral ratings completed by parents and teachers, has not always corresponded with impulsivity as measured by laboratory analog tasks (Milich & Kramer, 1984). Following the lead of Kendall and Wilcox (1979), Milich and Kramer (1984) explained this discrepancy with the hypothesis that two components of impulsivity may exist: cognitive and social impulsivity. The authors proposed that behavior ratings might be affected by the amount of exposure the raters have to these two forms of impulsivity while laboratory measures presumably measure the cognitive component. It can be argued that the hypothesized cognitive component would more closely reflect the processing deficits which underlie impulsive responses, while the behavioral component would reflect how impulsivity is expressed in real life.

The need for such a hypothesis reflects the state of our knowledge about the relationship between cognitive processes and impulsive behavior while this relationship and the parameters affecting impulsive processing are inadequately understood. This problem can be approached by investigating performance on laboratory measures using a pre-defined sample of children chosen for their behavioral impulsivity. Given the centrality of impulsivity to descriptions of the behavior of hyperactive children and the diagnosis of SLP, it can be argued that these children are prototypically impulsive. They are good exemplars of the very behavior that impulsivity researchers set out to measure. Indeed, the impulsive behavior of slow learners' children has regularly been confirmed by behavioral ratings made by parents and teachers (Conners, 1969; Conners & Werry, 1979).

In their review of impulsivity research, Block and his colleagues highlight an additional requirement of such research. The authors stated that, given the current state of impulsivity research, it may be necessary to employ a variety of "insufficient indicators" each with its partial validity to develop a composite measure of impulsivity (Block et al., 1974, p.631). By holding the presence of behavioral impulsivity constant via sample selection, and by using multiple measures of impulsivity, it is possible to investigate patterns of performance generated across commonly used cognitive measures of impulsivity.

2.1.3 Slow Learners & Inattention

Inattention, as based on information from the DSM-IV-TR (2000), can "manifest in academic, occupational, or social situations" (p. 85) and is characterized by the inability to complete tasks, give or sustain attention to details, appear not to be listening or are elsewhere in their thinking, fail to complete assignments, quickly and unexpectedly shift from one task to another, appear disorganized, are easily distracted, unable to maintain conversations, and forget assignments, tasks, or activities. Inattention, as defined, was measured by the cognitive problems/inattention subscale on the Connors' Parent Rating Scale-Revised: Short Form and the Connors' Teacher Rating Scale-Revised: Short Form (Connors, 1997).

Slow learners' children are often described as more passive or as more fearful and apprehensive about things than other children of their age. Parents of slow learners' children tell us that they are not only hyperactive but are lethargic sluggish or slow-moving compared to other children. These children seem to wander through their daily lives only half attending to events around them, acting like little absent-minded professors. They often miss a lot of information in situations that other children are attending to and so seemingly out of it. They make more mistakes than children in following oral or written instructions but not because they go headlong or headstrong into their work and make impulsive mistakes as slow learners' children do. They seem to have a problem with sifting through the information given in instructions as their mental filter seems less able to sort out the relevant from the irrelevant. slow learners' children also made more mistakes on a memory test (Muthiah, 2015). In particular, they had more trouble consistently recalling information they had learned as time passed.

2.1.4. Slow Learners & Hyperactivity

A diagnosis of Attention Deficit Hyperactivity Disorder (ADHD), or hyperactivity, is made when some combination of three basic attributes is present. These attributes are inattention, impulsiveness, and excess motor activity. The choice of these indicators in the diagnostic requirements speaks to the marked shift over the last two decades in thinking about this syndrome. Whereas hyperactivity was once conceptualized as a problem of poor motor control, "motor overflow" or excessive motor activity, the explanatory emphasis is currently placed on the attentional aspect — a shift which is reflected in the change in the syndrome's title from hyperactivity to Attention Deficit Disorder. Apart from attentional problems, aggressiveness and antisocial behavior have also been linked to impulsivity (e.g., Camp 1977; Riddle and Roberts, 1977; Dodge & Newman, 1981 in Mary 1993).

The DSM-IV-TR (2000) states school-age children manifest signs of hyperactivity by exhibiting "difficulty remaining seated, get up frequently, and squirm in, or hang on to the edge of, their seat" (p. 86). Besides, children with hyperactivity may talk and make noises excessively, run, jump, and have difficulty participating in quiet or less active events . Hyperactivity, as defined, was measured by the hyperactivity subscale on the

Connors' Parent Rating Scale-Revised: Short Form and the Connors' Teacher Rating Scale-Revised: Short Form (Connors, 1997).

On the other hand, individuals with slow learning also suffer from impairments of executive functioning (Willcutt, Doyle, et al., 2005). Therefore, slow and rational analytical decisions might as well be impaired in SLP. These are commonly referred to as decisions under risk (Brand, Labudda, & Markowitsch, 2006). Risk-taking behavior has been linked to impulsivity (Llewellyn, 2008).

2.2 Treatments of SLP

Multiple treatments are available for the treatment of SLP which include medication, behavioral treatments/ therapies, and technology-assisted treatments. A brief description of these treatments are mention below

2.2.1 Pharmaceutical Medication

There are two types of medication available for the treatment of SLP encloses stimulant medication and non-stimulant medication (Taylor, J.F., 2013). The stimulant medication increases the activity in the central nervous system and body and exists in two forms as approved by the FDA is *Amphetamines* and *Methylphenidate.* Stimulants are prescribed as extended-release or sustained-release preparations in addition to the immediate-release tablets while short time stimulants need to be dosed twice or thrice a day. Most doctors start the treatment with a low dose which is gradually increased to find the optimal amount suitable for the treatment (Bren, L., 2004).

Non-stimulant include atomoxetine from the Strattera group, extended-release guanfacine from Intuniv, and extended-release clonidine from Kapvay. Later two groups were effective in treating high blood pressure but also participated efficiently in the treatment of SLP. Children showing side effects toward the stimulant medications are usually treated with non-stimulant (Duong et al., 2012).

The treatment of SLP induces multiple side effects in children and stimulant medication generally invokes stomach pain, headache, reduced appetite, and weight loss. Some may pertain to the reduction in growth rate in the early years of treatment but gradually becomes normal after 2 to 3 years (Faraone et al., 2008). Side effects associated with non-stimulants medication include falling heart rate and blood pressure, faintness, dizziness, fatigue, nausea, vomiting, and depression.

2.2.2 Behavioral treatments

MTA study (the Multi-modal Treatment Study of slow learners' children) suggest three approaches for behavioral treatment which include:

a) Training of parents regarding SLP to assist them in adopting ways and adequate management of behavior towards children while parenting.
b) Treating children accompanying SLP with the help of therapies to improve their cognitive skills and learning approaches which enhance their ability to solve academic and social problems.
c) School-based improvements which assist the educationist in delivering the educational needs and managing the behavior of slow learners' children which include the improvement in the reward system, academic curriculum, sitting arrangements and techniques adopted in the curriculum to attract the attention of students with the disorder (Barbaresi et al., 2020).

Behavior-oriented psychosocial treatment also knows as behavioral therapy plays a fundamental role in curing slow learners' children which provides a multimodal frame while engaging parents, teachers, and school in managing the behavior of children. It helps the child in overcoming the problems of daily life provoke by the existence of impulsiveness and inattentiveness. Behavior modification is approached in terms of ABCs which encloses; i) Antecedents which provide the information of the event that happens before behavior ii) Behaviors which demonstrate the child behavior that is required to be change and iii) Consequences which provide the analysis for the things happen after the behavior (Reid, R. and Maag, 1998). Interventions need to be made at the same time by each individual who is directly participating toward the child learning which include teachers, parents, and child himself and following 5 points refer to the operant approach should be considered for effective behavior modification.

i. Begin the therapy by incorporating small goals that a child can easily accomplish.
ii. Consistency needs to be adopted throughout the intervention
iii. Provide consequences instantly for the child-specific approach toward the event
iv. Behavioral intervention must be a long-haul process not temporary.
v. The modifications and incorporating new skills will deploy improvements slowly in children thus ensuring a time taking process.

Behavioral therapy proves to be effective in improving cognitive and learning skills and is grounded in multiple learning theories which encompass classical and operant conditioning, cognitive-behavioral theory, and social learning theory. A study provides the meta-analysis for the identification of impact endorse by conducting behavioral therapy. The author identifies 174 studies of behavioral treatment extracted from 114 individual research papers and the results presenting the overall effect size provide evidence for the importance of behavioral therapy in treating SLP (Fabiano, G.A., Pelham Jr, et al.). These behavioral therapies get modified with the advancement in technology which not only improves cognitive and motor skills but also improves academic and social learning skills which enhanced their behavioral management in daily life problems (Lindstedt, H. and Umb-Carlsson, Õ., 2013).

2.2.3 Technology Assisted treatment for Slow learning

Technology Assisted Treatment (AT) for kids with LD is defined as any device, piece of equipment or system that helps bypass, work around or compensate for an individual's specific learning deficits. Over the past decade, a number of studies have demonstrated the efficacy of AT for individuals with LD. AT doesn't cure or eliminate learning difficulties, but it can help your child reach her potential because it allows her to capitalize on her strengths and bypass areas of difficulty. For example, a student who struggles with reading but who has good listening skills might benefit from listening to audio books.

In general, AT compensates for a student's skills deficits or area(s) of disability. However, utilizing AT does not mean that a child can't also receive remedial instruction aimed at alleviating deficits (such as software designed to improve poor phonic skills). A student could use remedial reading software as well as listen to audio books. In fact, research has shown that AT can improve certain skill deficits (e.g., reading and spelling).

AT can increase a child's self-reliance and sense of independence. Kids who struggle in school are often overly dependent on parents, siblings, friends and teachers for help with assignments. By using AT, kids can experience success with working independently.

2.3 Models of Slow Learning

2.3.1 Douglas' Model of Slow Learning

In the 1970s, Douglas and her colleagues at McGill University laid the groundwork for current theoretical models of SLP (Barkley 1998; Quay, 1997). They proposed that a constellation of closely related deficits in attentional, inhibitory, arousal, and reinforcement mechanisms could not only account for the hyperactive behaviors seen in SLP but also could explain problems with sustained attention (the maintenance of Douglas (1983) also identified two deficit areas generally present in the behaviors of slow learners' children. These included a strong inclination to seek immediate gratification and difficulties with self-control or response inhibition. Many researchers (Barkley, 1989, van der Meere & Sergeant, 1988) espoused the position that SLP arose out of a neurologically based deficit in motivation. For example, Barkley (1989) asserted that deficits in rule-governed behavior (decreased control by partial reinforcement attention over time) and impulsivity (Barkley, 1998; Douglas, 1983). Problems with distractibility were seen as related to deficits in the investment, organization, and focused attention and modulation of effort and arousal levels rather than as deficits related to filtering out extraneous stimuli or difficulties discriminating between relevant and irrelevant information (Douglas, 1983). Schedules, rapid habituation to behavioral consequences and diminished regulation of behavior by rules) rather than disordered attention were underlying etiological factors. Later, Barkley (1997c) expanded his model.

2.3.2 Baddeley's Model of Working Memory

To explain observed inconsistencies in long-term learning that arose using Atkinson and Shiffrin's (1968) model of short-term memory (See Figure 2.2), Baddeley and Hitch, (1974), developed a multi-component model of working memory. It postulated an integrated system for holding and manipulating information during the performance of complex cognitive tasks. The working memory model consists of three interrelated systems. These systems include a central executive system that interacts with the phonological loop and visuospatial sketchpad sub-systems. See Figure 2.1

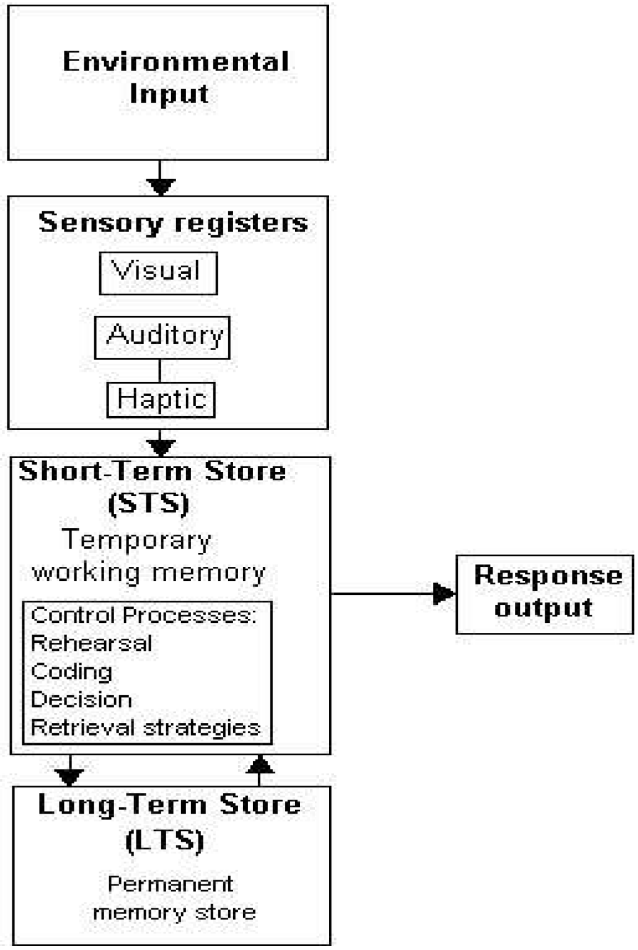

Figure 2.1 Atkinson and Shiffrin Modal Model of Memory

According to Baddeley (2000), the phonological loop has two interactive components. The first is a temporary storage area where an acoustic or phonological memory trace is held for approximately two seconds. The second is a sub-vocal auditory rehearsal process that can refresh the memory trace and can also register visually presented nameable material.

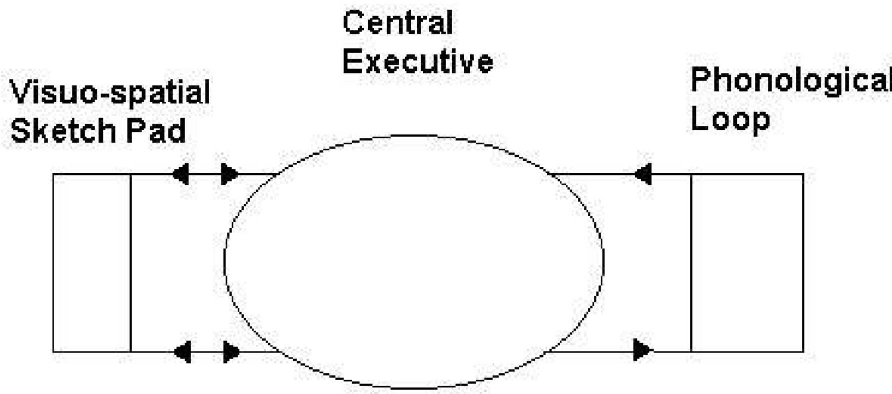

Figure 2.2: Baddeley and Hitch Multi-component Model of Working Memory.

For example, when verbal information is placed in the phonological loop, it can be kept accessible by rehearsal, freeing the central executive to retrieve information from other parts of the memory system.

As the name implies, the visual-spatial sketchpad briefly stores visual-spatial information and assists with the generation and manipulation of images, though the sketchpad is thought to be composed of two separable elements. These elements include visual features (what something looks like) and the spatial elements involving location or position (Baddeley, 2000). Both verbal and visual storage systems are in direct contact with the central executive. Although the central executive is the least elaborated of the three elements in the working memory model, the central executive is hypothesized to control information flow, retrieve knowledge from long-term memory and control multiple concurrent cognitive activities (Baddeley & Hitch, 1974; Baddeley, 1996, 2000).

2.3.3 Neuroanatomical and Neurophysiological Models

Neuroanatomical and Neurophysiological Models Recent neuroimaging techniques enable researchers to reveal patterns of differential neuroanatomical structure and function in the brains of patients with SLP and slow learners. In (Camin, E. and Güell, F., 2017), the authors presented the classification of memory to clearly understand the Neurological models. Memory exists in three forms depending on the events and actions evolving around a human life which encompasses short term memory, long term memory, and sensory memory. Short-term memory exhibits the information for a short period which is processed by working memory described earlier. Long term memory can store information for a longer period either retrieved information is conscious (experience or time-based memories) (Dickerson, B.C. and Eichenbaum, H., 2010) or unconscious (skills or abilities). Sensory memory attains information that is retrieved from the senses (Siegler, R.S., 1991).

The importance of memory is inevitable for developing skills, automatic processing of input, and phonological abilities. A study conducted on the memory of slow learners where they show below average results for the numeric testing of their working memory (Birch, K.G., 1969). Slow learners are more likely to have difficulties in neuro-development functions which encompasses the deterioration of coordination and language and these differences were observed by Yule (Rutter, M. and Yule, W., 1975).

The neurobiological domain of research has primarily involved the frontostriatal system, which is responsible for adaptive responses to environmental situations. This intricate matrix of cortical and subcortical nuclei is responsible for the collective operation of attentional control, or the product of working memory and processing speed functions that mediate behavioral output (Lichter & Cummings, 2001). In their summary of the neuroimaging findings related to SLP, Giedd, Blumenthal, Molloy, and Castellanos (2001) have concluded that the brains of patients with the disorder consistently demonstrate having aberrant frontal lobes, basal ganglia, corpus callosa, and cerebella.

Each of these regions, with a disproportionate influence by the prefrontal lobes, affects internally guided behavior (Wagner, Maril, Bjork, & Shacter, 2001). Also, other authors have identified loci among these global regions that differ structurally from the brains' of controls. For example, Hesslinger, Tebartz van Elst, Mochan, and Ebert (2003) have reported that the left orbitofrontal cortex, a specific subregion of the frontal lobes, differentiates patients with SLP from controls. This region is the primary locus associated with attentional control (Barkley, 1997, 1998; Konishi, Kawazu, Uchida, et al., 1999; Nathaniel-James, Fetcher, & Frith, 1997).

Charlie Fairhurst presents the basic neurosciences which demonstrated the functioning of the nervous system with the help of assistive electronic technology (Fairhurst, C., 2019). He explains the procedure for the skill development regarding motor or cognitive and also highlights the impairments associated with the nervous system which ensure the room for the assistive technology for the development and improvement of neurological skills for the improvement in learning. Additional research findings have also implicated functional deficiencies related to these cortical and sub-cortical loci. Along with the developmental continuum patients with SLP consistently show dysfunctional neural circuitry involving the frontal lobes, cingulate cortex, striatum, and cerebella (Ernst, Liebenauer, King, et al., 1994; Enrst, Zametkin, Matochik, et al., 1994, 1999; Giedd, Blumenthal, Molloy, & Castellanos, 2001; Lou, Hendrikson, Bruhn, et al., 1989; Zametkin, Liebenauer, Fitzgerald, et al., 1993; Zametkin, Nordahl, Gross, et al., 1990). Substantial evidence highlights the respective roles these regions play in regulating: (a) attentional control (i.e., working memory and processing speed) (Bunge, Oschsner, Desmond, et al., 2001; Geschwind & Iacoboni, 1999); (b) learning and memory (Knowlton, 2002); and (c) sequencing and coordinating behavioral output (Doyon & Ungerleider, 2002).

a) Neurochemical Models

Individuals with SLP also demonstrate having dysregulated neurochemical circuits across the lifespan (Matochik, Nordahl, Gross, et al., 1993). Catecholamines are a class of neurotransmitters including dopamine, norepinephrine, and serotonin. The Catecholamine Hypothesis posits that an insufficient quantity of catecholamines is available in the brains of individuals with SLP; and this neurochemical abnormality is responsible for the cognitive and behavioral dysregulation found in those with the syndrome (Solanto, 2000).

Each of these neurotransmitters produces partially independent effects on the brain and behavior. This feature of the hypothesis makes it a powerful theoretical model to Account mechanistically for the heterogeneity so often found in the syndrome. For example, norepinephrine is thought to mediate signal-to-noise discrimination (Berridge, 1993; Hasselmo & Linster, 1999), attention and arousal states (Feifel, 1999), as well as memory (Gloor, 1997). The role of this neurotransmitter in the etiology of SLP is so heavily regarded that some investigators have gone so far as to describe SLP as a "noradrenergic disorder" (e.g., Biederman & Spencer, 1999). Alternative routes to deficiencies in executive functioning also stem from other catecholamine irregularities. Another catecholamine, serotonin, is known to exert an inhibitory effect during regulation. This single neurotransmitter increases impulse control and frustration tolerance (Robert, Aubin-Brunet, Darcourt, 1999), elevates mood, and enhances memory (Swartz, 1999). Thus, the single neurotransmitter affects broad emotional and motivational systems that are dysregulated in patients with SLP. In contrast dopamine, a third exemplar of the catecholamines is known to affect motor, behavioral, and reward circuits (Swartz, 1999). This neurotransmitter system has sparked significant interest within the SLP research community because the most effective psychopharmacological treatments for the disorder (methylphenidate and amphetamine) act as indirect dopamine agonists (Wender, Wolf, & Wasserstein, 2001). Like dopamine itself, these interventions increase voluntary control of motor function, reduce responsiveness to externally dependent reward states, and increase motivation (Solanto, 2000; Swartz, 1999). Each of these neurotransmitters differentiates SLP from controls and mediates several aspects of executive functioning. For example, Hanna et al. (1995) have reported that dopamine and norepinephrine levels differ among slow learners' children relative to controls. Similarly, Oades (2002) has reported that measures of working memory and processing speed are positively associated with norepinephrine levels, but negatively related to levels of serotonin. These findings are not unique, as others have reported similar correspondences between catecholamine metabolism and measures of attentional processing (e.g., Llorente et al., 2000). These interactive features of the catecholamines draw further attention to the complexity of these systems and add depth to how the heterogeneity in SLP may be understood. The Catecholamine Hypothesis receives further support from studies following a different methodological approach. These investigations have involved measuring the level of psychostimulant response among individuals with SLP. Reimherr, Wender, Ebert, and Wood (1984) have reported lower levels of metabolized dopamine in psychostimulant responders relative to non-responders with SLP, or Normative controls. In like manner, Castellanos and colleagues (1995, 1996) have found that the same dopamine metabolite is the best predictor of psychostimulant response and acquire approximately 50% of the symptomatic variation.

Taking another approach, authors such as Wood, Reimherr, and Wender (1983) have made use of two agents known to prevent the metabolism of dopamine and reported that this caused a marked reduction in symptoms for 60% of slow learners. These findings not only implicate the multi-systemic etiology of this heterogeneous disorder (Biederman & Spencer, 1999; Faraone & Biederman, 1998) but also suggest that psychopharmacological and behavioral treatment interventions must be specifically honed to the neurocircuitry and environmental context of the individual slow learners.

2.4 Learning Theory and Learning Strategies For SLP

By interviewing students, Spekman, Goldberg, and Herman (1992) explored both the qualitative and quantitative factors that impact long-term outcomes. It was found that on measures of IQ, the successful individuals had significantly higher Verbal IQs than unsuccessful individuals. The two groups did not differ significantly on measures such as race, socioeconomic status (SES), gender, diagnosis, services received, or reading and math achievement scores. The factors found to be most important to the long-term success were self-awareness, proactiveness, perseverance, emotional stability, appropriate goal setting, and the presence and use of effective support systems. In a 20-year follow-up study, the same six attributes were again found to be strong predictors of success (Raskind, Goldberg, Higgins, & Herman, 1999).

Specific research has been completed to better understand what variables contribute to the success of students with learning disabilities at the postsecondary level (Vogel, A. S., & Adelman, B. P., 1992; Vogel, A. S., Hruby, J. P., & Adelman, B. P., 1993; & Murray 2003). Research has identified variables that impact student achievement over which the student may not have control such as socioeconomic status, gender, age, cognitive functioning, and diagnosis. Research has also been conducted to better understand which additional variables impact student success. Vogel and Adelman (1992) found that high school preparation (defined as the number of regular core curriculum courses the students completed with a C or better) and overall high school grade point average (GPA) were two of the best predictors for success in postsecondary education for students with LD. In a follow-up study, Vogel, Hruby, and Adleman (1993) found that successful college students were significantly older and had taken a greater number of regular English courses in high school than the unsuccessful students. Study habits and attitudes have also been found to impact success at the postsecondary level (Murray, 2003).

The theorizing identifies a leading role for the importance of behavioral inhibition that delays (or inhibits) initial prepotent responses to an event, stops ongoing responses, and controls potential interferences and distractions (Barkley, 2006). According to Barkley, these self-directed actions are the executive functions required to successfully engage in tasks and activities including schoolwork. Four executive functions are identified (non-working memory, verbal working memory, self-regulation of motivation, and reconstitution (Barkley, 2006). Importantly also, because behavioral inhibition is a major area of vulnerability for slow learners' children, their executive functions tend to be impaired, as are component functions related to goal-directed behavior and goal-directed persistence. Intervention relevant to the self-regulatory processes has been identified. These include a pharmacological intervention to address behavioral inhibition, activities to train working memory, and even classroom approaches to reduce distractions (Barkley, 2006).

According to the conductive research on slow learning, children exhibit impulsiveness apart from the attention problem which provides the main obstacle for academic and mental growth. (Milich and Landau, 1982; Pelham and Bender, 1982). However, it seems research in educational psychology channels has been relatively silent on the issue of attention deficit disorder and a total of 100 articles have been published 'attention deficit with hyperactivity disorder' between the years 1990 and 2010 in three major school psychology journals (Journal of School Psychology, Psychology in the Schools, School Psychology Quarterly). Educational psychology outlets have been a dominant presence in the area of goals and goal-directed behavior in learning and achievement. Thus, educational psychology research investigating these factors and processes among slow learners' children enables substantive and applied contributions from this psychological perspective that, in conjunction with school psychology (and clinical and other psychological perspectives), lays a broad base for effective educational intervention.

2.4.1 Cognitive learning theory

Jerome Kagan and his colleagues developed the Matching Familiar Figures test (MFF; Kagan, Rosman, Day, Albert, & Phillips, 1964) as a measure of a cognitive style that has been labeled in various formulations as Reflection-Impulsivity or Cognitive Tempo. Kagan defines reflection-impulsivity as "the child's consistent tendency to display slow or fast response times in problem situations with high response uncertainty" (Kagan, 1965, p.134). The cognitive style was operationalized in the MFF by linking latency of response to errors. Despite serious criticism (Block, Block, & Harrington 1974), the MFF has been the measure of choice for investigations of impulsivity in slow learners' children.

A brief history and succinct review of theories of attention in slow learners will set the stage for our review of the recent literature. Sergeant and Scholten (1983) applied a cognitive energetic theory of information processing and found that in slow learners' children central processing stage was intact and that deficits are restricted to the motor organization and output stages of information processing. Swanson et al (1991b) applied a cognitive anatomical theory of attention (Posner and Petersen, 1990), and found that in slow learners' children, the posterior system for engaging attention was intact and those deficits were restricted to the anterior system of maintaining (disengaging and moving) attention. Pennington and Ozonoff (1996) proposed that the core deficits of slow learners were linked to the abnormal development of executive functions in childhood. The most prominent and influential theory (Barkley, 1997) was based on the Fuster theory of frontal lobe function (Fuster, 1980), and it proposed that slow learners was characterized by a core deficit in response inhibition, which theoretically would lead to cognitive symptoms as secondary manifestations.

Until recently, much of the research on cognitive difficulties in slow learners' children has focused on attention. Few studies have looked at higher-order components of cognitive processing while focusing on aspects of executive functioning (Nigg, 2006). However, to better understand the academic problems faced by slow learners' children, more needs to be known about the children in specific academic functions comparatively, such as the processing of complex stories or story comprehension. Story comprehension is important early on in school performance for children. Effective story comprehension requires the usage of several different cognitive functions.

The considered cognitive functions encompass selection and focusing attention on important story information, retrieving relevant background information, and generating inferences to allow an interpretation of the presented information, encoding important story information, and monitoring comprehension (Lorch, Milich, & Sanchez, 1998). Therefore, in assessing higher-order cognitive abilities, it is useful to study story comprehension due to its relevance to the academic curriculum while providing insight into the cognitive functionality of children. Early research on story comprehension in slow learners' children found few reliable group differences (O'Neill &Douglas, 1991; Zentall, 1988). However, only global measures of recall were considered in these studies while ignoring other aspects that may prove to be more indicative of story comprehension abilities as they do not provide information about the types of story events and how their recall is influenced by factors such as the importance of story events which was significant in determining the effect of variations.

One of the significant developmental change that has been identified involves children's sensitivity to the thematic importance of individual story events. As children mature, they become better at distinguishing between story events that are more important to the overall theme of the story and events that are less important or extraneous to the overall theme (Brown & Smiley, 1977; Brown, Day, & Jones, 1983). Because sensitivity to thematic importance is a skill that develops with age and enhances story comprehension, it would be useful to include this component when evaluating story comprehension in children with SLP.

Tannock, Purvis, and Schachar (1993) offered one of the first investigations to address this issue by examining the recall of story events by slow learners' children as a function of the level of thematic importance. In this study, thirty slow learners' boys and 30 comparison boys (ages 7 to 11 years) listened to two audiotaped stories and retold the stories in their own words. Both stories had been previously rated by adults for the thematic importance of each story unit. Results indicated that slow learners' boys recalled fewer story events than comparison boys, but the groups did not differ in their sensitivity to the level of importance of the events. Additionally, when the slow learners' boys retold the stories, they included more ambiguous referents and semantically inappropriate word substitutions and gave more incorrect or misinterpreted information than the comparison children.

Comparison children showed significantly more sensitivity to the importance level and the number of causal connections in their recall than did slow learners' children, and they remembered more story units than slow learners' children. Lorch, O'Neil, et al. (2004) replicated the results of Lorch, Diener et al. In this study after the children completed a free recall of the audiotaped story, they were allowed to study a written version of the story for up to ten minutes and then completed a second free recall of the story. Group differences in sensitivity to the number of causal connections increased for story events newly added to recall after the studying period had been allowed.

A study by Lorch, Sanchez, et al. (1999) demonstrates the usefulness of the television viewing methodology. In this study, four- to six-year-old slow learners' children and normal children watched a televised program (Sesame Street). For half of the children's toys were present during the program, and the other half toys were absent. This study examined whether children's free recall of story events was predicted by several story structure properties (number of causal connections, whether an event is on or off the story's causal chain, story-grammar category, and position in the story's hierarchical structure). Both groups of children attended significantly less to the program when toys were present than in their absence, but this effect was larger for slow learners' children. Additionally, both groups of children were sensitive to the causal structure of stories; however, when attention was reduced by the presence of distracter stimuli, the slow learners' children were less sensitive to the causal properties of stories. Although this study investigated sensitivity to causal properties and not thematic importance, these two variables are conceptually and empirically related (Trabasso &Sperry, 1985; Trabasso & van den Broek, 1985). Thus, if group differences are found sensitive to causal properties, then it is likely that group differences would also be found sensitive to thematic importance.

In decision making research not only emotional but also cognitive processes are thought to contribute to the result of the decision-making process. Two ways of making decisions have been postulated: the so-called intuitive-experiential system and the rational-analytical system (Starcke, Pawlikowski, Wolf, Altstötter-Gleich, & Brand, 2011). Both systems have been studied in adolescent populations suffering as slow learners. One study (Toplak, Jain, & Tannock, 2005) found disadvantageous decision making using the Iowa Gambling Task (IGT) in which subjects are required to choose from various alternatives (card decks) without having any information about the outcome of gains and losses. Explicit rules for outcomes or winning probabilities are not given. In decision-making research, the IGT is commonly referred to as a task measuring decision making under ambiguity. The disadvantageous decision-making behavior found in slow learner's adolescents utilizing the IGT can be ascribed to the so-called intuitive-experiential system of decision making (Evans, 2003).

On the other hand, a task that simulates decision-making under risk is the Game of Dice Task (GDT; Brand et al., 2005) which offers explicit rules for gains and losses as well as obvious probabilities and the possibility to measure processing of positive or negative feedback following choices. Thereby, one study (Drechsler et al., 2008) found that preadolescents with slow learning difficulties made significantly more risky choices compared to healthy control children. However, these observations were only made when they played the game a second time (Drechsler et al., 2008). Another study (Drechsler et al., 2010) found that slow learners' children opted more frequently for less likely, but larger rewards than controls when using the Make a Match Game. Various studies suggested adolescence as a factor of influence (Drechsler et al., 2008) since risky decision making in the pursuit of rewarding experiences is often observed during adolescence (Fareri, Martin, & Delgado, 2008).

Motivational development may also be important. Behavioral inhibition enables the processing of information by the executive functions to occur by preventing individuals from reacting to a stimulus too rapidly. Barkley (1994, 1997) suggested that behavioral inhibition in individual's slow learner is impaired, which leads to impaired executive functions, causing an individual to appear hyperactive and impulsive. These individuals are also likely to be inattentive. Barkley suggested the attention deficit associated with the Predominantly Inattentive subtype could be due to slow information processing and problems with focused and selective attention whereas the attention deficit in the other subtypes could be due to a deficit in sustained attention and increased distractibility brought about by impaired behavioral inhibition. Milich, Balentyne, and Lynam (2001) reviewed the literature and concluded that the Combined and Predominantly Inattentive subtypes are distinct disorders. In their longitudinal study Lahey, Pelham, Loney, Lee, and Willcutt (2005) found that the Predominantly Hyperactive/Impulsive subtype tended to be unstable, and a significant proportion of young children with that diagnosis shifted to the combined subtype as they grew older. More recent causal models (Sonuga-Barke, 2005) have attempted to account for the heterogeneity seen within slow learning by proposing that slow learning might be explained by a combination of the cognitive dysfunction model and motivation-based dysfunction models. They are based on the consistent findings that many slow learners' children are averse to delay, have motivational difficulties concerning delayed rewards, and find it difficult to concentrate for extended periods whilst acknowledging that in certain circumstances a slow learners' child can delay a response. However, an impulsive child typically has difficulty succeeding in an environment that requires them to delay their responses in pursuit of a later reward. In situations when delay cannot be reduced, an impulsive child tries to divert their attention to something else, which gives the impression that they have attentional and hyperactivity difficulties.

Whilst these theories suggest pathways for the cause of slow learners' symptoms, it is not clear which features lead to underachievement in school. Is it possible that the problem of sustaining attention can fully explain poor attainment levels and that impulsivity and/or hyperactivity are either not relevant or advantageous to school attainment? Williams and Taylor (2006) suggested several advantages to hyperactivity and impulsivity which they split into individual and group factors. However, still schools are not focusing on the individual level factors that are advantageous such as "testing limits" could be beneficial to the class as a whole including the normal and slow learners.

Although slow learners behavioral characteristics are often reported on two dimensions, recent studies have suggested that the symptoms of hyperactivity and impulsivity included in the slow learners form two distinct factors (Merrell & Tymms, 2005; Smith & Johnson, 2000). Further, there is evidence that impulsivity itself is not a unitary construct (Evenden, 1999). White et al. (1994) conducted a longitudinal study of boys whose impulsivity was assessed when they were on average between 12 and 13 years old. The eleven measures were weakly related to one another, the highest correlation is 0.33. Factor analysis identified two dimensions which were labeled Cognitive and Behavioural. Cognitive Impulsivity was associated with poor performance on tasks that required mental control and the ability to shift between tasks. Behavioral impulsivity reflected under-controlled and uninhibited behavior. Cognitive Impulsivity was assessed by tasks and Behavioural Impulsivity by rating scales, prompting the authors to note that the factor analysis may have picked out modes of assessment. A different perspective was taken by Dickman (1990) who, looking at gambling, distinguished between functional and dysfunctional impulsivity appear to be linked to the inhibition deficits and problematic behavior, they seem to correspond to dysfunctional impulsivity. But they could also be seen as linked to behavioral impulsivity as opposed to cognitive impulsivity because they are descriptions of behavior and are also rating-based rather than task-based. On the other hand, the first item (Often blurts out answers before questions have been completed) is perhaps cognitively related in that it is associated with computing answers rapidly. Although the three DSM-IV impulsivity items load on a single factor (Merrell & Tymms, 2005; Oades et al., 2008) Oades et al. commented: "Of interest is the item "blurts out answers before the question is finished"… This item could be construed as an example of impulsive behavior overlying a cognitively impulsive decision."

It is recognized that executive functioning continues to develop during childhood (Best, Miller, & Jones, 2009; Brocki & Bohlin, 2004), and there is a risk that some severely inattentive, hyperactive, and impulsive behavior in some young children will be a consequence of immaturity. However, it is also recognized that these behavioral problems can lead to children being excluded from pre-school and school from an early age and that early interventions are promising (McGoey, Eckert, & DuPaul, 2002). The further study of the relationship between inattention, hyperactivity, and impulsivity, and academic attainment has potential implications for educational interventions.

2.4.1.1 Cognitive Effects of Stimulants

Stimulant drugs (methylphenidate (MP) and amphetamine (AMP)) are particularly effective for the clinical treatment of slow learners' children, and accordingly, pediatricians and psychiatrists have been prescribing them for over seven decades (Bradley 1937). Clear reductions in symptoms justify treatment with stimulant medications (MTA, 1999b), but the cognitive effects are less clear. The evaluation of cognitive effects of stimulants on slow learners' children has a long history (Knights, 1974; Conners, 2002; Ottenbacher and Cooper, 1983; Rapport and Kelley, 1993; Swanson et al, 1991a). A basic finding is that the percentage of children who benefit depends on the task used to assess improvement, with the highest response rates for the assessment of activity (with decreases considered beneficial) and the lowest response rates for the assessment of learning or problem solving (with increases considered beneficial). An early study of dose-related effects (Sprague and Sleator, 1977) had suggested that the optimal dose for cognitive effects was lower than that for behavioral effects of MP, and in an early study of the effects in normal individuals, Rapoport et al (1978) suggested that the response in slow learners' child was not 'paradoxical', but instead was in the same direction for some measures in control normal individuals. Sahakian and Robbins (1977) and Robbins and Sahakian (1979) suggested that this task-dependent pattern of response may be a consequence of the general dose-related effect of stimulants to increase stereotypic behavior, which would improve performance on some tasks (eg, tasks that require sustained attention for repetitive action and thought), but impair it on others (eg, tasks that require reversals in cognitive strategy).

Children with slow learning have limited cognitive skills and find it difficult when it comes to finding the solution for a mathematical problem. Mathematical difficulties are also subgrouped as a mathematics learning disability (MLD) and a study conducted by Zhang presented to highlight the significance of mathematical development monetization throughout the early grades for the effective identification and interventions (Zhang, X., Räsänen, P., Koponen, T., Aunola, K., Lerkkanen, M.K. and Nurmi, J.E., 2020).

The developmental courses of behavioral manifestations of the disorder (symptoms) and neuropsychological performance (executive function deficits) have been evaluated in prospective studies of slow learners' children followed into adulthood, and some suggested attenuation in executive functioning deficits among slow learners' children (Halperin and Schulz, 2006). However, the combined reports on neuropsychological testing of slow learners' children present a highly inconsistent picture, with several studies failing to find differences on many measures of executive functions. Several meta-analyses designed to determine the degree to which executive function deficits can adequately account for the underlying cause of slow learning have failed to settle this question (Homack and Riccio (2004), Huang-Pollock, and Nigg (2003), and van Mourik et al (2005). One interesting hypothesis is that the lingering slow learning–control discrepancy may be related to underlying heterogeneities in brain maturation trajectories. The following describes key cognitive skills that are critical for learning.

Attention Skills: A student's ability to attend to incoming information can be observed, broken down into a variety of sub-skills, and improved through properly coordinated training. We train and strengthen the three primary types of attention:

Sustained Attention: The ability to remain focused on the task, and the amount of time we can focus.

Selective Attention: The ability to remain focused on tasks while being subjected to related and unrelated sensory input (distractions).

Divided Attention: The ability to remember information while performing a mental operation and attending to two things at once (multi-tasking).

Memory: The ability to store and recall information:

Long-Term Memory: The ability to recall information that was stored in the past. Long-term memory is critical for spelling, recalling facts on tests, and comprehension. Weak long-term memory skills create symptoms like forgetting names and phone numbers, and doing poorly on unit tests.

Short-Term / Working Memory: The ability to apprehend and hold information in immediate awareness while simultaneously performing a mental operation. Students with short-term memory problems may need to look several times at something before copying, have problems following multi-step instructions, or need to have information repeated often.

Logic and Reasoning: The ability to reason, form concepts, and solve problems using unfamiliar information or novel procedures. Deductive reasoning extends this problem-solving ability to draw conclusions and come up with solutions by analyzing the relationships between given conditions. Students with underdeveloped logic and reasoning skills will generally struggle with word math problems and other abstract learning challenges. Symptoms of skill weaknesses in this area show up as questions like, "I don't get this", "I need help...this is so hard", or "What should I do first?"

Auditory Processing: The ability to analyze, blend, and segment sounds. Auditory processing is a crucial underlying skill for reading and spelling success and is the number one skill needed for learning to read. Weakness in any of the auditory processing skills will greatly hinder learning to read, reading fluency, and comprehension. Students with auditory processing weakness also typically lose motivation to read.

Visual Processing: The ability to perceive, analyze, and think in visual images. This includes visualization, which is the ability to create a picture in your mind of words or concepts. Students who have problems with visual processing may have difficulty following instructions, reading maps, doing word math problems, and comprehending.

Processing Speed: The ability to perform simple or complex cognitive tasks quickly. This skill also measures the ability of the brain to work quickly and accurately while ignoring distracting stimuli. Slow processing speed makes every task more difficult. Very often, slow processing is one root of ADHD-type behaviors. Symptoms of weaknesses here include homework taking a long time, always being the last one to get his or her shoes on, or being slow at completing even simple tasks.

2.4.2 Kolb learning model

David Kolb, Professor of Organizational Behavior at Case Western Reserve University, is credited with launching the learning styles movement in the early seventies and is perhaps one of the most influential learning models developed. Learning is the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping experience and transforming it. - Kolb (1984).

Kolb's learning theory sets out four distinct learning styles, which are based on a four-stage learning cycle. In this respect, Kolb's model differs from others since it offers both a way to understand individual learning styles, which he named the "Learning Styles Inventory" (LSI), and also an explanation of a cycle of experiential learning that applies to all learners.

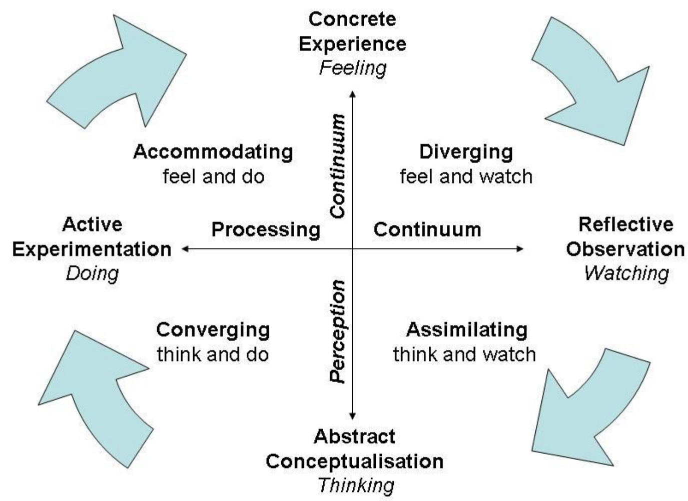

Figure 2.3 Kolb Learning Theory Model

Kolb proposes that experiential learning has six main characteristics:

- Learning is best conceived as a process, not in terms of outcomes.
- Learning is a continuous process attained during the experience.
- Learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world (learning is by its very nature full of tension).
- Learning is a holistic process of adaptation to the world.
- Learning involves transactions between the person and the environment.
- Learning is the process of creating knowledge that is the result of the transaction between social knowledge and personal knowledge.

Kolb called this Experiential Learning since experience is the source of learning and development (1984). Each end of the continuums (modes) provide a step in the learning process:

- Concrete experience (feeling): Learning from specific experiences and relating to people. Sensitive to other's feelings.

- Reflective observation (watching): Observing before making a judgment by viewing the environment from different perspectives. Looks for the meaning of things.

- Abstract conceptualization (thinking): Logical analysis of ideas and acting on the intellectual understanding of a situation.

- Active experimentation (doing): Ability to get things done by influencing people and events through action which includes risk-taking.

Depending upon the situation or environment, the learners may enter the learning cycle at any point and will best learn the new task if they practice all four modes.

2.4.2.1 Kolb's Learning Styles

This matrix provides a learning cycle that involves four processes that must be present for learning to occur, which is more useful rather than trying to pinpoint a learning style for which he demonstrated a model learning program.

Kolb theorized that the four combinations of perceiving and processing determine one of four learning styles of how people prefer to learn. Kolb believes that learning styles are not fixed personality traits, but relatively stable patterns of behavior that are based on their background and experiences. Thus, they can be thought of more as learning preferences, rather than styles. Kolb called this Experiential Learning since experience is the source of learning and development (1984). Each end of the continuums (modes) provides a step in the learning process that encompasses concrete experience (feeling), Reflective observation (watching), abstract conceptualization (thinking), and active experimentation (doing) as discussed earlier. Depending upon the situation or environment, the learners may enter the learning cycle at any point and will best learn the new task if they practice all four modes.
Listed below are some examples:

- **Learning to ride a bicycle:**

- Reflective observation - Thinking about riding and watching another person ride a bike.
- Abstract conceptualization - Understanding the theory and having a clear grasp of the biking concept.
- Concrete experience - Receiving practical tips and techniques from a biking expert.
- Active experimentation - Leaping on the bike and have a go at it.

- **Learning a software program:**

- Active experimentation - Jumping in and doing it.
- Reflective observation - Thinking about what you just performed.
- Abstract conceptualization - Reading the manual to get a clearer grasp of what was performed.
- Concrete experience - Using the help feature to get some expert tips.

- **Learning to coach:**

- Concrete experience - Having a coach guide you in coaching someone else.
- Active experimentation - Using your people skills with what you have learned to achieve your coaching style.
- Reflective observation - Observing how other people coach.
- Abstract conceptualization - Reading articles to find out the pros and cons of different methods.

- **Learning algebra:**

- Abstract conceptualization - Listening to explanations on what it is.
- Concrete experience - Going step-by-step through an equation.
- Active experimentation - Practicing.
- Reflective observation - Recording your thoughts about algebraic equations in a learning log.

Kolb views the learning process as a context of people moving between the modes of concrete experience (CE) and abstract conceptualization (AC), and reflective observation (RO), and active experimentation (AE). Thus, the effectiveness of learning relies on the ability to balance these modes, which Kolb sees as opposite activities that best promote learning. Besides, Kolb (1999) claims that concrete experience and abstract conceptualization reflect right-brain and left-brain thinking respectively.

Kolb theorized that the four combinations of perceiving and processing determine one of four learning styles of how people prefer to learn. Thus, they can be thought of more as learning preferences, rather than styles.

- **Diverging** (concrete, reflective) - Emphasizes the innovative and imaginative approach to do things. Views concrete situations from many perspectives and adapt by observation rather than by action. Interested in people and tends to be feeling-oriented. Likes such activities as cooperative groups and brainstorming.
- **Assimilating** (abstract, reflective) - Pulls several different observations and thoughts into an integrated whole. Likes to reason inductively and create models and theories. Likes to design projects and experiments.
- **Converging** (abstract, active) - Emphasizes the practical application of ideas and solving problems. Likes decision-making, problem-solving, and the practical application of ideas. Prefers technical problems over interpersonal issues.
- **Accommodating** (concrete, active) - Uses trial and error rather than thought and reflection. Good at adapting to changing circumstances; solves problems in an intuitive, trial-and-error manner, such as discovery learning. Also tends to be at ease with people.

2.5 Project-based learning model

Slow learners exhibit educational backwardness due to their limited ability or intelligence level. Such students face difficulties while solving any mathematical problem or analysis based basic computation which demands a certain degree of intelligence. Continuous educational backwardness and poor academic records result in the degradation of their self-confidence and motivation, thus leading them to drop out of school (Kaznowski, K., 2004). Such students are not mentally disabled and therefore, don't fall into the category of a special school. They require special attention in school and assistance in discovering the well-suited learning pattern for themselves. Therefore, there is a need for the amendment in educational or learning patterns to accommodate students with the increasing number of students which has been exceeded from 14 % (Lisdiana, A., 2012).

Coping up with a child who is suffering from a learning disability or educational backwardness becomes a stressful experience for the family when encountered with problems associated with education failure or depression or stress with personality destruction. A study conducted in Nigeria to demonstrate effective coping strategies for families to handle the circumstances associated with the affected member (Chukwu, N.E., Okoye, U.O., Onyeneho, N.G. and Okeibunor, J.C., 2019). These strategies include patterns that are grouped into emotion-focused, problem-focused, and religion-focused which help families to effectively handle the situation.

According to a study conducted in Indonesia (Sunardi, S. and Sunaryo, S., 2016), the obstacles in the learning process while accommodating such student encloses;

a) The learning process is not structured in the team teaching manner
b) Educationist finds it difficult to plan an academic curriculum which is flexible enough to enroll children with special needs considering the individualized educational program (PPI) while providing with the objectives and ways of learning.
c) Curriculum targeting the students with SLP along with normal student disrupts the learning process especially when children demands assistants intellectually or emotionally as the learning process rate differs for every child

d) There is a need for an adaptive environment and learning method based on the demand like utilizing media or other visuals/audio-based programs to boost the learning process which sometimes gets unaddressed due to the limited resources.
e) The Scoring system must be flexible for the assessment and new approaches for the ability evaluation need to be included.
f) The set of learning outcomes should be maintain considering the fall-back of slow learners.

The project-based model presented to address the problems relevant to the hurdles faced during the learning process especially by students with SLP due to the distraction or limited ability. This model presents an in-depth investigation while considering the facts in real words practically which assists in keeping a track of attention structurally (Moursund, D.G., 1999). The characteristic of the Project-based learning model prevail during a study (Harris, C.J., Penuel, W.R., D'Angelo, C.M., DeBarger, A.H., Gallagher, L.P., Kennedy, C.A., Cheng, B.H. and Krajcik, J.S., 2015) are as follows

i) Decision opted by the learner about a particular framework.
ii) The problem statement was proposed to the students.
iii) Designing the process for the accomplishment of the solution addressing to the defined problem.
iv) Management and accessibility of the information required to address the problem.
v) The assessment process for the evaluation of outcomes.
vi) Quality analysis of the learning product.

George presented the syntax for the learning-based project model demonstrated in the figure 2.4.

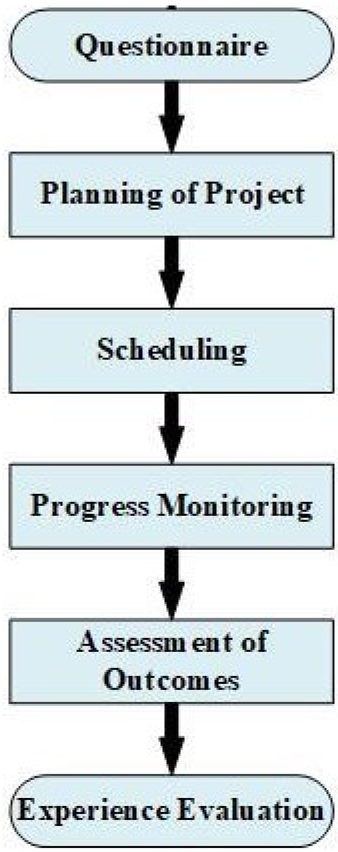

Figure 2.4: learning-based project model

Considering the requirement of slow learners, this model not only provides the learning ways to acquire objective-based outcomes but also help teachers in maintaining curriculum considering their needs (Hartini, A., Widyaningtyas, D. and Mashluhah, M.I., 2017). Hamza in his research explains that teachers need to adopt a diverse strategy of learning for the different calibrations of intelligence by adjusting goals, objectives, time allocated in a task, or assistance in learning procedure (Uno, H.B. and Mohamad, N., 2011). He further structured the model for teachers which encompasses; i) structuring learning objectives, ii) the requirements demand by children according to their capability and iii) Learning material which may include media or interactive technology to assist the students with better visual or auditory learning. Hence, a strategy-based model will allow slow learners to adopt a group system and assist teachers in planning objective-based assessments for their learnings without ignoring academic achievements that are adaptive to a friendly environment.

2.6 Piaget Theory

In early 1920 the swiss biologist jean Piaget began studying children's responses to problems similar to these. Piaget was the first psychologist to make a systematic study of cognitive development (Hsueh, 2002). His contributions include a theory of cognitive child development (Piaget, 1964), detailed observational studies of cognition in children, and a series of simple but ingenious tests to reveal different cognitive abilities. He found for instance that 4 years olds often have difficulty with the problem of the beads as they are likely to say that there are more brown beads than wooden beads but that 7 and 8 years olds almost always answer the question correctly. He found that 10 years old have an easier time with logic problems that involve real-world phenomenon rather than hypothetical and contrary to fact ideas.

Piaget called the schema the basic building block of intelligent behavior which provides a way of organizing knowledge (Piaget, 1964). Indeed, it is useful to think of schemas as "units" of knowledge, each relating to one aspect of the world, including objects, actions, and abstract (i.e. theoretical) concepts. When a child's existing schemas are capable of explaining what it can perceive around it, it is said to be in a state of equilibrium**, i.**e. a state of cognitive (i.e. mental) balance.

Piaget emphasized the importance of schemas in cognitive development and described how they were developed or acquired (Piaget, 1964). A schema can be defined as a set of linked mental representations of the world, which we use both to understand and to respond to situations. There are three basic components to Piaget's Cognitive Theory**:**

- **Assimilation**
  This is using an existing schema to deal with a new object or situation. For example, a 2-year child sees a man who is bald on top of his head and has long frizzy hair on the sides. To his father's horror, the toddler shouts "Clown, clown" (Sigler et al., 2003).
- **Accommodation**

This happens when the existing schema (knowledge) does not work and needs to be changed to deal with a new object or situation. For example: In the “clown” incident, the boy’s father explained to his son that the man was not a clown and that even though his hair was like a clown’s, he was not wearing a funny costume and wasn’t doing silly things to make people laugh (Sigler et al., 2003).

- **Equilibration**

  This is the force, which moves development along. Piaget believed that cognitive development did not progress at a steady rate, but rather in leaps and bounds. Equilibrium occurs when a child's schemas can deal with most new information through assimilation. However, an unpleasant state of disequilibrium occurs when new information cannot be fitted into existing schemas (assimilation).

  Equilibration is the force that drives the learning process as we do not like to be frustrated and will seek to restore balance by mastering the new challenge (accommodation). Once the new information is acquired the process of assimilation with the new schema will continue until the next time, we need to adjust to it (Sigler et al., 2003).

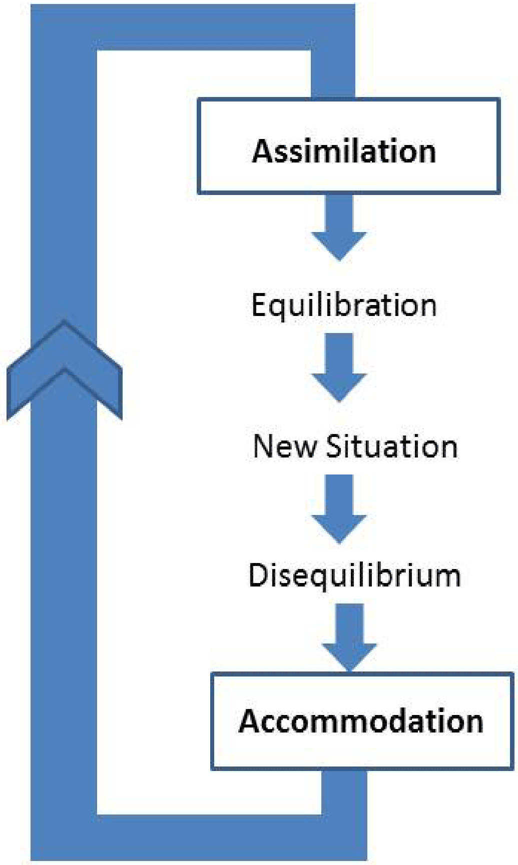

Figure 2.5 Piaget Learning Theory Model

Jean Piaget was interested in the process of learning and focused on both “how children learned” and “how they thought”. Piaget studied children from infancy to adolescence and carried out many of his investigations using his three children. He used the following research methods. Naturalistic observation: Piaget made careful, detailed observations of children. These were mainly his children and the children of friends. From there he wrote diary descriptions charting their development. Clinical interviews and observations of older children who were able to understand questions and hold conversations. Piaget believed that children think differently than adults and stated that they go through 4 universal stages of cognitive development. Development is therefore biologically based and subjected to changes as the child matures. Cognition, therefore, develops in all children in the same sequence of stages. Each child goes through the stages in the same order, and no stage can be missed out -

although some individuals may never attain the later stages. There are individual differences in the rate at which children progress through stages. Piaget did not claim that a particular stage was reached at a certain age - although descriptions of the stages often include an indication of the age at which the average child would reach each stage. Piaget believed that these stages are universal - i.e. that the same sequence of development occurs in children all over the world, whatever their culture.

2.6.1 Piagets' Basic Assumptions

Piaget introduces several ideas and concepts to describe and explain the changes in logical thinking during his observation made by children.

1) Children are active and motivated learner Piaget believed that children are naturally curious about the world and activity to seek out information to help them understand and make sense of it. They continually experiment with the objectives they encounter, manipulating them, and observing the effects of their actions.

2) Children construct knowledge from their experience children don't just amass the things they learn into a collection of isolated facts. Instead, they pull their experience together into an integrated view of how the world operates. For example, by observing that food, toys, and other objects always fall when released, children begin to construct a rudimentary understanding of gravity. Piaget proposed that children construct their own beliefs and understandings from their experiences, his theory is sometimes called a constructivist theory or more generally constructivism.

3) Children learn through the two complementary processes of assimilation and accommodation. Piaget proposed that learning and cognitive development occurs as a result of two complementary processes: assimilation and accommodation. Assimilation entails dealing with an objective or event in a way that is consistent with an existing scheme. For example, an infant may assimilate a new teddy bear into her putting things in mouth schema.

4) Interactions with one's physical and social environment are essential for cognitive development. According to Piaget, active experimentation with the physical world is critical for cognitive growth that is by exploring and manipulating physical objects or playing games with balls and bats, etc.

5) The process of equilibration promotes progression towards increasingly complex thought. Piaget suggested that children are often in a state of equilibrium. They can comfortably interpret and respond to new events, using existing schemes.

Many theorists propose that we learn from our experience and that effective perception and processing of experiences improves performance.

Merrill suggests that the most effective learning environments have problem-solving as their basis. This trial and improvement, problem-solving covers four distinct phases of learning:

a) Activation of prior experience
b) Demonstration of skills
c) Application of skills
d) Integration of these skills into real-world applications (Merrill, 2001).

One of the key theorists of experiential learning is David A. Kolb. Kolb developed his experiential model, as opposed to a purer cognitive one, following the influence of Dewey and Piaget [McGill & Beaty 1995]. Kolb formally recognized that people learn from experience and described learning as following a cycle of stages:

a) Concrete experience
b) Observation and reflection
c) Abstract conceptualization
d) Testing concepts in new situations. [Kolb, 1984]

In crude terms, learners have to do something, think about it, pull out its key points and apply them to work or life. In the first, perceptual, half of this cycle learners sense and absorb the information coming from concrete experience and reflect on its significance. During the processing period, learners build cognitive models that can be tested in practice. Kolb argued that learners can enter this cycle at any point and that learning is a process of repeatedly looping about these four stages. Feedback from the experience becomes key in the refinement of performance and the learner's ability to apply knowledge in new circumstances.

The experiential view of learning is considered more sophisticated than pure behaviorism or constructivism because it represents a more holistic view of the learner. However, like constructivism, experiential learning draws on the learner's personal experience. The role of the facilitator is to encourage learners to address the various stages of the learning cycle. The role of practitioners is not about teaching specific knowledge or training fixed behaviors but helping the learner to discover approaches that work for them. Facilitation is about creating and providing space for learners to try out something new, reflect on their experiences, arrive at new conclusions, and think about how they would apply these conclusions in their work and life.

In physical role-play, children have been observed to use real objects to create imaginary situations in which they role-played and formulated rules that surfaced naturally during their play (Berk & Winsler , 1995). Similarly, simulations allow for the simplification of systems by describing manageable chunks of behavior that learners can absorb. The structure and simplification of environments give users the chance to parse information more effectively.

Herz (1997) suggests that the circumstances within a simulation are less important than the forces that create them. The "four-dimensional building blocks" of moving resources in time do not change the system as they merely illustrate how it operates while allowing the user to establish the rules and relationships between elements. The simulation, therefore, describes environmental processes through graphics, animations, and other dynamic media, portraying complex abstract relationships more recognizably and intuitively.

Piaget (1962) shifted the focus of study from social and emotional aspects of play to children's cognition. He placed play within his stage-based theory of cognitive development and assigned it a significant role in the growth of children's minds. Considering his view of the contribution of play towards the cognitive development of children, he highlighted two processes through which children construct knowledge through assimilation and accommodation. Piaget maintained that assimilation is dominant in play because children take something and make it fit to what they know, such as when a child makes rolled paper to be a royal scepter. Talking about the symbolic play, he outlined the importance of play in the development of children's mental representation and abstract thinking (Leontiev, 1978, 1981).

2.7 Education In SLP

1. Learn as much as you can about the disorder. Education equals power, the better you understand the condition the better you can deal with it. Buy books or borrow them from the library, ask your doctor questions and attend talks.

2. Put in place a structured routine. SLP individuals need structure, routine, and consistency. Get organized. Have daily and weekly routines and place them on large posters on the wall and stick to them. Organize a routine for things like mealtimes, homework, and bedtime which is followed each day. Color code schoolbooks to have a color for each subject to ensure the right books go to the right classes. Removed the randomness.

3. Increase the amount of exercise done. Exercise and activity will improve brain function. Slow learners' sufferers should do at least 30 minutes of high activity exercise every day like bike riding, swimming, dancing, and ice skating, etc.

4. Introduce a rewards system. SLP kids find it quite easy to earn immediate bad attention for doing the wrong thing but struggle to earn good attention. They need attention more than most kids so they will do whatever it takes to get it which is usually not favorable under some social circumstances. Make it easier to earn good attention for doing the right thing. Have a points chart and award points for things like being polite, waiting for turns, getting started on homework, staying on task, completing tasks, following instructions, playing well with siblings, and so on. Points can be exchanged for privileges like TV time, computer time, video games, a special treat, etc. Have lots of choices including small rewards they can earn quickly and large rewards that they can save up for. It is essential that the child's life is not too much filled with privileges otherwise they will feel that the rewards are pointless and won't bother. Schools can use the same system for their educational curriculum. Adults also should use a rewards system to motivate them for completing tasks and sticking to a goal.

5. Be noticeably clear in instructions given to a Slow learner's child or adult. Try to use less words, the less you say the more the slow learner child sufferer remembers. Be clear and give one instruction at a time. Make sure you get the slow learners' persons attention first and asked them to repeat the instructions back to you if you feel it is necessary.

6. Don't give too many warnings, Slow learner's kids will not connect consequences to their behavior if too many warnings are given and will learn nothing. Also if the number of warnings changes every time they misbehave as they will constantly have to test to see where they are to analyze for the modification in their behavior.

Before we diagnose slow learners' children, we need to consider if it is simply a conflict of learning styles being adopted. Educational Psychologist Melanie West stated in January 2012, after looking into recent slow learning guideline changes by the American Academy of Pediatrics "Many children are visual and kinaesthetic learners. When forced to sit in schools that rely heavily on pencil-paper tasks and rote memorization, these types of learners become distractible, restless, and low performing often ending up being incorrectly diagnosed slow learners."

2.7.1 Kinect therapy

Slow learning has been becoming more common among people over time. Therefore, instead of feeding them drugs, we should take new advancements in therapies by using

Kinect to therapy this kind of childhood diseases. Kinect based games have a positive impact on children with slow learning (Retalis, S., Korpa, T., Skaloumpakas, C., Boloudakis, M., Kourakli, M., Altanis, I., Siameri, F., Papadopoulou, P., Lytra, F. and Pervanidou, P., 2014). The study presented was conducted on 11 slow learners' children which shows a remarkable effect of Kinems learning while improving their learning and cognitive skills. Another study reveals the improvement of motor skills through Kinect based system (Chang, Y.J., Chen, S.F. and Huang, J.D., 2011). In (Altanis, G., Boloudakis, M., Retalis, S. and Nikou, N., 2013), an authentic classroom environment was provided to study the case for the improvement of motor and cognitive skills while utilizing Kinect-based learnings. Some critics of this game following in below.

- The game employs a time limit, further encouraging players to focus intently and find items fast.
- Players revisit locations several times, emphasizing memorization and the need to recall layouts and identify items quickly.
- *Make more* active and motion-based games to employ a great deal of movement and vigorous exercise, for which studies have predicted the change of brain chemistry in a positive way that improvement of attention.
- The games teach players specific movements that are used to control the game. Players jump to dodge obstacles, duck to avoid bars, and move left and right to steer a raft.
- During gameplay, players have to remember these movements and pay attention to on-screen visual cues to know when to perform them. This stretches their Working Memory, as they don't only have to remember what each movement does, but also perform it.
- Players aren't just focusing on the various visual signs, they are remembering what they mean, the action needed to react to it and how to perform the required action.

- The numerous tracks offered in both games are quite long, and to improve their score players need to learn their layout, committing for the memorization of the tracks to better navigate and anticipate obstacles.

2.8 Game Theory

There is a growing belief that students and learning methods are changing. Students today have grown up in a different generation than their parents. They have grown up with computer games and other technologies that have changed their preferred leisure styles, their social interaction, and even their learning preferences (Bekebrede, Warmelink, & Mayer, 2011). Since children are accustomed to the daily use of technology such as computers, mobile devices, consoles, etc., this generation is commonly referred to as the 'gamer generation' (Beck & Wade, 2004, 2006), 'digital natives' (Prensky, 2001), or the 'net generation' (Tapscott, 1998). Prensky pointed out that these 'digital natives' have experienced 'mind alterations' and 'cognitive change' (2001, p. 39). Beck and Wade highlighted the fact that the 'gamer generation' has 'systematically different ways of working' that are the consequence of 'one central factor: growing up with video games' (Beck & Wade, 2004, 2006, p. 2). Tapscott argued that the 'net generation' 'are learning, playing, communicating, working, and creating communities very differently than their parents' (Tapscott, 1998, p. 2, quoted in Prensky, 2001, p. 39). It is also widely accepted that this new style of learning requires new ways of teaching. Cognitive changes of digital natives make it difficult to keep within the zone of proximal development (Vygotsky, 1978) while using the learning methods of their parents. They require new motivations that capture and hold their attention, engaging them in the learning process when they are in a state of flow (Csikszentmihalyi, 1990).

Modern theories of play:

- **Psychoanalytic theories** (A. Freud 1968, S. Freud 1959, Erikson 1963)—play reduces anxiety by giving children a sense of control over their world and an acceptable way to express forbidden impulses. Does this computer game enable children to gain a sense of control over events that they could not control in their lives, including traumatic experiences? If so, in what way?

- **Cognitive theory** (Piaget 1962)—play consolidates acquired learnings while allowing for the possibility of new learning in a relaxed atmosphere. Does this computer game have the potential to consolidate existing learning? If so, what kind of learning? Does this computer game have the potential to develop new concepts and skills? If so, what concepts and skills? Does this computer game allow for and nurture the active participation of the child? If so, in what way? Does this computer game engage the child in such approaches as problem-solving and self-discovery?
- **Arousal modulation theory** (Berlyne 1960, Ellis 1973)—play keeps the body at an optimal state of arousal, relieving boredom and reducing uncertainly. Does the computer game engage and sustain the interest of the child?
- **Bateson's communication and met communication** (1976)—play promotes the ability to comprehend multiple layers of meaning. Does this computer game operate at literal and figurative levels of meaning? Does this computer game enable children to reflect on the rules and means of communication?
- **Mead's theory of self** (1934)—play promotes a sense of self in terms of personal identity and social relations with others. Does this computer game develop a sense of a child's own identity? If so, how? Does this computer game develop a child's sense of his/her own social identities towards others? If so, how?
- **Socio-cultural theory** (Vygotsky 1977, 1978)—play promotes abstract thought by separating meaning from objects and actions while utilizing them in symbolic ways. Play allows children to reach beyond their actual development in their cognition and self-regulation and develop a mental representation of social roles and the rules of society. Does this computer game involve and develop the use of symbolic meaning? If so, in what way? Does this computer game allow children to engage in their zone of proximal development and function above their everyday abilities in cognitive and socio-emotional areas? Does this computer game provide children with an opportunity to act out and explore the

roles and rules of functioning in adult society? Does this computer game allow for group work and collaboration?

A task that simulates decision-making under risk is defined as the Game of Dice Task (GDT; Brand et al., 2005). It offers explicit rules for gains and losses as well as obvious probabilities and the possibility to measure the processing of positive or negative feedback following choices. Thereby, one study (Drechsler et al., 2008) found that slow learners' children made significantly more risky choices compared to healthy control children. However, these observations were only made when they played the game a second time (Drechsler et al., 2008). Processing of positive or negative feedback following risky or safe choices had not been reported in this study. According to a study conducted by Drechsler, slow learners' children attain more control while playing Make a Match Game (Drechsler et al., 2010)

Cognitivism replaced Behaviourism as the dominant learning paradigm in the 1960s (Ormrod, 1999). Cognitive psychology proposes that learning comes from mental activity such as memory, motivation, thinking, and reflection. Cognitivism believe that learning is an internal process that depends on the learner's capacity, motivation, and determination (Craik, F. I. M. & Lockhart, R. S., 1972). Although cognitivists such as Jean Piaget (Piaget, J., 1962) and Jerome Bruner (Bruner, J. S., 1966)have different emphases, both believe that learning is demonstrated through a change in knowledge and understanding. Cognitivism describes this change as altering a learner's mental model and presented that the mind, thinking, and understanding mediate the stimulus and response described by behaviorists. That is, while learning may result in a change of behavior which is primarily a change in understanding.

Cognitivism focuses on the transmission of information from someone who knows (expert) to learners who do not know. The learners receive it, take it on board, store it, relate it to existing ideas and information that they already have, index it (like a filing system) and then retrieve it, so that they can find it in their memories later when they need it. In cognitivism, learning is the process of connecting pieces of knowledge in meaningful and memorable ways. Cognitivism is more concerned with process than the product and is therefore demonstrated by games that improve reflexes, promote critical thinking, or help people learn different patterns of association. In 2009, Alain Lieury, claims that brain training games were better than even the humble paper and pen for increasing brain 'power' but puzzles and strategy games that offer a free environment for decision-making such as Tetris, Age of Empires and Professor Layton are good examples of the cognitivist approach. Bandura's later theory of Social Learning (Bandura, 1977) attempts to bridge the gap between behaviorist and cognitive learning theories because it encompasses attention, memory, and motivation.

Game-based learning (GBL) is thought to be an effective tool for learning (Kebritchi & Hirumi, 2008; Papastergiou, 2009) that can promote enhanced learning experiences (Connolly, Stansfield, & Hainey, 2007) and student motivation (Papastergiou, 2009). According to Connolly et al. (2007), GBL can be defined as "the use of a computer game-based approach to deliver, support, and enhance teaching, learning, assessment, and evaluation". There is also the widespread acknowledgment of the advantages that the use of games has attained in elementary and secondary education (Ebner & Holzinger, 2007). Kebritchi and Hirumi (2008) identified the following five reasons for defining GBL as an effective tool for learning: 1) GBL uses action instead of explanation; 2) GBL creates personal motivation and satisfaction; 3) GBL accommodates multiple learning styles and skills; 4) GBL reinforces mastery of skills, and 5) GBL provides an interactive and decision-making context. Computer games not only integrate knowing and doing, but also "bring together ways of knowing, ways of doing, ways of being, and ways of caring: the situated understandings, effective social practices, powerful identities, and shared values that make someone an expert" (Shaffer, Squire, Halverson, & Gee, 2004). According to O'Neil (Baker, Wainess, 2005), computer games are useful for instructional purposes and they also provide multiple benefits: (a) complex and diverse approaches to learning processes and outcomes; (b) interactivity; (c) ability to address cognitive as well as effective learning issues; and (d) motivation for learning. Robertson and Howells (2008) considered that computer games could develop several cognitive skills. Moreover, game-playing activity is linked with the possibility of developing skills in decision-making, design, strategy, cooperation, and problem-solving (Ebner & Holzinger, 2007; McFarlane, Sparrowhawk, & Heald, 2002). Students use games to explore, discover, and question. These “learning by doing” and “active learning” concepts are important principles, which underlie GBL (Yang, 2012).

In the last few years, the use of mobile devices as platforms for GBL offers new options for providing better learning experiences. Mobile devices could change how students behave and interact with each other (Motiwalla, 2007). M-learning is a new learning paradigm that exploits the use of mobile devices in education (Sharples, Corlett, & Westmancott, 2002). Thanyaluck Ingkavara presented the technological approach for teaching mathematics to students with learning disabilities. He coupled mathematics learning with different technologies including computers and mobile applications infrastructure on a synthesized instructional model which provide effective results and prevail that these technologies led students to develop the abstract while visualization and interacting with devices enabled them to focus for a longer span thus boosting the learning process (Ingkavara, T. and Yasri, P., 2019) Similarly, Rubia E.O presented that computer vision-based augmentative and alternative communication (AAC) can assist to overcome the impairments while improving motor and cognitive skills which allow the interaction as personalized gestures which assist in developing the interest of student with SLP (Ascari, R.E.S., Silva, L. and Pereira, R., 2019). Serious games with learning outcomes are effective assistive technology that enhances the rehabilitation process (process to restore towards optimal state functioning) (BASTOS FILHO, T.F., BRAVO, E., NAVES, E., NOGUEIRA, B. and FERNANDES, A., 2019). Thus, incorporating games along with the academic peers can enhance the learning process by boosting up their interest. For the validation of the effectiveness of assistive technology in aiding the learning process, Veiko conducted a study over the students with dyslexia of Eros Girls School (EGS) and the results prove to be in favor of assistive technology which encourages the learning while assisting them in improving mathematical and English skills (Veiko, V., 2019).

Jones and Jo (2004) added that m-learning includes the concept of any time/anywhere providing an ideal platform for GBL because these systems can improve lifelong learning and can provide more versatile educational methods (Lavín-Mera, Moreno-Ger, & Fernández-Manjón, 2008). The extended use of portable gaming platforms among young people makes mobile GBL truly relevant because some idle moments can be taken as an opportunity for learning (Virvou & Alepis, 2005). Apart from allowing users to access the video game anytime and anywhere, mobile GBL also improves m-learning scenarios and offers additional value to the educational advantages of GBL (Lavín-Mera et al., 2008). If all of these benefits and technologies are considered, educators can incorporate powerful tools into their teaching activities that can enrich and complement children's skills through play.

2.8.1 Kinect Xbox

Using Microsoft Kinect helped the therapist to monitor better the movement of students with cerebral palsy. Kinect-based rehabilitation system assisted therapist to detect students' movement and determine whether their movement are correct. The system also includes an interactive interface to enhance students' motivation, interest, and perseverance with rehabilitation (Huang 2011).

Recently (Peter et. al. 2013) introduced a game called "The Sorcerer's Apprentice" which is a serious motion tracking game using Microsoft Kinect that improving strength and mobility of the shoulder area targeting support of supervised physiotherapy. It proposes a customizable environment for supplementary exercises in the context of rehabilitation for a one-sided Shoulder-Impingement-Syndrome

The potential of motion-based interaction for learning is grounded on theoretical approaches that recognize the relationship between physical activity and cognitive processes (Wilson 2002). One study indicates if learners are forced to gesture, those elicited gestures also reveal implicit knowledge and, in so doing, enhance learning (Broaders 2007)

Kynigos et al. (2010) reported that children perceived body motion as a natural way to interact and mutually communicate, and directly connected their body actions with the mathematical concepts embedded in the games. Another study (Bianchi 2007) on the relationship between body involvement and engagement in educational motion-based gaming shows that an increase in body movement increases the player's engagement level, and, in multiplayer conditions, enforces the social nature of the gaming experience.

A study (Williamson, B., 2009) conducted on game-based interactive learning in the UK to analyze the effect of games as a media literacy while providing constructive knowledge utilizing Xbox and other interactive devices. This survey engaged 1634 teachers from primary and secondary schools from the age group of 20 to 50 while 72% were female and 28% male. The survey concluded that 60 percent of teachers foresee the games and media literacy as a future classroom for constructive knowledge while 19% denied and the rest were uncertain. The learning outcomes demonstrated that interactive games enhance cognitive and motor skills by 85%, ICT skills by 73%, and critical thinking by 65%. Thus this survey provides solid grounds for the improvement in slow learners.

Several researches (Evans 2012), (Hsu 2011), (Kandroudi 2012) and (Lee 2012) discuss the potential and impact of Kinect interactive applications for teaching and learning purposes at school. According to (Hsu 2011), motion-based educational activities can facilitate kinaesthetic pedagogical practices for learners with strong bodily-kinaesthetic intelligence (who learn better when they are physically involved in what they are learning). Giannis Altanis presented the findings of a case study within the authentic classroom environment in which students with a learning disability or motor impairments play a Kinect learning game and the study was focused on the kinemes approach which encloses innovative games with the user interactive modem including their body movements and hand gestures (Altanis, G., Boloudakis, M., Retalis, S. and Nikou, N., 2013). Results assure that Kinect technology can enhance and assist the learning process and improve the motor skills of slow learners or students with Dyspraxia. However, there are challenges encountered while adapting assistive technology for training or healthcare purposes (Manship, S., Hatzidimitriadou, E., Stein, M., Parkin, C., Raffray, M., Gallien, P. and Delestre, C., 2019).

Using Microsoft Kinect for slow learners' children is another research going on in Malaysia and the UK. Researchers (Behrang 2013) designed and developed an interactive game-based motion detection application to enhance the level of attention and concentration of children with SLP while they are learning mathematics. Motion games also can be used for hyperactive students (since they cannot sit in the classroom quietly for more than a few minutes. Using a kinaesthetic model of learning will have a positive impact on slow learners' children.

2.9. Assistive technologies and existing learning-based design

As mentioned above in literature that game-based learnings can enhance the motor and cognitive skills in slow learners whereas, with the advancement in technology and HCI, the game era has been evolved around digital media enhancing the chances of learning at the comfort of home or within a room. Digital games are software-based applications installed on personal devices or computers, tablets, phones, etc. which engage the audience with eye-appealing interfaces developing curiosity and entertainment to keep them playing. If this addiction of curiosity and entertainment of game when integrated with learnings influence students to grasp concepts more frequently (Barab, S. et al, 2005). With the discovery of augmented reality, digital games have become more interactive and enjoyable due to the new method of feeding input to the system.

2.9.1. Types of Game Designs

Computer games boost multiple skills including decision making, cooperative teamwork, cognitive skills, and problem-solving (Robertson, J.et al., 2008). There are multiple types of games that are designed based on the targeted skill set required. For instance, the design of a game for improvement in the language or skills would be different than a decision-making game which is oriented on judgmental skills. Some of the game design according to skillset has been demonstrated in table 2.1.

Table 2.1 Types of game designs based on targeted skills

Type of Skill	Examples	Learning activities during the game	Type of Game Design
Facts and implication of rules	Policies, law, characterization	Memorizing Questions Association drill	Mnemonics Game show competition Flashcard games Action
Management Skills	Teaching, project management, running a machine	Pretend Feedback Coaching and training Iterative challenges	Roleplay game Adventurous game Tenacity-state game Detective games
Judgment	Management decision, time framing, ethics	Reviewing Assessment Questioning Opt an option Feedback	Strategy games Roleplay games Multiplayer Detective games Adventurous games

Behavioral ethics	Self-control, Administration	Imitation Feedback Practices coaching	Roleplay games
Concept and theories	Learning process of humans, Marketing psychological tactics	Reasoning Experimental analysis Questioning	Open-ended simulation-based games Building and construction games
Logic and reasoning	Strategic and critical thinking, assessment of the quality	Problems Examples as reference	Puzzles
Processing	Inspection, development of strategies	System assessment Practice	Strategical games Adventurous games
Creativity	Designing a product, Innovation	Play	Invention games Creative development games
Language	Acronyms, foreign languages, business terminology	Imitation Practice Involvement	Reflex games Roleplay games Flashcard games
Systems	Markets, industries, health care units	Understanding rules and principal Accomplishing tasks	Simulated Games
Observations	Assessment of problems, Morals, Inefficiency	Analysis through observation Feedback	Focus games Adventurous games

2.10. HCI and Games Interfaces

Computer games provide highly interactive software that has been successful for more than a decade in engaging with swift access and fast processing even though the game interface paradigm and principles are different when compare to the other applications installed on the computer. During the early era of digital games, the developers focus on the system performance and speed while ignoring adaptable windows systems, the fundamental widget libraries, and the toolkits that are directly associated with the outlook of the game. To change the conventional system, game UIs were introduced which is popular for attaining the characteristics of providing effective performance and innovation while not affecting or limiting the design factors like how a game should look or how the user would carry out the interaction with games, etc. Whenever the game is designed, it is important to consider the user perspective, expectations, and satisfaction while the uniqueness in-game by integrating cool effects, eye-appealing, and soothing features bring the novelty in the game development. As a result, HCI technologies and HCI interaction designs become fundamentals for the development of an effective and efficient game that can engage users with the sense of amusement and entertainment while conveying or boosting the targeted skill on which game is purposely designed (Park, H.et al, 2018).

Early adoption of HCI initiated with Diablo II integrating transparent overlays (Cox et al., 1998), Everquest inaugurates transparent menus (Harrison and Vicente, 1996), Warcraft integrate radar views in graphics (Gutwin et al. 1996), Black and White include gestural commands (Wolf, C.G., 1992), Neverwinter Nights couple radial menus in HCI (Hopkins, D., 1991). Later on, the market competition and the expectations from the player community led the designer to improvise the previous games as well as introduced new games with attractive and appealing HCI. Hence, HCI is a good blend of not only the graphics (visuals) and development but also indulge the human psychological aspects blended with sociology and many other human factors. A visual illustration has been shown in figure 2.6.

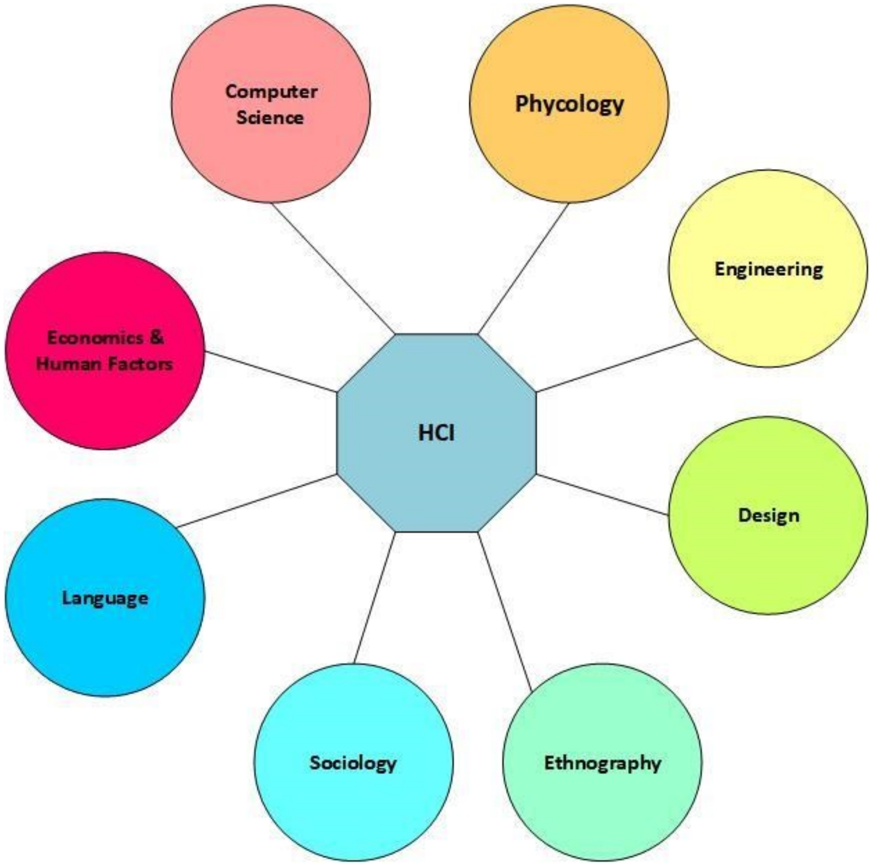

Figure 2.6 Factors of HCI

Source: Author

2.10.1. Input methods

Just like a man to man communication model where two modes of communication are considered i-e Verbal and nonverbal communication, Human to computer communication (HCI) is interpolated similarly. Verbal communication during face-to-face interaction includes verbal words to convey a message while in HCI, it is the direct communication through Keypad, mouse, touchscreens, and on advanced level voice input, etc. (Carter, M, et al, 2015). Nonverbal communication refers to the message communication via body gestures, facial expressions, or eye contact while in HCI, indirect mode of the interface is integrated with the assistance of a variety of input develop for the more natural interaction, comfort, and amusement to the game which focuses on body motion like Nintendo Wii, Playstation Move or Microsoft Kinect.

The basic interaction with the machine world is imitated with the direct manipulation interface in which visible objects displayed on the screens are directly interpolated with the pointing devices. The first model of direct manipulation interface was Sketchpad (Sutherland, I.E., 1964) which supported the interaction with a light pen to select and move objects or resize them displayed on the screen. This innovation proves to be fundamental which lead to enormous interface ideas while the interaction techniques which become popular during the era of direct manipulation interface, followed the principle of “WYSIWG” which is abbreviated for ‘what you see is what you get’. Bravo text editor and the Draw drawing program were built considering this principle which is more focused on how you select the object, open it or interpolate it (Goldberg, A., 1988). The first commercial product or system based on Direct Manipulation includes Xerox Start (Smith, D.C., et al, 1982), Macintosh (Williams, G., 1984), and the Apple Lisa (Williams, G., 1983). Similarly, the mouse was developed as an inexpensive replacement to the light pen which becomes a famous mode of input after being adopted by Xerox PARC in the 1970s and later on, commercially available as a part of Xerox Star, The Apple Lisa, the Three Rivers Computer Company’s PERQ (Myers, B.A., 1984) and Apple Macintosh.

The game industry took a hype with the development of game controllers and consoles creating a dedicated gaming platform for the gamer’s community (Forster, W., 2005). During the development era of console-based games, the majority of newer generations of the game console were accomplished by merely integrating the few degrees of innovation or modified version with more attributes in the previous generation, while some of them bring significant changes and innovation to the gaming industry like Nintendo Wii Remote, Nintendo Entertainment System Gamepad, etc. There are standardized or platform-specific controllers for the majority of games available and the console associated with each game has a standard first-party controller. Nowadays, most games support the available standardized console, for instance, games on the mobile phone are supported by standard phone controls, games on computers are mostly take inputs from the keyboard and mouse providing the control for game application, PDA games take input from a stylus while the evolution of touchscreen in devices also supports the interactive input for games.

Apart from computers and mobile phone media, there is a growing interest of gamers community in diverging games to the television just like online streaming content to play the games without extra effort and set up at the comfort of a TV lounge. PS3, Xbox 360, and Wii are the most popular gaming platforms nowadays for this digital convergence with the adaptability of accessing new media for the gaming experience. Apart from the accessing comfort, these types of gaming platforms come with the price of interface challenges regarding the designing of controller since the provided controller must be efficient in providing or interlinked with online content (Cox, D., et al, 2012).

2.10.2. Windows

The first multiple tiled windows were presented by Engelbart's NLS (Engelbart, D.C.et al, 1968) while the research on systems like COPILOT (Swinehart, D.C., 1974) and EMAC text editors also influence the discovery of tiled windows (Stallman, R., 1979). Later on, overlapping windows were introduced which first appeared in the Smalltalk system (Goldberg, A. and Robson, D., 1979) and InterLisp system (Teitelman, W., 1979). The first tiled window manager was introduced by Xerox PARC names as 'The Cider window manager' and soon after, 'The Andrew window manager' was introduced in the market (Myers, B.A., 1988). In the late 1980s, the main commercial system interfacing windows were integrated by Xerox Star, the Apple Lisa, and the Apple Macintosh while initial versions integrated by Star and Microsoft Windows were tiled based windows but later on switch to the overlapping windows like integrated into Lisa and Macintosh. Currently, X Window System is considered an international standard and is being widely deployed due to its adaptability towards multiple functionality and efficiency (Scheifler, R.W. et al, 1986). The development of extensive forms of games that integrate a large number of actions demands a careful architecture and abstraction of spacing for actions since this directly affects the performance and user experience. Multiple research in this domain has initiated while in (Hawkin, J., et al, 2012), the author makes use of sliding windows to generate action abstractions while addressing the extensive form of games and testing no-limit poker games.

2.10.3 Application types for Games

There are multiple applications developed to support game interface, some of the most popular application types are discussed below

2.10.3.1 Drawing programs

Most of the present technology has been influenced through the development of the Sketchpad system which was first presented in Sutherland (1963) while the mouse interface for graphics was presented by NLS. Later on, Ken Pulfer use a mouse along with a keyframe animation system to draw all the movie frames while an award-winning movie ‘Hunger’ integrated tablet technology instead of a mouse (Burtnyk, N. and Wein, M., 1971). The first drawing program was developed for Xerox PARC’s Alto in 1975 which was named ‘William Newman’s Markup’ and the ‘Patrick Baudelaire’s Draw’ was introduced immediately after it which was capable of handling lines and curves more efficiently. In 1975, the first computer painting program ‘Dick Shoup’s Superpaint’ was launched at PARC which effectively handles the basic designing paradigms.

2.10.3.2 Text Editing

Engelbart proposed a word processor with multiple functionalities including self-wrapping text, scroll text, find and replace, user-defined macros along with the integration of multiple commands like copying, moving, deleting characters or blocks of text. Initially, CRT-based display editors were in practice introduced by Stanford's TVEdit (Tolliver, B., 1965) but the trend takes a shift when the Hypertext Editing system demonstrated by Brown University allowed the screen editing and was capable of formatting the arbitrary sized strings with the aid of lightpen. The first WYSIWG based editor format was designed and presented by Butler Lampson while the first marketable WYSIWG editors introduced were the Star, LisaWrite, and MacWrite (Meyrowitz, N. and Van Dam, A., 1982).

2.10.3.3 HyperText

The idea of connecting the subjective document with the relevant documents influence the formation of HyperText demonstrated by Vannevar Bush (Bush, V., 1945) and titled as 'Hypertext' by Ted Nelson in 1965 (Nelson, T.H., 1965). NLS system presented by Engelbart incorporates extensive usage of linking and the NLS journal was the first journal available online with full linking of articles (Goldberg, A., 1988). The first Hypertext system made available for the user community was released by Vermont's PROMIS in 1976 and was incorporated successfully for linking patient and the medical information of the patient at the University of Vermont's medical center. Ben Shneiderman's Hyperties add on feature to the hypertext system where the user can click on the highlighted items to get directions to the other pages (Koved, L. and Shneiderman, B., 1986) while HyperCard from Apple introduced these features to the public making accessibility easier for the user community. There are multiple other hypertext systems launched subsequently and has been integrated to various application with different functionality. For instance, Tim Berners-Lee launched the first World Wide Web by incorporating hypertext, and later on, Mosaic was introduced as a commercial hypertext browser for the World Wide Web (Nielsen, J. and Nielsen, B., 1995).

2.10.3.4 Computer-Aided Design (CAD)

The IFIPS conference conducted for sketchpad also introduced multiple CAD systems which enclose Doug Ross's Computer-Aided Design Project (Ross, D. and Rodriguez, J, 1963) and Coon's work with sketchpad (Coons, S., 1963). Timothy Johnson leads a pioneering step by introducing a 3D CAD system interfaced as sketchpad3 (Johnson, T., 1963) while the first commercial CAD/CAM system was launched by General Motor's DAC-1 in 1963.

2.10.3.5 Video Games

The SpaceWar was the first video game that integrates graphical frames into the game with another addition of input i-e the very first computer joystick for PDP-1 to enhance the user experience (Levy, S., 1984). The initial idea of the adventure game was introduced to the audience by Will Crowther at BBN while later on, Don Woods add on more features and graphical interpolations to this game making it more user-friendly and enthusiastic to play. In 1970, the game of life presented by Conway was first integrated into the computers at MIT and Stanford while the first game commercially available for the public was Pong in 1976.

2.11. Design principals

A designer must consider its audience demands and needs while designing an interface since it is critical and important to have an insight into the audience or user perspective before the development so that the required quality and content can be abstracted in-game to gain the targeted results. Authors like Kamaruddin et al (2012) and Preece et al. (2002) give the perspective for the interface as the surface of the screen aiding the particular manipulation of the medium according to the user perception of the communication process. There are generally four types of interfaces (Weiss, J., 1993) which are described as follow

1) Demonstration of 'the controls' for the interface where the user manipulates the information (view of the game and the information of user interface)
2) The method adopted for communication between the user and the controls of the system.
3) The navigation controls are integrated with a user interface through which a user navigates from one part of the information provided in the interface to another.
4) Details of interface controls i-e how a user going to interact for controlling different activities e.g. icon usage for efficient performance and good user experience.

Apart from the appealing and eye-catching graphics, interface design must be capable of keeping track and easy to remember the information to perform certain actions. In most of the literature, the emphasis has diverted toward the understanding and manipulation of function provided in the interface for the delivery of learning content and facilitate user engagement. The gaming interface can be categorized into three aspects enclosing user-centered design, application of interface design, and functionality of interface design. Kim et al (2013) presented in their study that the present learning environment is reshaping with the advancement and the interactive media enable the user to enhance their learning capabilities by interacting with learning content with more enthusiasm and interest via interfaces. It is also described as dynamic relativity of "behavior sequence" (Wu, Q., and Guan, Y., 2011) while Chase (2012) presented in his study a well-functioned user interface design that emphasizes learning and successfully meets the learning curve in his experimentation. Later on, Faghih's work supported the idea and incorporated different multimedia elements such as text, graphics, images, videos, and animations, etc bridge the learning content while abstracting interface design (Faghih, B., et al, 2014).

The list of principles and elements for interface design addressed by multiple authors has been reviewed and a list of common attributes and principles has been collected through a systematic approach, demonstrated in table 2.2. For instance, Dave Wood presents the hierarchal principles for each step incorporated for interface design (Wood, D., 2014) while the same objectives can be seen in Tay Vaughan's work. Hence a systematic analysis of the work presented by 16 authors on the principles for designing game interface required to convey targeted learning has been summarized in the table. The study consider the design from Wood (2014), however several note able authors has developed principles for the HCI such as Norman (1999) who developed the major principles for HCI. The reason of the current adoption from Wood (2014) is that his study was one of the latest available study which covers the basic principles from Norman (1999). However, with the advancement of technologies Norman (1999) can be considered as traditional approach.

There are five basic principles regarding content assessment targeted for games retrieved from the above-presented studies which enclose consistency (flow), contrast, hierarchal order, balance in content, and harmony. Also, these studies categorize the interface design into 7 basic milestones which include text, graphics (visuals), color and contrast, button (icons for interface), audio, video, and animated content. These attributes corresponding to studies has been defined below along with the categories of targeted content.

Table 2.2 Game design principles in literature (1998-2015)

Study	Author	Principles	Elements	Attributes
A Study of Usability Principles and Interface Design for Mobile E-Books (2015)	Chao-Ming Wang and Ching-Hua Huang's	Visibility Enjoyment Ease Efficiency Graphics	Graphic Video Text Color Icon	Hierarchal-contrast Based on User Experience Visual Appealing
Interface Design: An introduction to visual communication in UI design. (2014)	Dave Wood	Flow (Consistency) Contrast Balance Harmony Hierarchy	Text	Flow and consistency, short paragraph, avoid capitalization of text
			Color	Harmony Contrast No bright colors in long text Avoid Distractions Hierarchy
			Image	Focus, hierarchy, balance, contrast Appropriate suiting content Left Alignment
			Icon	Simple Limited selection of colors Supplements Universal and balanced
			Video	Demonstration of the main purpose Control buttons integration Introductive

				Breaking into subsection
			Animation	Assist comprehension
			Audio	Induce impact of content Short and fragmented Consistent
Introduction to Digital Multimedia 2nd Edition. (2014)	T. M Savage and K. E. Vogel	Divergence Balance Contrast Harmony Flow	Text Type	Header: Serif Body: Sans Serif No fancy fonts Grid column left alignment
			Color	Reflect meaning, contrast, and balance
			Image	Function oriented, relatable For navigation
			Icon	Optimal use of text Function oriented
			Video & Animation	Attention driven Consistency No interference
User Interface Design for E-Learning Software (2013)	Beghnam Faghih and Mohd Reza Azadehfare	Focus Contrast Coherence Clustering	Color Text Audio Graphic Animation	Balance, Minimal Text, Emphasis through Hierarchal contrast, Minimizing cluttering, User Support
Interface Design in Interactive Science Courseware for the	Norfadilah Kamaruddin	Uniformity Acquaintance Elasticity	Color Graphic	Relatability

Malaysian Smart School Project (2012)		Efficient Feedback Appealing	Text Audio Animation Image Icon Layout	Clarity Effectiveness Communicate Adaptable to the audience
Teaching Visual Design Principles for Computer Science Students. (2010)	Roymieco Carter	Balance Focus Movement Contrast Unity Repetition	Text Graphic Color Image Icon	Emphasize Harmony Hierarchy Contrast
Digital Multimedia (2009)	Nigel Chapman and Jenny Chapman	Consistent Simplicity Contrast Harmony Variety Hierarchy	Video	Contrast, Clarity
			Graphics	Icons Consistency
			Sound	Used when required
			Animation	User adaptable, Minimal
			Text	Clarity Contrast Standard font
			Color	Contrast, focus, balance
			Image	Integrate when needed
			Animation	Functionality Speed control format
			Audio	Sync with content
			Graphic	Simple visuals
The Effect of Closed Interactive Multimedia Learning Environments on	Troy A Johnson	Hierarchy Constancy Stability	Graphic	Hierarchal contrast

Student Memory Retention: A Linear versus Non-Linear Approach (2009)		Emphasis Contrast Variation	Color Text	Consistency Focus Visually appealing Readability and clarity Limited fonts
The dynamics Involved in Web-based Learning Environment (WLE) Interface Design and Human-Computer Interactions (HCI): Connection With Learning Performance (2007)	Ivana Schnitman	Consistency Balance Clearness	Graphic Color Text Audio Animation	Spontaneous Relevance Functional Limit redundancy
Guidelines for Cognitively Efficient Multimedia Learning Tools: Educational Strategies, Cognitive Load and Interface Design (2006)	Tiffany Grunwald and Charisse Corsbie-Massay	Harmony Grouping Regular Diversity	Color Text Animation Graphic	Cluttering reduction Harmony Regularity Targeted Learning Contrast
The Origin of Graphic Screen Design Principles Theory or Rethoric (2005)	Barry O Williams, Lisa R. Stimart	Contrast Uniformity Clearness Emphasize	Audio Text Graphic Color Animation	Clarity Avoid abundance Minimal Text Lower case text
Design for New Media: Interaction Design for Multimedia and the Web (2004)	Lon Barfield	Contrast Diversity Weight Harmony Balance	Text	Clarity and readability, Hierarchical contrast with consistency
Multimedia: Making it Work (2004)	Tay Voughan	Grading Coherence Contrast	Text Graphic Color Layout Image Animation	Organized Clustering of elements with similarity Avoid align center

Designing the Instructional Interface (2000)	L. L. Lohr	Contrast Hierarchy Unity Emphasize	Color Text Graphic image	Differentiate Integrate clear spacing Accustomed structure Visualizing
Screen Design Guidelines for Motivation in Interactive Multimedia Instruction: A Survey and Framework for Designers (1999)	Shung Heum Lee and Elizabeth Boling	Contrast Constancy Emphasis Coherence Unity	Graphics	Assist Function Learning oriented
			Color	Logical coordination Contrast harmony Visual appealing
			Audio	Balance
			Text	Limited Length (Upper and lower case) Animating text Balanced Contrast
			Animation	Dynamic, facilitate learning Visual assistant
Principles of Educational Multimedia User Interface Design (1998)	Lawrence J. Najjaar et al	Variety Balance Emphasis Supportive	Text Color Image Graphic	Integrate balance and harmony, Communicate target learning
			Audio Video	Introduction, Conveying information
			Animation	Visual assistance

2.12. Advancement in HCI and Assistive technologies

The evolution in HCI invokes improvements in learning patterns and multiple assistive technologies have been introduced to provide an interactive ambiance for the educational purpose improving their learning capacity while overcoming the challenges faced by students with learning disabilities or slow learners. Few popular assistive technologies and advancement has been discussed as follow.

2.12.1 Gesture Recognition

The RAND tablet introduced the first pen-based input while Sketchpad available in 1963 integrate light pen gestures. The first model of trainable gesture recognizer was presented by Teitelman in 1964 while Tom Ellis introduced the GRAIL system on the RAND tablet which integrates gesture recognition. In the 1960s, it was a common practice to integrate a few gesture recognition in light pen-based systems like the AMBIT/G system while Micheal Coleman developed a gesture-based text editor in 1969. The commercial use of gesture recognition initiated when integrated into CAD systems available in the 1970s and become popular worldwide when introduced in Apple Newton in 1992.

Natural ways of input involving physical movement or body gesture-based input enhance user experience while simplifying the interaction between a computer and a human. These type of interactions and interfaces like provided by Sony Playstation 2, EyeToy, and Nintendo Wii Console endorse the essence of enthusiasm, amusement, and entertainment while delivering the objectives and learning-based content targeted during the development of the game. Gesture recognition can be made by integrating different kinds of sensors e.g. camera, Kinect sensor, etc. The recognition of gesture through stereo camera retrieve depth of the targeted object (user's movement) and deploy pattern recognition techniques to retrieve the commands associated with that action (Wu, Y. and Huang, T.S., 1999). Multiple studies incorporate the technique of recovering human body posture captured through the camera (Bray, M., et al, 2004), and these recovered postures later on used to recognize action (Wang, Y., et al, 2008). There are multiple active sensing techniques like incorporating structured lightning (Bray, M., et al, 2004) and time of flight sensor to retrieve depth masking while providing the advantages of accurate depth measurements and fewer computations comparatively but the requirement of active illumination put constraint to this approach.

Kinect has gesture recognition capabilities that have been researched at least since the late 70s', with Chris Schmandt's 1979 work at the MIT Media Lab demonstrating key Kinect concepts such as gesture tracking and speech recognition. The influence of Schmandt's work can be also be seen in Mark Lucente's work with gesture and speech recognition in the 90s' for IBM Research on a project called DreamSpace. These early concepts came together in the central image from Steven Speilberg's 2002 film *Minority Report* that captured viewers' imaginations concerning what the future should look like (Jarrett & James 2012).

The motion-sensing capability has become a boon in the gaming industry, with 90 million Nintendo Wii units sold since after its 2006 introduction and over 10 million units of Microsoft's Xbox360 Kinect peripheral sold since after its winter 2010 launch, the latter having surpassed the former as the "world's fastest-selling consumer electronic device". The marketing slogan for distinguishing Kinect from Wii was demonstrated as "you are the controller" for defining its dedication towards pure controller-less motion input (Clare 2011).

One of the key aspects of Kinect that has generated much excitement is its promotion of the Natural User Interface (NUI) paradigm, which in many ways aims to succeed in the traditional graphical user interface (GUI) and command-line interface (CLI) paradigms while providing human-computer interaction. Indeed, Microsoft's approach towards Kinect focuses on the expansion of NUI and a vision for Kinect that goes far beyond gaming (Clare 2011). As a tool to support learning, the affordances of Kinect can be analyzed as two major aspects. First, as a stimulating tool provides the major advantage of motivation and affective concentration during the learning process (Smith, Higgins & Miller, 2005). If lesson plans and interactions are carefully designed, the Kinect-enabled classroom has the affordances to create enjoyable and interesting interaction by augmenting virtual reality which provides the students with a virtual understanding of the study rather than still text over book thus boosting student motivation and interest towards learning. Second, Kinect can be used with software programs to enhance its role as a learning tool. The idea of a learning tool aligns with constructivism, which emphasizes building external, sharable artifacts and personal relationships with knowledge in the process of learning (Papert, 1980 & 1996). Educational software is designed to facilitate the development of personal representations toward knowledge. Since Kinect can gather information from users, students can add creativity to their multimedia works by feeding the information into the programs. In this way, Kinect can extend the varieties of interaction types supported by the software programs and bring new features to the multimedia works created by students.

Kinect is described as a revolutionary gadget as it provides a new type of interaction with computers (New Scientist, 2011). Kinect is a software-enabled device that can capture, track and decipher body movements, gestures and voice. The audio and video information serves as commands to interact with digital content presented in games or software programs. In other words, users do not need to be bound by keyboards, mice, or joysticks and thus have intuitive and virtual experiences (Hui 2011). The Kinect device is shown in Figure 2.7.

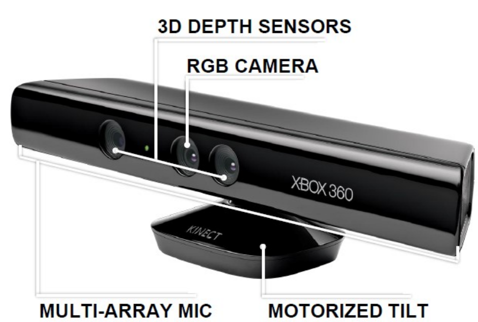

Figure 2.7 Kinect Technology

Its original intention is to be used in combination with Microsoft Xbox 360 to enhance entertainment experiences. The appearance of Kinect also encourages educators to evaluate its feasibility in education. For example, Kissco (2011) expresses his excitement by predicting that Kinect will become a focal classroom technology in the next few years. As Kinect can actively track users, the teachers and students can control learning materials by their body and voice without being bothered by wired or wireless devices. Consequently, Kinect seems to provide natural and diverse interactive experiences for teachers and students (Hui 2011).

With the development of Kinect Sensor, depth masking has become easier providing new opportunities for interface but also subjected to challenges when it comes to tracking human gesture, facial recognition, or hand gesture interpolation which requires the consideration of minimal details. Finger-Earth Mover's Distance (FEMD) has been integrated as a distance metric to handle the noisy image obtained from Kinect sensor to retrieve the smallest details (Ren, Z. et al, 2013) while the proposed approach shows 93.2% mean accuracy for the data set of 10 gestures. Similarly, in another study Kinect sensor was incorporated to detect hand gestures which divided the system into two modules i-e hand recognition and gesture recognition whereas the approach adopted integrate both depth and color information from the Kinect sensor to detect handshape which proves to be efficient despite the provided environmental distortion (Chen, Y., et al, 2015).

2.12.2 The 3-D system

Timothy Jhonson introduced the first 3D CAD system and later on in 1966, 'Lincoln Wand' was introduced by Larry Robert which was a 3D location sensing system based on ultrasonic wave detection which had 3D interactive hidden line reduction, the first time introduced in 1966. The 3D systems were also integrated into the chemistry and physics field where it was incorporated for the modeling of the molecule. The research at the 3D raster graphics took a hype in the early 70s and multiple valuable works were contributed by Dave Evans, Gouraud, Watkins, Phong, Ivan Sutherland, and many more. The real-time 3D commercial system was introduced by military-industrial flight simulation (Brooks, F., 1977). The 3D virtual environment has been created in (Lan, Y.J., Hsiao., et al., 2018) for the development of language, enhancing vocabulary, and sentence formation for students with learning disabilities. Four students were taken into consideration for the three-month training to provide a learning platform for the development of Mandarin Chinese (mother language). Investigation for two cycles presented that proposed HCI design principles were effective in boosting learning skills and the results were infer from in-class observations, analysis of videos captured during the learning process, and post-study interviews with students and parents. Similarly, multiple studies in the literature incorporated 3D systems to assist learning like in () author proposed a 3D video game named ‘Safety Inspector’ to deliver a safety training environment in which students are provided with the environment where they assume themselves as a Safety Inspector and identify the potential hazards encountered on the way. The game was developed to promote self-learning, enhance interactivity, and providing realism factor virtually so they can be trained for the real-time scenario in the physical world. The virtual 3D environment was integrated with the assistance of the Torque 3D game engine along with Autodesk 3ds Max and Milkshape 3D to create virtual images. Results showed significant improvement in the interesting development and adopting the targeted subjective consider while game development but the game doesn’t cover all the safety aspects that need to be addressed.

2.12.3 Tablet Learning

With the advent of tablet technology, the era of application-based games initiated introducing a new approach to assist learning disabilities. To understand the effectiveness of digital interaction provided by the tablet interface, the author in the study (Hassan, A. and Mahmud, M., 2018) attempt to understand the difference in the standard school education for slow learners as they face difficulty in absorbing complex instructions. The tablet technology enables the integration of simulation-based multimodal features like animated videos, graphics, audio, and colors while providing a touch interface to the users enhancing user experience. Embedded learning with the apps enables users the freedom of learning with amusement and enjoyment when interacting with screens through digital touch or swiping as it introduces a new experience to the learning pattern for slow learners. The study was conducted on 10 students with learning disabilities for 6 weeks while introducing guidelines for teachers, developers, parents, and policymakers for bridging the gap between digital media and education providing efficient results in terms of confidence, learning pace, and attention.

Similarly, the scaffolding approach was considered to deliver game-based learning via tablet technology to develop an instructional based model designed for learning objectives to improve mathematical concepts for slow learners (Waiyakoon, S.et al. , 2015). The game developed considering different aspects encloses instructional design model inferred from the literature, LO for a tablet device, GBL, scaffolding approach, mathematical instructions, and learning disability. These 5 factors were processed through 10 steps which include viability assessment, planning of the project, analysis for requirement through the gap, functional assessment, and identification of objectives, designing and developing a game, implementation, and final evaluation while the results showed significant improvement in learning.

2.12.4 Virtual reality and augmented reality

Augmented Reality (AR) is a variation of virtual reality (VR) (Azuma 1997). However, unlike VR in which users are brought into a virtual/synthetic environment, AR merges virtual objects with the real world. Hence AR is supporting the real-world interaction rather than replacing it with a synthetic environment (Maqableh 2010). AR can be used in learning to enhance students' motivation and attention; in addition to that, the students' interaction with AR objects has been found to improve understanding and memory (Sumadio 2010). The study presented by Sumadio was conducted over 33 participants and designed the qualitative research which was incorporated by think-aloud protocols and recording of interviews followed by observations during experimentation to investigate their interaction with the application and respond towards AR for academic purposes. Results were calibrated from 1 (worst) to 5 (best) and AR proves to be effective in self-descriptiveness (helpfulness) with an index of 4.5, controllability with 4.45, and suitability for learning (learnability) with an average index of 4.4. By creating the appealing interaction of a 3D object appearing in the physical world, AR gains and keeps the attention of students by enhancing their interest toward task or learning outcome which is difficult to pertain comparatively in other forms of education (Doswell et.al 2006). Other than these benefits, AR can overcome the problem of cost involvement during experimentation and broken experiment equipment, while enabling students to conduct experiments in a safer environment (Nor Azlina et. al 2012). AR also breaks the space and time boundary and allows the object of study to be brought to life for better understanding and enhancing learning ability (Li 2010). A study was conducted to incorporate AR in a network environment to peruse social engagement where teenagers were targeted to promote Malaysian Independence Day over Facebook in which participant can capture their images with the Malaysian flag and position it on a 3D model virtually with the help of Flash-based ARtoolkit. In the Virtual Merdeka AR application, it was found that AR elements can add the excitement of the new experience involved with technology attracting pupil’s interest and making it more engaging (Rafi 2011).

The first valuable contribution in the field of VR was made by Ivan Sutherland in 1965 and Tom Furness while Henry Fuch’s group and Fred Brooks did early research majorly focusing on force feedback. With the advancement in technology, educational curriculum when integrated with ICT allows the students to experience more natural interaction with the digital tools for learning which enhances children's motivation and enables them to grasp educational concepts (Abdulraheem, H., 2006). There is a need to integrate advancement in the educational system to assist the students striving at the initial process of learning due to their inability to keep pace with the complex information (Almousa, A. A., 2005). This urge accelerates the evolution of ICT capable enough to aid the advent of new digital reality or 'Augmented Reality' which is an extension of Virtual reality providing the contemporary application of e-learning while creating a semi-real surrounding based on simulations for the users (students) (Safar, A.H et al, 2016). The VR system provides a completely virtual environment which incorporates 75% virtually and indulges 25% reality like headset or glove while AR augments the reality to the real world with 25% virtually and 75% real-world environment in which user collect, send and process the data incorporates through the camera of the digital device (Keighrey, C. et al, 2017). Due to the enhanced user experience and adaptability, AR is continually making its mark over VR technology and due to the significance of providing real views with the augmented virtual details, it enables an effective learning process making the classroom an attractive learning hub for slow learners. AR technology has also been integrated into games for learning purposes especially for children which enhances their interest and makes them learn and grasp the complex concept unconsciously (Lin, C.-Y., et al, 2016).

In another study, AR is incorporated into educational projects to enhance cognitive skills by providing simulation-based active learning via a game-based scenario (Chen, S.Y. et al, 2018). The design principles and educational concepts were embedded with AR technology to provide leverage of more interacting and amusing class environment and also, the demonstration of 3D graphics based AR simulation game for android with the 3D modeling skills has been made to provide a guideline for teaching. Similarly, the author (Cheng, Y.W. et al., 2019) conducted an experiment integrating Augmented Reality based mathematical games to investigate the significance of incorporating interactive media for learning. For this purpose, 24 students from 6th grade were considered which work in 6 groups and compete in the game while the results indicated that students were able to achieve learning goals thus developing co-constructed knowledge for learners. The major challenge faced while providing AR-based learning is the establishment of an effective strategy that can assist the student in focusing on the things they need to observe and learn while playing the game. The author (Hwang, G.J., et al, 2016) addressed the issue while proposing a competitive game approach to assist the activities based on real-world interaction through AR. The results indicated that the proposed approach of incorporating AR-based games when integrated with game principles has a positive effect not only on student's behavior but also improved their learning patterns.

A brief overview of some assistive technologies has been demonstrated in table 2.3

Table 2.3 Applications for game-based learning

Name of application	Features	Type of education	Reference
Sprint	Text-to speech, partially personalized (users can choose texts)	Formal and informal	Diraä, N., Engelen, J., Ghesquière, P. and Neyens, K., 2009
PHAES	Interactive, multisensory, user-friendly navigation	Formal and informal	Kazakou, M., Soulis, S., Morfidi, E. and Mikropoulos, T.A., 2011
iLearnRW	Interactive, multisensory individualized approach (learning material selected based on student's difficulty and progress)	Formal (under supervision) and informal	Zakopoulou, V., Toki, E.I., Dimakopoulos, G., Mastropavlou, M., Drigkopoulou, E., Konstantopoulou, T. and Symvonis, A., 2017.
EasyLexia	Multisensory, Interactive, user - friendly interface,	Formal and informal	Skiada, R., Soroniati, E., Gardeli, A. and

	gamification elements, and interface		Zissis, D., 2014.
LexiPal	Multisensory, gamification approach, Interactive	Formal and informal	Saputra, M.R.U. and Risqi, M., 2015.
ClassDojo	Gamification approach including badges and reporting system	Formal and informal	Gooch, D., Vasalou, A., Benton, L., and Khaled, R., 2016
ICT -AAC applications	Interactive applications for different language inputs, multisensory, user - friendly	Formal and informal	Zorić, A., 2019

Thus under the review of literature, it can be inferred that assistive technologies can bridge the gap for slow learners but very little work has been done for mathematical concepts with the interactive media since mathematics require practicing learning pattern and is an iterative process of concept development which is missing in the majority of the work.

Chapter 3. Research Methodology

3.1 Introduction

The main aim of this research is to analyze the effectiveness of technology in improving the learning capability of students with slow learning which may influence due to the existence of other diseases or abnormalities. This is done by incorporating learning objectives with games to improve the attentiveness by developing interest. This chapter provides an introduction to the methodology adopted for the proposed research. The operational framework provides the outlook of the stage-wise infrastructure adopted for the study. Afterward, research design and procedures are discussed which elaborate the proposed solution and consideration made during the study. The experimentation and setup section provides information regarding the planning and arrangements made for the research. Moreover, the evaluation and analysis made during the experiment are discussed and finally, this chapter is concluded with a summary.

3.2 Objectives and Goals

This research is focused on the effectiveness of integrating technology in the education system to provide the assistants to enhance the learning capability of the students with educational backwardness. Kinect sensors offer an interactive technology that has the potential to improve teaching and learning methods since it deploys the natural user interface which provides the active involvement of the students while boosting their engaging capability or focus to overcome their impulsive or inattentive nature. The Kinect Sensor as a learning tool sustains the capability to develop interactive games that boost learning motivations and learning proficiency by employing its multimedia and multisensory attributes. This study will focus on the following objectives.

- To design and develop a motion detection edutainment application for mathematics, based on learning theories and learning strategies developed for students with inattention and impulsive disorders, to improve and enhance levels of attention and concentration.

- To develop the prototype of a motion game for slow learners' children based on Mayer principles of learning integrated with Kolb's learning style by applying real-time game-based motion detection technology.
- To evaluate and test the content design based on motion detection game on the selected elementary school (grades k-5) for learning mathematics for slow learners' children.
- To investigate the effective learning of game-based motion detection application for slow learners' children on mathematical achievement.
- To compare the outcomes for slow learners' children with normal healthy students in terms of mathematical achievement.

3.3 Operational Framework

This research work is structured in three stages as demonstrated in figure 3.1. The first stage provides the literature review and analysis to prevail a better understanding of children with slow learning and their problems along with the existing solution which highlighted the potential for integrating technology for the improvements in academic performance. The second stage demonstrates the design and development for testing the hypothesis by providing a kinesthetic based learning model to enhance concentration and learning ability with the help of motion-based games. The last stage provides the performance and evaluation of the hypothesis in which the proposed work is analyzed both qualitatively and quantitatively in terms of efficiency, learnability, and satisfaction toward the technology. For a better understanding of the effectiveness of the proposed approach, results are compared with normal students and compiled subsequently.

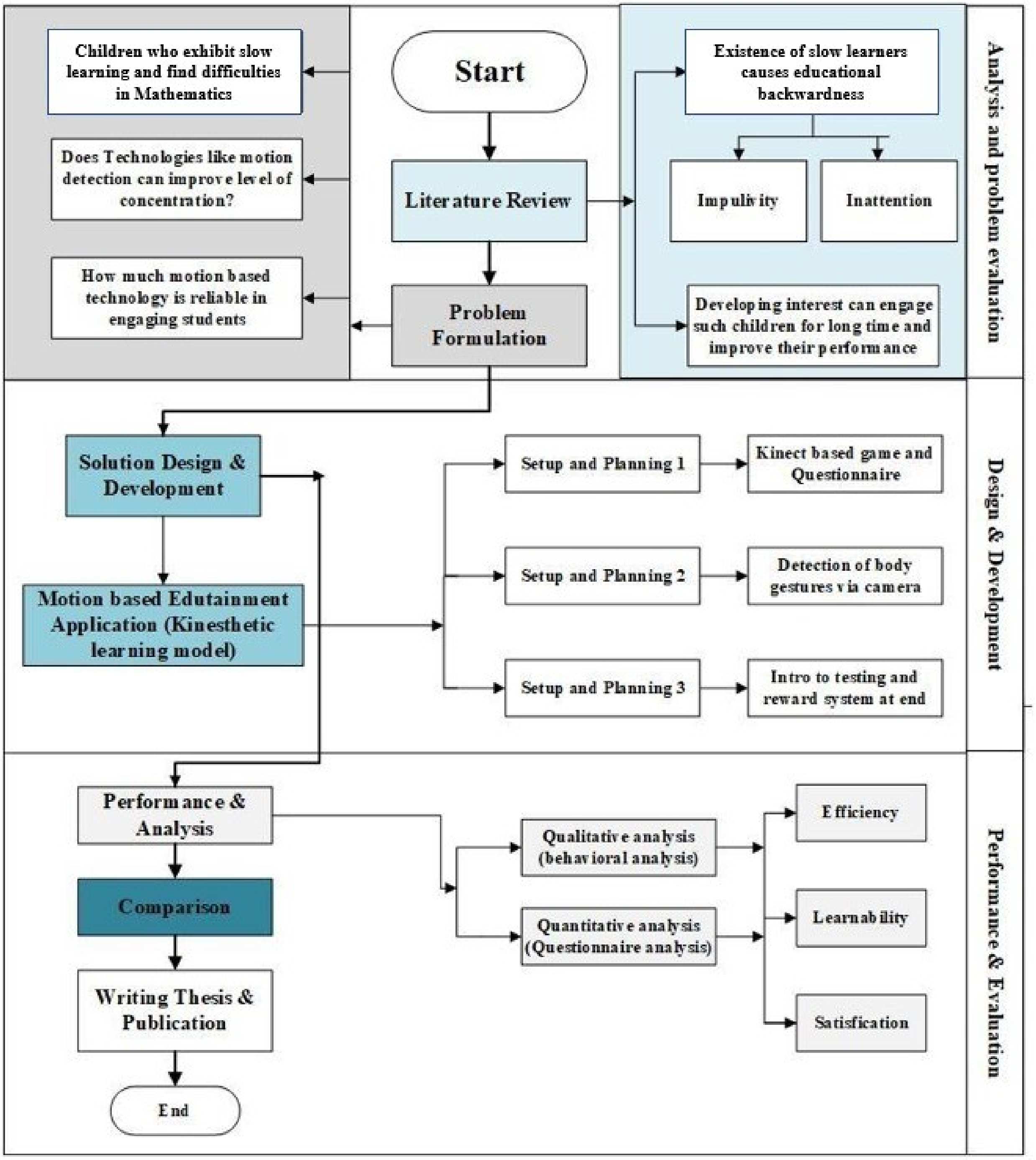

Figure 3.1 Operational Framework

3.4 Research Design and Consideration

This section provides the research methodology and consideration for the experimentation.

3.4.1 Model Consideration for Experimentation

This research considers Kolb's learning model to ensure learnability and Keller's ARCS model of motivation to induce satisfaction, motivation, and attention throughout the experimentation. David Kolb provides the learning styles model in 1984 in which he demonstrates the learning cycle based on the initial cognitive process. According to Kolb, learning is influenced by the acquisition of abstract concepts that can be implemented over a flexible range of circumstances. He stated that learning is developed through a process of the transformation of experience (Kolb, D.A., 1984). Kolb's learning cycle is infrastructure on John Dewey perception of learning that is grounded in experience (Dewey, J., 1938), Kurt Lewin's emphasis on active learning (Lewin, K., 1946) and Jean Piaget's theory of learning influenced by the interaction between individuals and environment (Piaget, J., 1957). Kolb's experimental learning theory considers the fundamentals for learning and is demonstrated in four stages which include: a) Concrete experience, b) Reflective observations, c) Abstract conceptualization, and d) Active experimentation.

Effective learning is observed when concrete experience (step-1) in which observation is made and experience (step-2) leads to the development of abstract concepts (step-3) which is utilized for testing hypothesis (step-4) in future situations resulting in a new experience. Kolb's learning steps are mutually supportive and provide outcomes at each step to be used in the subsequent step. The entrance can be made at any step but must be followed by its logical sequence. This learning model is incorporated in our research in the following manner

I. **Abstract Conceptualization-** Students will conduct a pre-test on paper before they engage with the game which will introduce them to the abstract concept regarding the game.
II. **Planning Active Experimentation-** Introduction to the game is provided in which instructions are delivered regarding how to play the game, where to stand, and how to move.
III. **Concrete Experience**- Implementation of Kinect based setup to engage students with games based on mathematics.
IV. **Reflective Observation-** Observation is made during the game by students for learning and this step is evaluated by considering their behavior and by conducting a questionnaire based on the system usability scale.

This research also considers Keller's motivation model while designing for the experimentation which assists by incorporating motivation in the learning process which lets them engage for a considerable duration while sustaining learner's attention (Keller, J.M., 1983) (Keller, J.M., 1999). There are 4 steps involved to peruse attention and motivation during the learning process which encompasses attention, relevance, confidence, and satisfaction as shown in figure 3.2.

Figure 3.2 Keller's ARCS Model of Motivation

According to Keller's theory, attention defines the interest demonstrated by the learner when encountered with learning concepts or ideas. Relevance refers to the adaption of language and examples that are familiar to the learner. The confidence emphasizes the establishment of positive expectations for the accomplishment of success and the last aspect refers to the satisfaction which must be accompanied by the learner or reward from learning outcomes as shown in table 3.1 (Bishop, 1989).

Table 3.1 ARCS motivational model and game components

Steps	Description	Components	Game Components
Attention	Arouse and sustain learner's curiosity and interest.	Perceptual arousal, Inquiry arousal, variability	Interactivity
Relevance	Link a learner's needs, interests, and motives.	Goal orientation, motive matching, familiarity	Representation in a familiar language and pretest conduction
Confidence	Develop positive expectations for achieving success.	Performance requirements, success opportunities, personal control	Rules and goals
Satisfaction	Provide reinforcement and rewards for learners	Intrinsic reinforcement, Extrinsic rewards, equity	Consequences

Appreciation, positive feedback, and reinforcement are key factors required by the learner to keep them motivated. Apart from steps involved to endure motivation in the learning process, the ARCS model does not provide the relevant information regarding the integration of the proposed elements in learning or demonstrating the interaction with motivation. Designers need to adapt motivation and adequate cognitive parameters to ensure effective learnings (Woo, J.C., 2014). Considering Keller's model, we design the experimentation with four key factors which are

i) Interactivity which provides attention
ii) Representation and pretest to incorporate relevance
iii) Rules and goals to integrate confidence
iv) Consequences and rewards in terms of satisfaction

This thesis implements a kinesthetic approach to see the influence over the learning process and teaching while considering ARCS and Kolb's model to study the effectiveness in terms of efficiency, learnability, and satisfaction.

3.4.2 Kinect Sensor

The Kinect sensors act as ears and eyes for the computer while enabling windows to process the information from these inputs. The Kinect device has been demonstrated in figure 3.3 which consist of the following parts

a) The video camera supplies the data of color stream in three primary colors which include red, green, and blue (RGB) in combination.
b) IR sensors with the assistance of its IR projector and CMOS sensor provide the information of depth while capturing video.
c) The microphone provides the audio input at 24-bit resolution integrated as a 4 element linear array.
d) The tilt motor provides the direction and angle control for camera vision that assists in tuning vertical angle within a range of 27 and -27 as per learner's height.

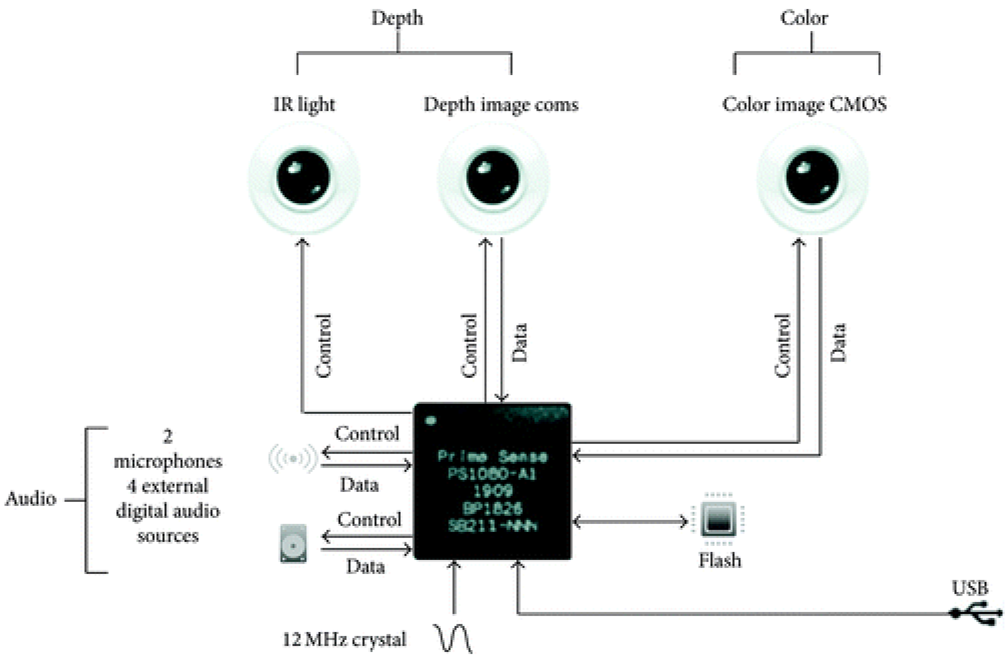

Figure 3.3 Kinect sensor and its parts (Reference: Traumabot blog)

The Kinect sensor retrieves the information in the form of video, audio, and depth streams while incorporating these into the library of the natural user interface. The central control for functions including tracking of hands, skeletal tracking, recognition of speech command, and tracking of the face is integrated with the assistance of the application interface (API).OpenNI provides the natural interaction organization along with the application programming interface (API) as demonstrated in figure 3.4.

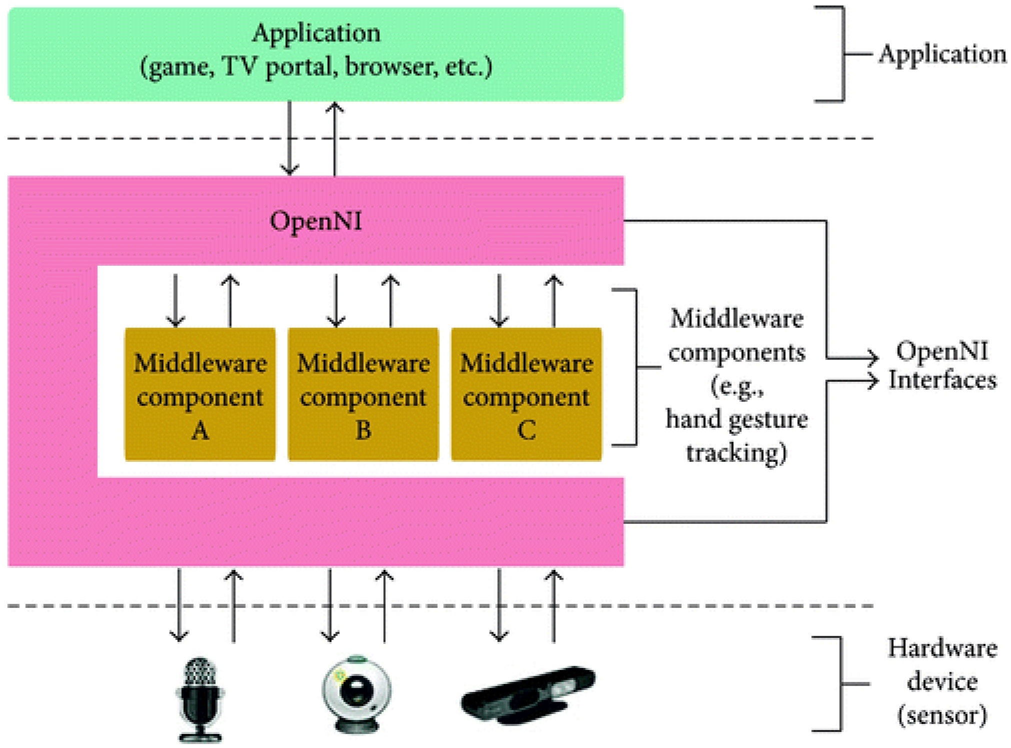

Figure 3.4 Tracking functionality of OpenNI (Reference: Microsoft Wiki.)

3.4.3 Game-based learning

The term Game-based learning (GBL) refers to the instructional strategy of applications with predefined learning outcomes. To engage learners with a particular goal, GBL incorporates video-based game technology, user interactive interface, flexibility, and feedback in terms of scores while interpolating games as meaningful learnings and providing a mental model to motivate the player (Chumbley, J. and Griffiths, M., 2006). The concept of "learning by playing" seems to be a potential strategy to overcome the inattentiveness and distraction exhibited due to the boring learning environment (De Freitas, S.I., 2006). A study conducted to prevail the effectiveness of e-learning demonstrated that a well-designed system can provide productive learning outcomes while providing entertainment (Hanley, G.L., 2004). The key components of cycles to induce learning outcomes has been shown in figure 3.5 (Garris, R., Ahlers, R. and Driskell, J.E., 2002).

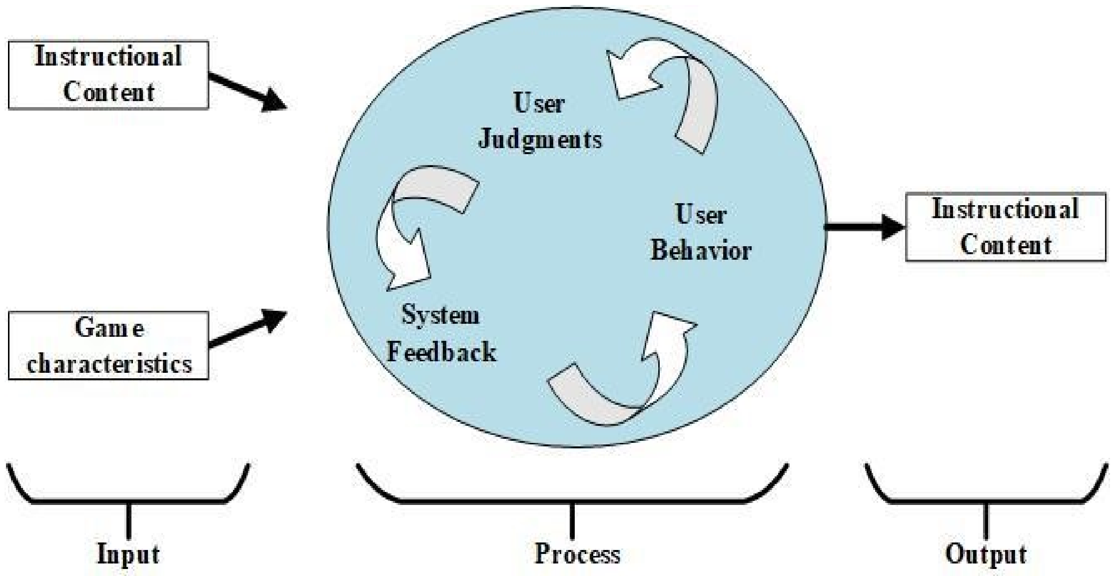

Figure 3.5 Game Cycle

The game cycle consists of three sections to provide an effective learning outcome along with entertainment. The first phase provides the input to the system which is the combination of predefined learning objectives with game characteristics. The second phase is composed of a cycle that encompasses user judgment in terms of enjoyment or interest, user behavior, and system feedback and the final stage represents learning accomplishments.

3.4.4 Experimentation setup and planning

This study gamified the learning outcomes regarding mathematics with the help of Kinect sensors to engage the students exhibiting SLP and to analyze the effectiveness of motion-based games for the objective-based learnings. The integration of gesture recognition technology prevents the students from distracting due to the active involvement and assists them in overcoming their impulsive and inattentive behavior and let them perform well. For experimentation, a room corner in a school was furnished with a projector and screen (can be a wall) to provide an adequate environment to test the effectiveness of the technology. Kinect Setup installed by connecting to the laptop and projecting the game to the wall. A total of 10 students exhibiting slow learning has been considered but initially, 5 students were tested out of which 1 student can play games while the other 4 can sit by and analyze the performance of that student while playing games. Meanwhile, students can interact and talk and can share their experiences. The setup for installation is shown in figure 3.6. The students taken into consideration have the basic knowledge of numbers and basic numeric operations.

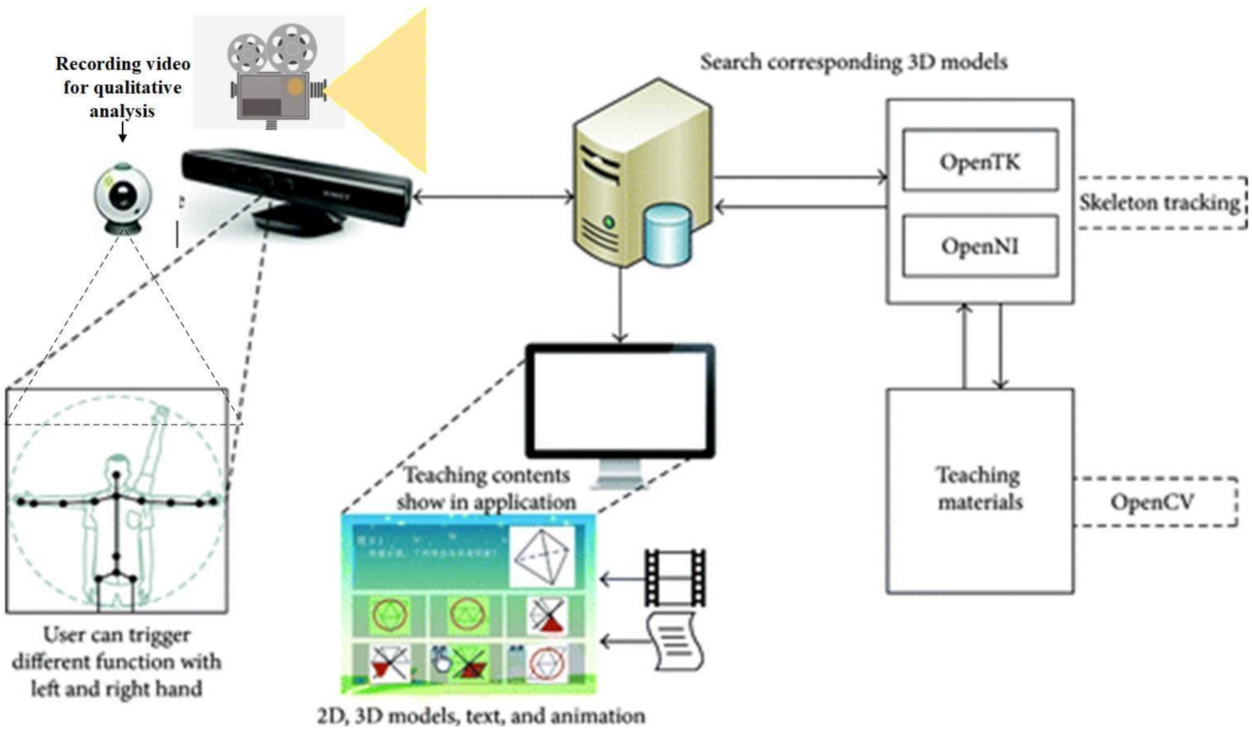

Figure 3.6 System Architecture

Whereas the best position for Kinect is shown in figure 3.7. 2 cameras are installed to analyze the student behavior and detecting motions. One focusing on the face and another camera is focusing on body movement.

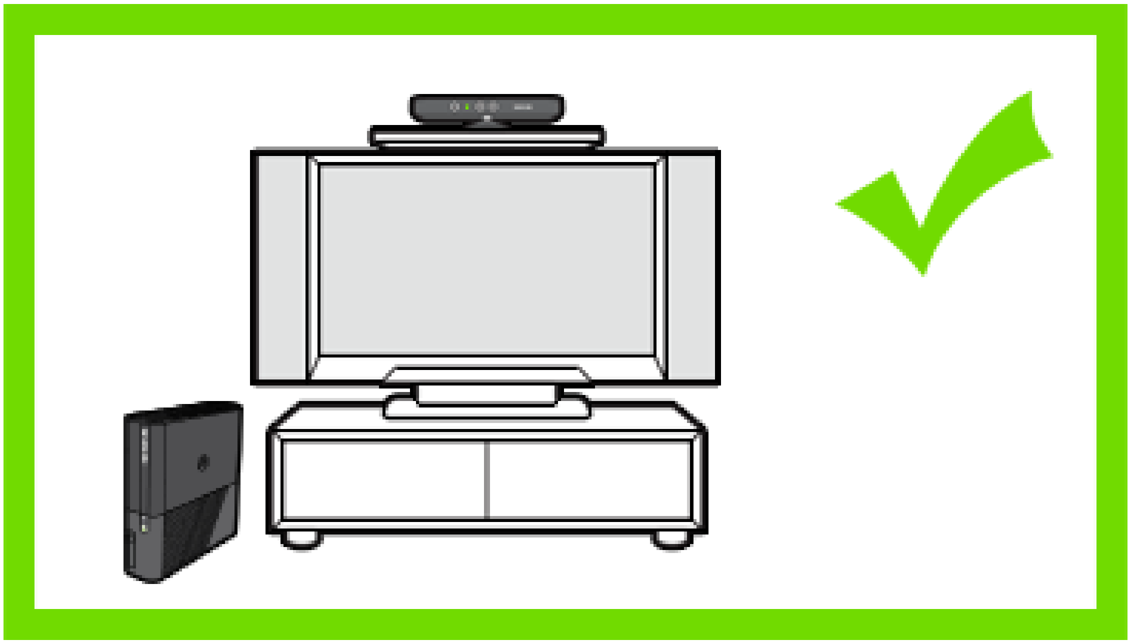

Figure 3.7 Recommended Kinect positioning

This research provides Planning and set up at three levels while considering the scenario before the game, in-between game, and after the game. The experimental procedure for the conducted study is as follow;

Setup-1 (Pre-test and time allocation)

i) A pre-test would be conducted before engaging students with games to have a better understanding of their current ability.

ii) Each student has 45 minutes for their first try which has been segmented as;

  a) Training that delivers the instruction which encloses the information regarding method to play the game, positioning, and movements, is conducted in the initial 5 mins.

  b) The next 25 minutes are allocated for the students to play game

  c) The usability questionnaire would be conducted in the last 15 mins.

Setup-2 (Game design)

iii) The motion game is structured on 3 levels corresponding to the difficulty and each level has 15 questions. The questions are generated randomly, so each student will get random questions at each level. Corresponding levels are defined as:

a) Basic level with the numeric operations of plus and minus for number ranged from 1 to 5.
b) The intermediate level provides the numeric operation of Multiplication and division for numbers ranging from 1 to 5.
c) The advanced level which includes all mathematical operations for numbers ranged from 1 to 10.
d) There is a break after every 5 questions in each level

Setup-3 (Introducing Game and end)

iv) Introducing children to the testing situation must be accompanied by the script delivering precise information to make them comfortable.

a. A possible script might be (after introducing yourself): “I call this a test, but I’m not testing you at all. I’m asking you to help us test our software design. I need to see what’s too easy or what’s too hard for children of your age so we can fix it and make it better. I’ll ask you to figure out things on your own most of the time, but I’m here if you get stuck.”

b. And also to say this to the parents: “I want to make it clear that I’m testing the software, not your child. We want the software to be fun and easy for your child to use on her/his own, so I will be asking you to sit back and allow your child to try things out. I’m right here if she/he gets stuck, and I will help her/him out by giving some hints and asking her to make some guesses.”

v) A post-test will be conducted just like the pre-test and each child will get a token of appreciation after finishing the game

3.4.5 Experiment Participant

We tested 10 students exhibiting slow learning with the age range of 6 to 9 years from both genders (male and female) who have basic knowledge of numbers and mathematical operations and for the comparative analysis, 10 normal students have been tested. Apart from children, the teacher and parents can be the observer in the room subjected not to distract the children. We take 5 teachers under consideration as specialists for the revelation of effectiveness and usability of the system. Specialists participate in the experimentation by providing a rating based on the System Usability Scale (SUS) while children will contribute by playing games and conducting a questionnaire structure on the Physical Activity Enjoyment Scale (PACES) at the end of the session.

3.5 Activity Design

The activity diagram presents the dynamic behavior of the game and workflow based on the consequences encountered as shown in Figure 3.8. The game starts from a menu with visually appealing effects to engage and interact with students with games. After selecting the menu, three status options would pop up which enclose the Start game, show about and show score. The 'Start game' tab will lead the students to the game panel while 'Score' will present the higher scores achieved to set an achievable goal while 'About' will demonstrate the activity tutorial to guide students or help them understand what is the game about and how you are going to interact with the game.

To keep engaging students, they are asked to mention their name for two purposes which include firstly for determining their level of interest whether they are ready to move on with the game or not, and secondly, for the appreciation purpose so that if they achieve the defined goal, they will be appreciated and rewarded with the highest score highlighting their names. Later on, three levels will be displayed on the screen which will be opted iteratively. The beginner level is designed for the initial beginners with achievable and easy-going questions to develop their interest and boosting their cognitive skills. Similarly, intermediate and expert levels include questions with increased IQ level, and depending on the ability of the student, the level will be upgraded.

Each level consists of 10 questions and the award for one question is 100 points at the beginner level, 200 points at the intermediate, and 300 points at the expert level. A gesture view is displayed to keep the session interactive after every 5 questions in each level and students are given 3 chances for wrongly attempted questions to endorse them to achieve the goal. After achieving a level, the student encountered the upgraded level until it reaches the expert level where after the game ends with the scores achieved displayed on the screen.

3.6 Scope

This thesis bridge the learning gap between the mathematical concepts and slow learners by interpolating the subject's requirements while considering the obstacles in learning for slow learners which highlights the scope for this working as under the literature review, very little work is being done in this domain. Mathematics refers to the abstract knowledge and demands an iterative practice unlike other scientific studies and to boost learning considering the learning pattern of slow learners, Kinect based interactive game has been proposed which provide interactive media to assist them to maintain focus while providing an iterative mathematical practice from a beginner level to expert level.

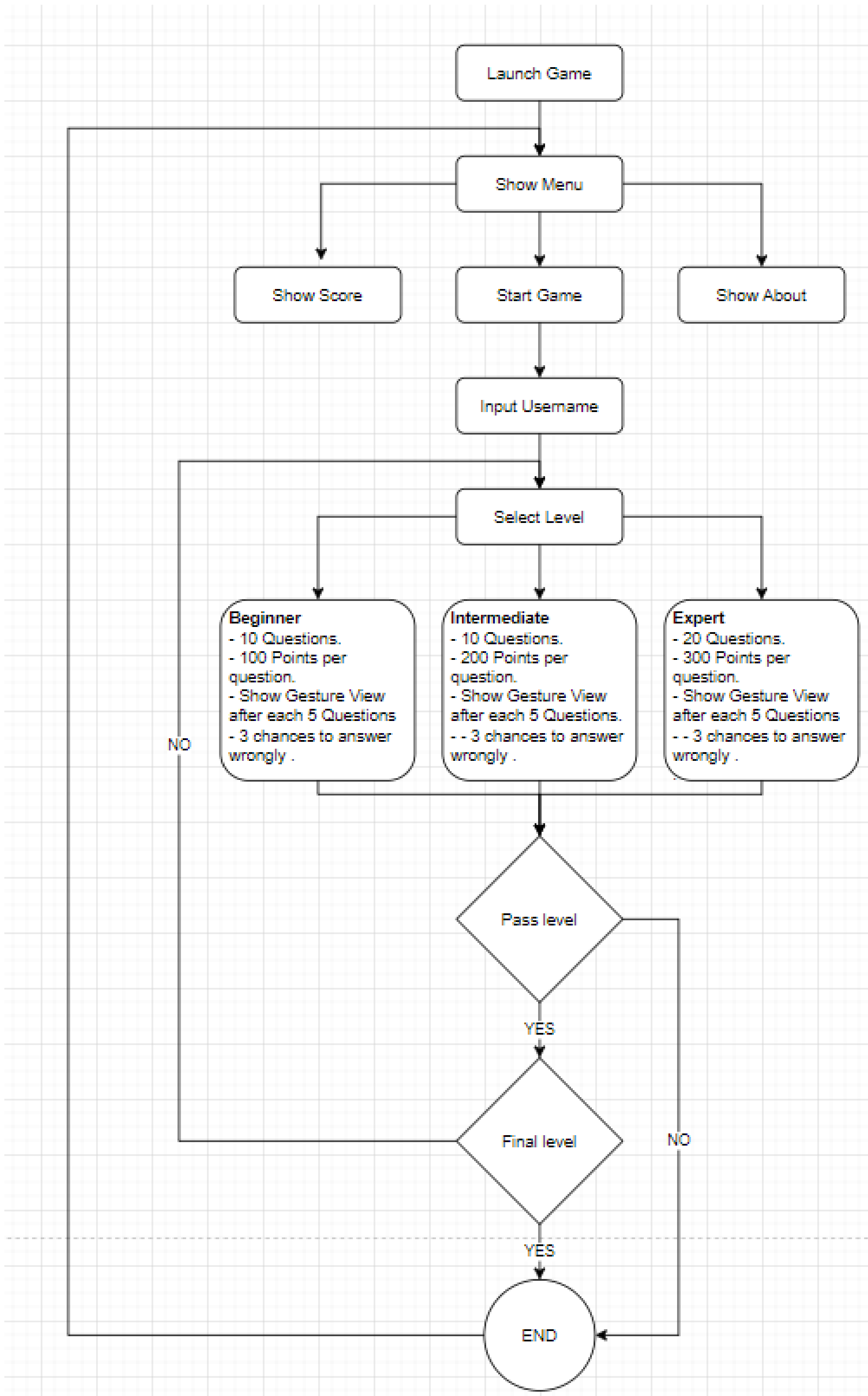

Figure 3.8 Activity Design

3.7 User Characteristics

The game is designed for students with learning difficulties from elementary school (grade: 5) and middle school (grade: 6, 7, 8) with a targeted IQ range of 50 to 110. Generally, the intelligent quotient is determined by

Intelligent Quotient = Chronical or mental age x 100

The main users of this developed game are teachers and students. Integrating games in the classroom environment will assist teachers in delivering mathematical concepts to children effectively while on the other hand, students can play the game for amusement and learning side by side.

3.7.1 Constraints

The implementation of the proposed system in a learning environment may be constrained by various factor out of which few are mentioned below

- Some of the users may not have high-end computers therefore the development of game must consider the limitations of user
- Availability of Kinect setup
- Multiple systems have been integrated during the development with specific defined limits of the system which further limit the capacity of the existing system

3.7.2 Game design principle

This game is designed on the principles described in two studies conducted for defining fundamental pillars necessary for the development of mathematical games which are discussed below

i) Buchheister, K.E. et al. (2017) in his study presented the model of Math's games in which they introduced a universal design approach for mathematical games integrating three main principles of learning which include modes of

   A) The pictorial presentation integrating effective visual representation.
   B) Expression i-e thinking expressions of students (students perspective, strength, and weaknesses)

C) Engagement through a variety of media to boost student interest

These principles have been demonstrated in figure 3.9. Attractive visual graphics have been integrated considering slow learners learning patterns while providing interactive media through Kinect Xbox.

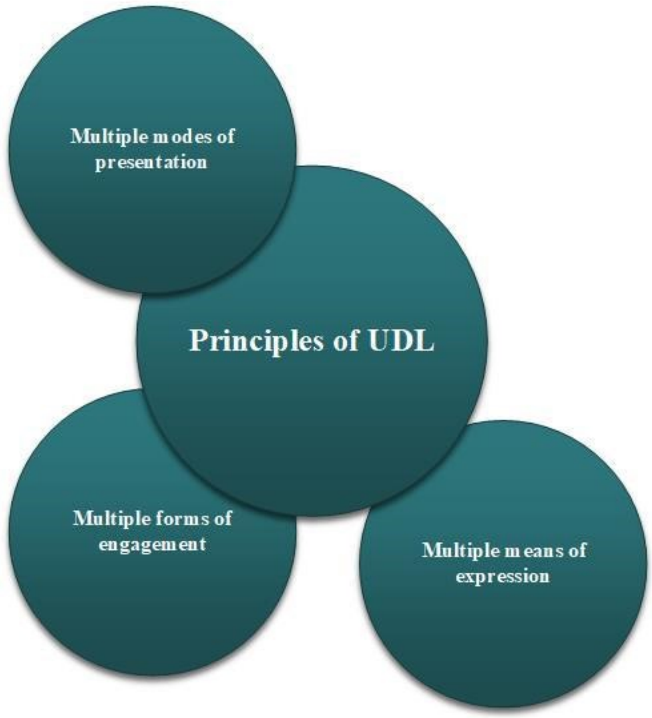

Figure 3.9 The basic principles of Universal Design Learning (UDL)

ii) Chorianopoulos, K., et al. (2014) in their study presented three main design principles highlighted for the development of mathematical games which encloses engagement, role play, and constructive trial and error. These principles have been illustrated in table 3.2 with the description of how these principles have been integrated into the proposed approach.

Table 3.2 Game design principles for mathematical games

Theory	Design Principle	Implemented element
Engagement and familiar interaction	Interacting with game media mechanics and functionalities.	Kinect based gesture recognition to act or input as an answer in-game.
Roleplay	Engagement with media as a special/main/heroic role in-game.	When student interact with Kinect media as an individual providing command consider themselves as the main contributor of the game.
Trial and error	Engagement of students with constructive gameplay.	The iterative process of questioning in 3 defined levels of difficulty with the provision of three chances to answer a question wrongly.

Although there has been a lot of interest in the employment of video games in education, there are no clear design guidelines. In this work, after surveying previous work in video game design, we highlighted three design principles: 1) engage the students with a story and a hero, 2) employ familiar game mechanics from popular video games, and 3) provide constructive trial and error gameplay for learning. As an illustrating example of those principles, we designed a video game that teaches addition and subtraction of signed numbers. Finally, we outline several more serious games that have adopted the above design principles. The results should be useful for designers, teachers, and researchers who work in the area of serious games for learning. Further research should extend and experimentally validate these principles according to the discipline and the learning style of student Although there has been a lot of interest in the employment of video games in education, there are no clear design guidelines In this work, after surveying previous.

3.8 System Requirement Specification (SRS)

The system requirements for the proposed game have been described below

3.8.1 Operating System Requirement

An operating system (OS) refers to the program which manages all operations and application program after being initiated through a boot program while providing a fundamental interface between the computer user and computer hardware. The application program interface (API) enables applications to request OS for required services to perform a specific function.

The operating system that can be integrated for the proposed approach include

- Windows 10
- Windows 8 (64-bit)
- Windows 8.1 (64-bit)

3.8.2 Hardware System

To incorporate a learning interactive model, the Kinect sensor has been integrated with the computer. Overall hardware specs required are mentioned below

- 64-bit (x64) processor
- Dual-core 3.2 GHz or faster processor
- Dedicated USB 3.0 bus
- 2 GB RAM
- A Kinect for Windows v2 sensor

3.8.3 Software requirement

The software embedded in the game for the development and playing purposes include

- Microsoft Visual Studio 2012 Express or any later Visual Studio edition
- .NET Framework 4.0
- Microsoft Speech Platform SDK v11 for developing speech-enabled applications for Kinect for Windows

3.8.4 Programming Language

The C# language is integrated for programming.

3.9 User Interface Design

The user interface is kept simple to make it easy to use. In step 1, the menu pops up with three options while the User input is retrieved and process in a commanding direction as demonstrated in figure 3.10. Step 2 demands the user to enter the name (figure 3.11) while step 3 defines three different levels depending on the IQ and basic mathematical operations (figure 3.12). At the basic level, questions are kept simple which encloses basic addition and subtraction as shown in figure 3.13. The intermediate level includes multiplication and division (figure 3.14) while at the expert level there is a mixture of all the basic operations and randomly generated questions as displayed in figure 3.15 respectively.

Figure 3.10 Menu - Step 1

Figure 3.11 Enter Name - Step 2

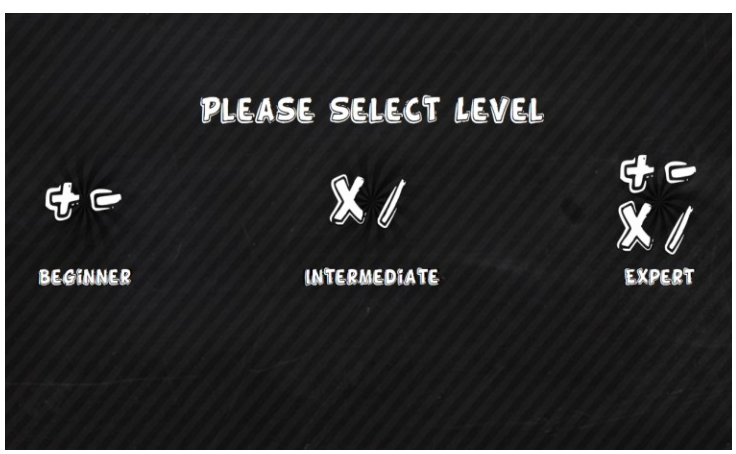

Figure 3.12 Define level - Step 3

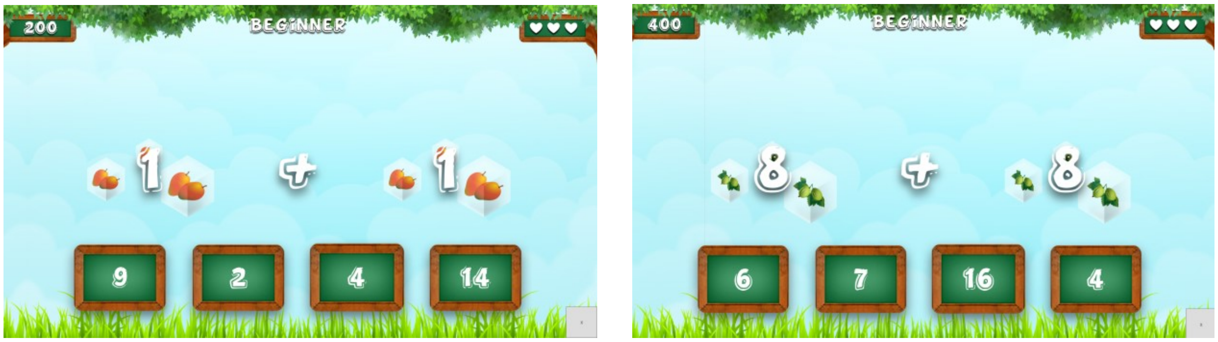

Figure 3.13 Basic level

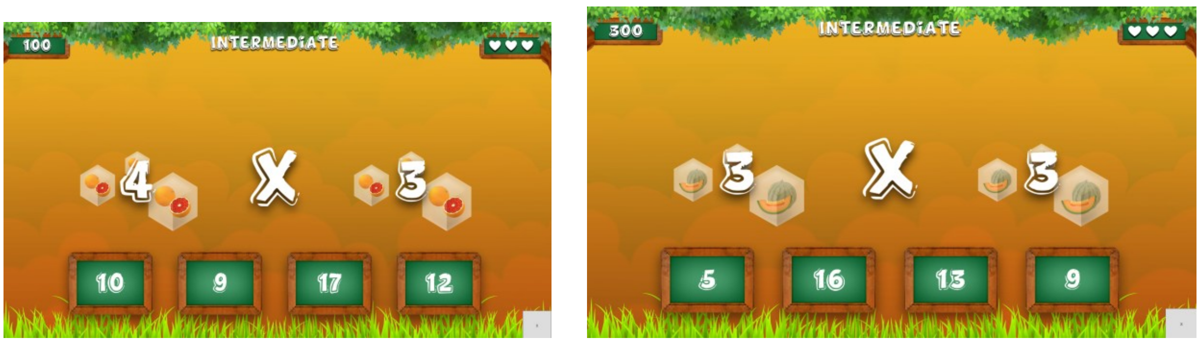

Figure 3.14 Intermediate level

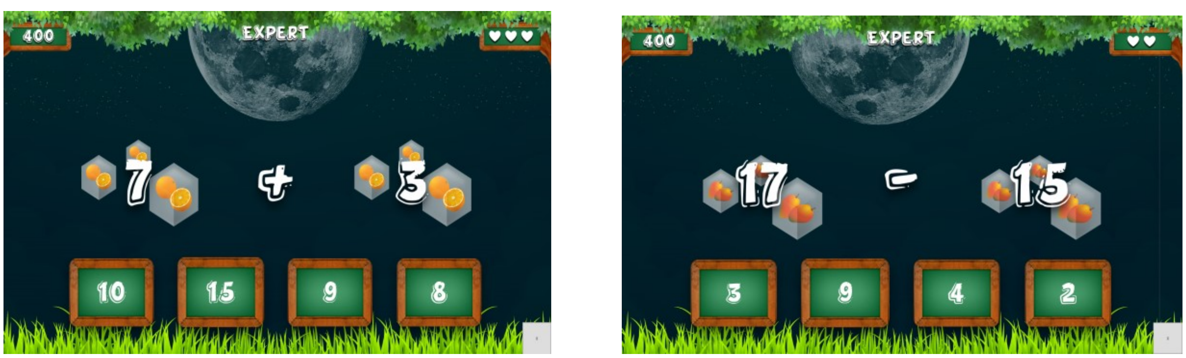

Figure 3.15 Expert level

Graphics are maintained to be visually appealing to make the game more interesting and engaging. In each level, there are 10 questions, and students are given a break of 5 minutes after attempting 5 questions and after the break, they are asked to attempt the remaining questions.

3.10 Source Code

The game is categorized into 3 different stages depending on the difficulty level and the input is provided with the assistance of gestures which after being manipulated, handle the movement of the objects. The step-wise source code has been mentioned below

3.10.1 User Interface

The source code providing user interface at the beginner level is shown in figure 3.16.

```
    <UserControl.Background>
        <ImageBrush ImageSource="/MathGame;component/Resources/UI/background_00.png" Stretch="UniformToFill"/>
    </UserControl.Background>
    <Grid x:Name="RootLayout">
        <Grid>
            <Grid.ColumnDefinitions>
                <ColumnDefinition Width="3.3*"/>
                <ColumnDefinition Width="3.3*"/>
                <ColumnDefinition Width="3.3*"/>
            </Grid.ColumnDefinitions>

            <Grid Grid.Column="2" HorizontalAlignment="Center" VerticalAlignment="Top" Margin="0,48,0,0" >
                <TextBlock x:Name="HeartTxt2" Text="♥♥♥"  Style="{DynamicResource FunnyKid}" Foreground="Black" Padding="0,12,0,0" FontSize="54" />
                <TextBlock x:Name="HeartTxt" Text="♥♥♥"  Style="{DynamicResource FunnyKid}" Foreground="White" Padding="0,12,0,0" FontSize="50" HorizontalAlignment="Center" VerticalAlignment="Center" />
            </Grid>


            <Grid  Grid.Column="1" HorizontalAlignment="Center" VerticalAlignment="Top" Margin="0,48,0,0" >
                <TextBlock x:Name="AnswersTxt2" Text="2/30" Style="{DynamicResource FunnyKid}" Foreground="Black" FontSize="78"/>
                <TextBlock x:Name="AnswersTxt" Text="2/30" Style="{DynamicResource FunnyKid}" Foreground="White" FontSize="72" HorizontalAlignment="Center" VerticalAlignment="Center" />
            </Grid>

            <Grid  Grid.Column="0" HorizontalAlignment="Center" VerticalAlignment="Top" Margin="0,48,0,0" >
                <TextBlock x:Name="SeasionTxt2" Text="" Style="{DynamicResource FunnyKid}" Foreground="Black" FontSize="73"/>
                <TextBlock x:Name="SeasionTxt" Text="" Style="{DynamicResource FunnyKid}" Foreground="White" FontSize="70" HorizontalAlignment="Center" VerticalAlignment="Center" />
            </Grid>

        </Grid>
    </Grid>
</UserControl>
```

Figure 3.16 User Interface

3.10.2 Functional Source Code

After initializing the game in which the user enters his ID, the questions of mathematical operations appears from the relevant level. A sample of functional code is shown in figure 3.17.

```
public partial class Beginner : UserControl, LevelDelegate
{
    #region Properties

    private Random random;

    private int quesLimit = 10;
    private int currentQues = 0;
    private int currentLevel = 0;

    private int scorePoint = 100;

    private int gameHearts = 3;

    private List<int> currentAnswers;
    private int currentAnswer;
    private List<int> previousAnswers;

    private Boolean Toggle = true;
    private int fNum, sNum;

    #endregion

    #region Init
    public Beginner()
    {
        InitializeComponent();
    }

    private void Beginner_Loaded(object sender, RoutedEventArgs e)
    {
        App.mLevel = 0;

        this.Height = App.shared.height;
        this.Width = App.shared.width;


        AnswersTxt.Text = AnswersTxt2.Text = App.mScore.ToString();
        HeartTxt.Text = HeartTxt2.Text = "";
        SeasionTxt.Text = SeasionTxt2.Text = "";

        previousAnswers = new List<int>();
        this.RenderTransformOrigin = new Point(0.5, 0.5);
```

Figure 3.17 Functional source code

3.10.3 Random question generation Source Code

The difficulty level in mathematical questions has been distinguished into 3 stages; Beginner, Intermediate and Expert level. Questions are generated randomly at each stage and for each question, multiple options are displayed out of which one is correct. Functionality code sample based on each level has been shown in figure 3.18.

```
        // generate random answers
        // insert corrcet answer
        currentAnswers.Add(currentAnswer);
        for(int i = 0 ; i < 4 ; i++)
        {
            int tst = random.Next(1, 20);

            while (true)
            {
                if (!currentAnswers.Contains(tst))
                    break;
                else
                    tst = random.Next(1, 20);
            }

            currentAnswers.Add(tst);
        }
        currentAnswers = currentAnswers.OrderBy(item => random.Next()).ToList();

        App.Debug("Beginner > generateQues > Current Answers " + string.Join(",", currentAnswers.ToArray()));

        Question _newQues = new Question(this, type, fNum, sNum, currentAnswer, currentAnswers);
        RootLayout.Children.Add(_newQues);

        currentQues++;

        AnswersTxt.Text = AnswersTxt2.Text = App.mScore.ToString();
    }
```

Figure 3.18 Random Question generation

3.10.4 Kinect based gesture input Source Code

The input is provided with the help of gesture movement in front of the Kinect sensor. The source code for recognizing gestures via Kinect is demonstrated in Figures 3.19 (a) and (b).

```
public GestureView(GestureViewDelegate parent) {
    InitializeComponent();

    this.parent = parent;

    setupView();

    App.Debug("Gesture View:: Init");
}

#region Setup View
private void setupView() {

    if(App.kinectSensor == null) {
        App.Debug("Gesture View:: Deinit because couldn't find Kinect Device!");
        parent.GestureViewDidEnd();
        return;
    }

    Height = App.shared.height;
    Width = App.shared.width;

    random = new Random();

    setupGestureController();

    tblGestures.Text = "Please " + gestureList[selectedGesture].name + " To Continue !";
}
```

Figure 3.19(a) Gesture view

```
private void setupGestureController() {
    gestureList = new List<Gesture>();
    gestureList.Add(new Gesture(0, "Jump", GestureType.Jump));
    gestureList.Add(new Gesture(1, "Clap", GestureType.JoinedHands));
    gestureList.Add(new Gesture(2, "Swip Left", GestureType.SwipeLeft));
    gestureList.Add(new Gesture(3, "Swip Right", GestureType.SwipeRight));
    gestureList.Add(new Gesture(4, "Wave", GestureType.WaveLeft));
    gestureList.Add(new Gesture(4, "Wave", GestureType.WaveRight));

    selectedGesture = random.Next(0, gestureList.Count);

    kinectViewer = new KinectViewer();
    kinectViewer.Width = 1280;
    kinectViewer.Height = 960;
    kinectViewer.BoneBrush = new SolidColorBrush(Color.FromRgb(255, 255, 255));
    kinectViewer.JointBrush = new SolidColorBrush(Color.FromRgb(255, 255, 255));
    kinectViewer.Margin = new Thickness(-640, -480, 0, 0);
    RootLayout.Children.Add(kinectViewer);

    App.kinectSensor.EnableAllStreams();
    App.kinectSensor.SkeletonFrameReady += Sensor_SkeletonFrameReady;

    gestureController = new GestureController(gestureList[selectedGesture].type);
    gestureController.GestureRecognized += GestureController_GestureRecognized;

    App.kinectSensor.Start();
}
```

Figure 3.19(b) Gesture detection

3.10.5 Level oriented question generation

Questions are selected at each level according to the level selected. The source code sample has been demonstrated in figure 3.20.

```
public Question(dynamic _parnet, string _symbol, int _leftside, int _rightside, int _correctanswer, List<int> _answers)
{
    InitializeComponent();

    PARENT = _parnet;
    leftSideCount = _leftside;
    rightSideCount = _rightside;
    totalNumber = leftSideCount + rightSideCount;
    correctAnswer = _correctanswer;
    answers = _answers;
    symbol = _symbol;

    ScaleTransform myScaleTransform = new ScaleTransform();
    myScaleTransform.ScaleY = 1;
    myScaleTransform.ScaleX = 1;
    TranslateTransform myTranslate = new TranslateTransform();
    myTranslate.X = 0;
    myTranslate.Y = 0;
    TransformGroup myTransformGroup = new TransformGroup();
    myTransformGroup.Children.Add(myScaleTransform);
    myTransformGroup.Children.Add(myTranslate);
    this.RenderTransformOrigin = new Point(0.5, 0.5);

    QuesLayout.RenderTransformOrigin = new Point(0.5, 0.5);
    QuesLayout.RenderTransform = myTransformGroup;

    Random rn = new Random();
    file = rn.Next(25).ToString();
    if (file == "0") file = "25";
    if (file.Length == 1) file = "00" + file;
    if (file.Length == 2) file = "0" + file;

    if (_symbol == "x")
    {
        symbolTxt.FontSize = 170;
        symbolTxt2.FontSize = 190;
    }

    AudioManager.PLAY(new List<String> { _leftside.ToString(), _symbol, _rightside.ToString()});
}
```

Figure 3.20 Level oriented random generation of question

3.10.6 Reward System Source Code

The reward system has been integrated to motivate students for learning. Depending on the performance, the student is awarded for which the source code has been displayed in figure 3.21.

```
private async void addStars() {
    Image newImg;
    BitmapImage starImg;
    for(int i = 0; i < 3; i++) {
        await Task.Delay(i * 150);

        newImg = new Image();

        if(i == 0)
            newImg.Margin = new Thickness(92, 206, 409, 30);
        else if(i == 1)
            newImg.Margin = new Thickness(410, 206, 91, 30);
        else
            newImg.Margin = new Thickness(250, 206, 251, 30);

        starImg = new BitmapImage();
        starImg.BeginInit();
        starImg.UriSource = new Uri("pack://application:,,,/MathGame;component/Resources/UI/game-popup-star.png");
        starImg.EndInit();

        newImg.Source = starImg;
        newImg.Style = Application.Current.FindResource("AnimatedStar") as Style;

        ContentGrid.Children.Insert(1, newImg);
    }
}
```

Figure 3.21 Reward System

3.10.7 Handling Kinect detection and movement

During the game, Kinect detects the motion of the user body and based on these motions, the movement of the object inside the game is being made accordingly. The source code for handling the movement of the object has been demonstrated in figure 3.22.

```
namespace MathGame.Controls
{
    /// <summary>
    /// A button that continually triggers a click when the mouse or hand pointer hovers over it
    /// </summary>
    internal class KinectHoverButton : KinectButtonBase
    {
        /// <summary>
        /// IsHandPointerOver dependency property for use in the control template triggers
        /// </summary>
        public static readonly DependencyProperty IsHandPointerOverProperty = DependencyProperty.Register(
            "IsHandPointerOver", typeof(bool), typeof(KinectHoverButton), new PropertyMetadata(false));

        // Trigger a click 60 times per second
        private const int ButtonRepeatIntervalMilliseconds = 1000 / 60;

        /// <summary>
        /// Boolean value to tell us if the control is being displayed in the Visual Studio designer
        /// </summary>
        private static readonly bool IsInDesignMode = DesignerProperties.GetIsInDesignMode(new DependencyObject());

        /// <summary>
        /// Timer to handle triggering the click events
        /// </summary>
        private readonly DispatcherTimer repeatTimer;

        private HandPointer activeHandpointer;

        public KinectHoverButton()
        {
            if (!IsInDesignMode)
            {
                this.InitializeKinectHoverButton();
                this.repeatTimer = new DispatcherTimer { Interval = TimeSpan.FromMilliseconds(ButtonRepeatIntervalMilliseconds) };
                this.repeatTimer.Tick += this.RepeatTimerTick;
            }
        }
```

Figure 3.22 Gesture-based Object handling

3.11 Research Testing and Analysis

While conducting experimentation (pre-test, in-between, post-test), qualitative and qualitative analysis is made to understand the effectiveness of integrating technology for learning. The qualitative analysis provides the behavioral observation and qualitative analysis is incorporated by the questionnaire attempted by children and specialists. After establishing setup and performing the initial pre-test, children play the game in which their behavior is detected through the camera focused on their faces while their skeletal motion is detected through another camera. After the game, a post-test is conducted along with a questionnaire for the quantitative analysis of testing. Observing signs of engagement are analyzed which encloses a smile, motivated face, laughs, or leaning forward to try more to check how much children like the game. Also, the signs of disengagement such as frowns, sighs, yawns, or even turning away from the game and stop playing are analyzed. These behavioral signs (qualitative analysis) are much more reliable than children's responses to questions (quantitative analysis) about their satisfaction or effectiveness of the game. Children may try to please adults while claiming that they like the game. Therefore, to avoid biasedness, an analysis should be made both qualitatively and qualitatively. Another test would be conducted after one week to analyze the difference induced by the game. Being the observer, Children and parents can give an idea of how to improve the game better. After the testing, students will receive a token of appreciation for the contribution.

Following are the conditions considered during testing:

- A warm-up session including some tutorial will be provided for students
- Students will get familiar with the environment, game, and feel more comfortable.
- Students can have a break during the game anytime when needed (probably between the level)
- Students and parents will be informed about the camera recording for their behavioral analysis to deploy satisfaction.
- There will be an ongoing assistant (the researcher) while playing the game if it's necessary.
- If the students didn't pay attention to the game and were distracted by other things inside the room, the researcher will gently remind them to focus on the game. If the student refused to continue the game, the session will be stopped. The evaluation might be postponed to another time

The analysis made during the conduct of the experiment emphasis on the following observation checklist

Table 3.4 Observation instrument

Type of Observation		Specific actions observed
Body Movement	Positive	• Focusing on screen • Leaning toward screen • Playing with accurate motions
	Negative	• Wrong motion • Looking around the room
Facial Expressions	Positive	• Smile / laugh • Concentrating / attentive
	Negative	• Bored • Distracted
Comments	Positive	• Discussion of game elements • Discussion of user's motions • Assertion of joy (time) • Assertion of learning (score)
	Negative	• Assertion of boredom • Requests to stop the activity
In-Game Behaviour	Positive	• Staying on task • Finishing each level • Following instruction
	Negative	• Spending a too long time on a question • Skipping tasks • Ignoring tasks

3.12 Evaluation and Results

Evaluation is based on both qualitatively and quantitatively to analyze the proposed approach in term of:

a) Learnability - How easy is it for users to accomplish basic tasks in the game.
b) Efficiency - How quickly users can perform the tasks
c) Satisfaction - How pleasant the design and the game is for users?

Qualitative analysis is made with the help of facial and body movement detection while qualitative evaluation is composed of Questionnaires attended by Specialists and teachers.

3.12.1 System Usability Scale (SUS) Questionnaire

The system usability scale was first demonstrated by John Brooke in 1986 to evaluate the usability of system or system appropriateness towards a purpose (Brooke, J., 1986). According to ISO 9241-11, usability must cover three aspects that are

i) **Effectiveness-** the capability of users to accomplish tasks while employing the system and quality of delivered tasks.
ii) **Efficiency-** the number of resources consumed while executing tasks.
iii) **Satisfaction-** Reaction of users when subjected to system utilization.

Hence, the System usability scale provides the Likert scale to evaluate the system in terms of usability along with user satisfaction and learnability. An adjective scale for a better understanding of the usability scale has been shown in figure 3.23. The SUS proves to be effective in terms of reliability (alpha equals to approx. 0.91) and utility while deploying variant interface types (Bangor, A., Kortum, P. and Miller, J., 2009). Initially, SUS was deliberately incorporated to analyze the ease of use, but later on, Lewis (Lewis, J.R. and Sauro, J., 2009) shows that it can be deployed as a global scale for calibration of system satisfaction while sub scaling the usability (Item: 1,2,3,5,6,7,8,9) and learnability (Item: 1,4).

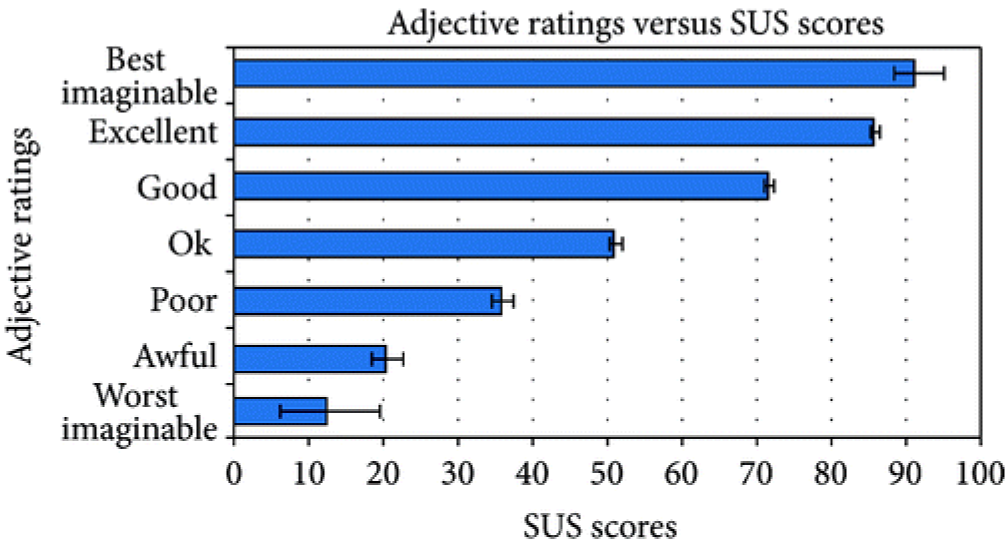

Figure 3.23 Adjective rating of SUS

The SUS is a set of 10 questions with a calibrated scale to be addressed by the user within the range of (0 to 5) strongly disagreed or strongly agreed. The response of the user is recorded after encountered the system but before any brief discussion to avoid any biased decision. If the respondent is unable to answer a particular query then the scale is marked with the center score over the scale. To calculate the overall scale, the following steps are followed;

a) Sum up all the scores from each item in the questionnaire.
b) Analyze the score contribution which is ranged from 0 to 4.
c) Items corresponding to odd numbers (1, 3, 5, 7, and 9) will provide the score contribution by subtracting the scale position minus 1.
d) Items with even numbers (2, 4, 6, 8, and 10) will contribute by subtracting scale position minus 5.
e) To measure overall SU, multiply the scores by 2.5 and the output of SUS will range from 0 to 100.

This questionnaire is conducted by specialists (teachers) for the evaluation of the effectiveness of the proposed approach toward learning. This questionnaire support research objective questions 1 and 2. Questions mentioned in the questionnaire conducted are as follow

System Usability Scale

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Figure 3.24 System Usability

3.12.2 Physical Activity Enjoyment Scale (PACES) based Questionnaire

Kendzierski and DeCarlo (1991) develop the Physical Activity Enjoyment Scale (PACES) to gauge the enjoyment associated with physical activity. The study provides evidence for the agreeable consistency and retest reliability among college students and the validation was accompanied by the collection of scores as a response toward the PACES scale presented as a single factor. Motl in 2001 analyzes the effectiveness of hypotheses proposed while influencing physical activity and provide a substantial relation of self-organized physical activity along with team indulgence with PACES (Motl, R.W., Dishman, R.K., Saunders, R., Dowda, M., Felton, G. and Pate, R.R., 2001). Amusement associated with physical activity lets children exhibiting educational backwardness focus on a particular task thus enabling them to control their impulsive behavior and inattentiveness. The interposition of physical activity within a classroom environment induces a positive impact while assisting with some of the difficulties associated with learning problems (Azrin, N.H., Vinas, V. and Ehle, C.T., 2007) thus mitigating the effect for slow learning.

This section refers to the questionnaire that was attempted by the children with SLP who attended games, to have a better understanding of the effectiveness of the proposed approach. The result of the video analysis can be used in addition to the survey results in determining user satisfaction and system usability which Supports Research Question 3. Physical Activity Enjoyment Scale (PACES) based Questionnaire has been adopted from Kendzierski (Kendzierski, D. and DeCarlo, K.J., 1991) and J. Moore et al (Moore, J.B., Yin, Z., Hanes, J., Duda, J., Gutin, B. and Barbeau, P., 2009). Questions involved in the study are as follows:

Table 3.5 Questionnaire

1	2	3	4	5
Poor	Limited	Good	Very Good	Excellent

Usability Questions
1- Effectiveness

Section I: Effectiveness Evaluation					
The Kinect Math game can effectively get and retain the attention of players based on your observation.	1	2	3	4	5
The Kinect game is interactive and can be played by children for some time without getting bored or distracted.	1	2	3	4	5
The game is matched with the school syllabuses for mathematics.	1	2	3	4	5
Does the game help to learn maths better?	1	2	3	4	5

Usability Questions:
2- User Friendliness & Ease of Use

Section I: User Friendliness and Ease of Use Evaluation					
The game design and game scenario are properly done and all the contents can be easily identified.	1	2	3	4	5
Students with minimum training and briefing can play the game and explore easily.	1	2	3	4	5
The text, colors, and images used are clear and nicely selected.	1	2	3	4	5
The type of motion designed is easy to follow and use the	1	2	3	4	5

motion to play.					
It's easy to start the game, interact with it and continue playing	1	2	3	4	5
Players can get stuck while trying to perform in the game.	1	2	3	4	5

Usability Questions
3-Others

Section I: Other Evaluation					
Which part do you like the most from this game?	1	2	3	4	5
Are there any weaknesses in this game?	1	2	3	4	5

3.13 Pilot Study

A pilot experiment was carried out to confirm if the measurements are correct and to get reliability. A small sample will be included in the pilot study, and all respondents who were not part of the questionnaire development will have to be surveyed. The main goal of the pilot study is to ensure that the measurements and design of the surveys are accurate (Rowley, 2014). It is suggested that an initial survey should be undertaken with a small group, but a few members of sample are supposed to be approached. Before actual pilots had been completed, the survey was content validated. As seen in prior to section, a few additional changes such as fine-tuning the questionnaire's vocabulary and formatting was done. Therefore, a pilot study was mandatory for the current research.

The suggested number of subjects for the pilot study is between 10 and 30 (Johanson and Brooks, 2009). The study approached 20 people for the validation of the survey from the small. The data revealed that all the variables surpasses the threshold value of 0.5 for the Cronbach Alpha. Table below shows the values for the variables.

Table 3.6 Pilot Study Results

Variable	Cronbach Alpha
Effectiveness	0.765
System Useability	0.831
User Friendliness	0.792

3.14 Summary

This chapter presents the research methodology acquired in the design proposed, which is developed to evaluate the incorporated motion-based Kinect technology with learning outcomes regarding mathematics to enhance the attentiveness and engagement of students with SLP. Also, the setup and procedure adopted and considerations to evaluate the effectiveness of the proposed approach is elaborated. The qualitative and quantitative analysis is provided to test the hypothesis in terms of learnability, efficiency, and satisfaction. The qualitative analysis encompasses the behavioral analysis of children during the execution of games while qualitative analysis includes the questionnaire conducted which is structured on system usability scale (SUS) and physical activity enjoyment scale (PACES) for the better revelation of the effectiveness of the proposed hypothesis.

Chapter 4. Research Findings

4.1 Introduction

This section covers the method of analysing data from the data collected for the study, the preliminary analysis includes descriptive statistics. Descriptive statistics are also evaluated on the discrete variables to determine normality, in addition to showing the demographic profile of the respondents. The check for normality is critical to assess how additional analyses are carried out through parametric or non-parametric methods. In addition, the reliability test is carried out to verify the reliability of a scale with the Cronbach Alpha. Further, analyses are then carried out in the sense of a validity test in order to ensure results are correct. In order to study the relationship between variables, analyses such as correlation and multiple regressions are carried out. Also to achieve the objective of the study qualitative analysis was also conducted. Ultimately, a summary of the analysis ends this chapter.

4.2 Quantitative Analysis Response Rate

The survey questionnaire was distributed to the respondents based on the minimum sample size. Considering the response rate from the previous studies to achieve the sample size of the study. This study distributed 130 questionnaires. The survey was printed and delivered to the respondents. The final use-able questionnaires were 80. The value surpasses the minimum sample size. Therefore 80 responses are sufficient to perform data analysis.

4.2.1 Demographics

a) Gender

Data gathered was analysed from the perspective of demographic profile. Firstly, gender of the respondents was examined. The respondents were sub-divided into normal learning students and slow learning students. Responses showed that among slow learning students majority of the respondents were male 24 accounted for 60% of the slow learning respondents. However, females were 16 accounted for 40% of the slow learning respondents. In contrast, among normal learning student majority of the students were male accounted for 65% of the NLS respondents. Male respondents were only 14 accounted for 35% of the respondents.

Table 4.1 Gender of Respondents

Type			Frequency	Percent	Valid Percent	Cumulative Percent
NLS	Valid	Male	14	35.0	35.0	35.0
		Female	26	65.0	65.0	100.0
		Total	40	100.0	100.0	
SLS	Valid	Male	24	60.0	60.0	60.0
		Female	16	40.0	40.0	100.0
		Total	40	100.0	100.0	

b) Level

From the demographic profile level of the students were examined based on the characteristics the level was sub categorised into beginners, intermediate and expert. Based on the data, the results show that among normal students 65% of the respondents were intermediate, 5% of the respondents were beginners and 30% of the respondents were expert. Among slow learning students, 20% of the respondents were beginners, 70% of the respondents were intermediate and only 10% of the respondents were expert.

Table 4.2 Level of the Respondents

Type			Frequency	Percent	Valid Percent	Cumulative Percent
NLS	Valid	Beginners	2	5.0	5.0	5.0
		Intermediate	26	65.0	65.0	70.0
		Expert	12	30.0	30.0	100.0
		Total	40	100.0	100.0	
SLS	Valid	Beginners	8	20.0	20.0	20.0
		Intermediate	28	70.0	70.0	90.0
		Expert	4	10.0	10.0	100.0
		Total	40	100.0	100.0	

c) Scores

Based on the test scores, among normal students, it was found that only 5% of the normal students gets marks between 1001-2000, and 40% of the students secured marks between 2001-3000. 50% of the students secured marks between 3001-5000 and 5% secured the highest marks above 5001. However, among slow learning students, it was found that there is no student who secured more than 5001 marks however the 55% of the students secured marks between 2001-3000. 20% secured marks between 1001- 2000, 8% secured marks between 3001-4000 and only 5% secure marks between 1001-2000.

Table 4.3 Test Scores

Type			Frequency	Percent	Valid Percent	Cumulative Percent
NLS	Valid	1001-2000	2	5.0	5.0	5.0
		2001-3000	16	40.0	40.0	45.0
		3001-4000	10	25.0	25.0	70.0
		4001-5000	10	25.0	25.0	95.0
		5001 and above	2	5.0	5.0	100.0
		Total	40	100.0	100.0	
SLS	Valid	1-1000	2	5.0	5.0	5.0
		1001-2000	8	20.0	20.0	25.0
		2001-3000	22	55.0	55.0	80.0
		3001-4000	8	20.0	20.0	100.0
		Total	40	100.0	100.0	

4.3 Normality Test

To order to conduct parametric experiments correctly (Hinton, McMurray & Brownlow 2014), statistical testing is necessary. Specific statistical methods assume that the scoring distribution of the dependent variable is' normal' (Pallant, 2014).

The authors propose that the shape of the distribution be checked, for example using histogram, in compliance with Tabachnick and Fidell (2007, p. 81). The normal distribution of the histogram, in form of a bell shows a lot of numbers clustered in the middle of the range. In this scenario, though, as shown in Figure 4.1, the measurements are not generated by the distributions of the frequency from normally distributed populations. The further step should therefore be taken to determine the normality of the scoring distribution. Greasley (2008) also notes that Kolmogorov-Smirnov and Shapiro-Wilk statistics should be analysed for a more objective measure of whether the distribution is normal.

First, the meaning of the original mean and the newly cut mean (5 percent trimmed mean) should be contrasted as stated in Table 4.3, which assesses the assumption that the extreme scores have a significant influence on the mean. The outliers are shown when the meaning of these means differs greatly from each other. Therefore, there is no need for further analysis of the two values for the attribute unnecessarily. Similar figures can also be used for outliers (Pallant, 2014), because the outliers are affected if the trimmed mean and mean values are very different. In this case, the mean values are not at issue, and these instances are therefore retained.

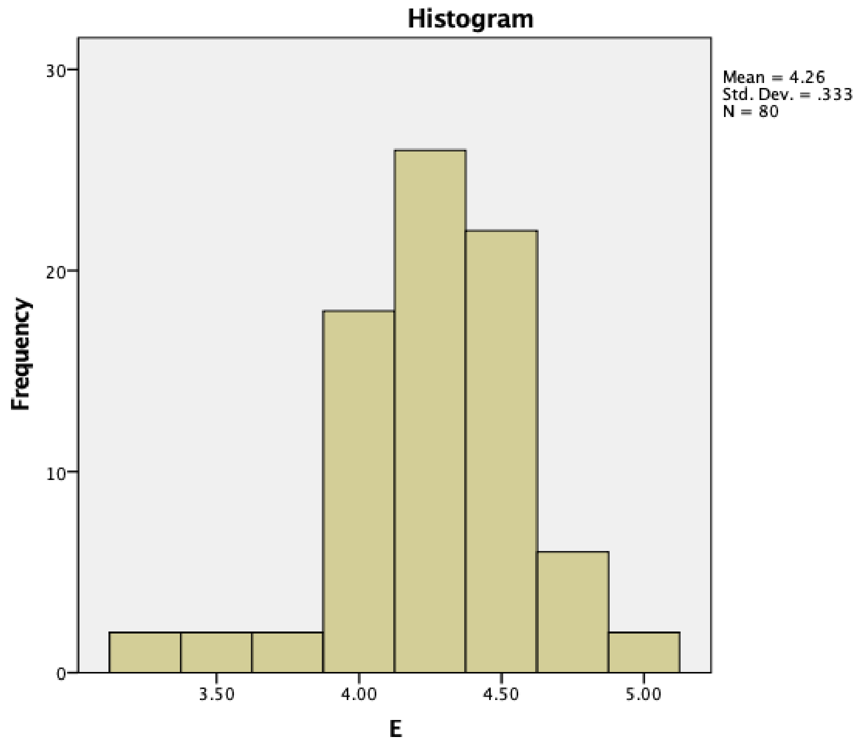

Figure 4.1 Histogram of Effectiveness

The skew and kurtosis values should be analyzed in the same table to find out whether a sample is distributed normally. When distribution is normal the skewness and kurtosis values are zero (Tabachnick & Fidell, 2014).In Hinton, McMurray, and Brownlow's 2014 estimation of the degree to which skew and kurtosis deviate from normal distribution is accomplished by dividing skew by standard skew error, dividing kurtosis by standard kurtosis error. If one or both these concepts is 2 or greater, the assumption of normality is rejected.

In this case, there is a negative value of both skewness and kurtosis, which indicates that the data is left-skewed and flat (platykurtic) compared to a normal distribution. Applying the rule of thumb of dividing each value by its standard error, skew = -.423 with a standard error of .269, giving a value for the skewness of -.423/.269 = -1.721, whereas kurtosis is 1.351 with a standard error of .732, giving the value of 1.351/.732 = -1.84. These values are much less than 2, so there is no rejection of the assumption of normality. Hence, it can be concluded that the data can be assumed to be approximately normally distributed in terms of skewness and kurtosis.

Table 4.4 Descriptive Table for Effectiveness Variable

	Statistic	Std Error
Mean	4.2625	.03718
Std. Deviation	.33257	
Skewness	-.423	.269
Kurtosis	1.351	.732

The result of Kolmogorov-Smirnov and Shapiro-Wilk statistics is subsequently created in a table called Normality Assessment which measure the Normality of the distribution of scores. Normality is claimed on the grounds that the sig results are not significant if it approaches 0.05. This is the Sig in this case. The value is both less than 0.05 for Kolmogorov-Smirnov and for Shapiro-Wilk suggesting that the values are significant.

In this case, the result of Kolmogorov-Smirnov statistics is to be used for reporting as the sample is more than 50 (n = 80) (Davis, 2013). Hence, in terms of the Kolmogorov-Smirnov statistics test, data can be assumed to be normally distributed.

Table 4.5 Test of Normality for Effectiveness variable

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
E	.185	80	.000	.917	80	.000

a. Lilliefors Significance Correction

4.4 Reliability Analysis

Cronbach's Alpha is the most popular way to assess reliability. Tavakol and Dennick (2011) note that the appropriate values of alpha range from 0.70 to 0.95. Cronbach's alpha value range is 0 (completely unreliable examination) and 1 (completely reliable test). The Revised Item-Total Correlation column thus represents the relationship between the answers to each question and the total score for the test in the item-total results section. Ideally, the optimistic relation to an overall total over 3 should have a valid question. If an element has been deleted, then the column Alpha of Cronbach when Element Deleted documents the value with Alpha for Cronbach. Analyses of accuracy on both the fixed and independent variables are performed. The value of Cronbach's Alpha for the dependent variable were 0.947, which is within the range of 0.70. Therefore, if an element is discarded, no object should show a higher alpha for Cronbach so that all objects should be retained.

Table 4.6 Reliability Statistics for Effectiveness (E) Variable

Cronbach's Alpha	N of Items
.947	4

Table 4.7 Item-Total Statistics for Effectiveness Variable

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
E1	11.13	8.009	.880	.928
E2	11.20	8.111	.870	.931
E3	11.10	8.268	.874	.930
E4	11.13	8.136	.866	.933

The magnitude of Cronbach's Alpha were 0.892, the first independent variable (user friendliness and ease of use), which exceeds the cut off value of 0.70. In fact, if an object is removed, no item will show a greater Cronbach's Alpha.

Table 4.8 Reliability Statistics for User Friendliness and Ease of Use

Cronbach's Alpha	N of Items
.952	6

Table 4.9 Item-Total Statistics for User Friendliness and Ease of Use (UF)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
UF1	16.15	34.078	.777	.950
UF2	16.18	33.716	.810	.947
UF3	16.36	31.247	.912	.935
UF4	16.46	31.492	.898	.937
UF5	16.45	31.213	.830	.946
UF6	16.21	31.334	.881	.939

The value of Cronbach's Alpha were 0.880, which is the acceptable 0.70 range for the second independent variable (System Usability Scale). Therefore, the revised element-Total Correlation column displayed a positive relationship. Moreover, if an object is omitted, no item will show a higher Alpha of Cronbach, therefore all items are to be preserved.

Table 4.10 Reliability Statistics for System Usability Scale

Cronbach's Alpha	N of Items
.880	10

Table 4.11 Item-Total Statistics for System Usability Scale (SUS)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
SUS1	27.56	66.275	.688	.862
SUS2	27.75	67.911	.701	.861
SUS3	29.11	74.304	.369	.885
SUS4	28.53	64.658	.787	.854
SUS5	28.54	63.290	.818	.851
SUS6	27.44	70.072	.614	.868
SUS7	27.16	72.695	.562	.872
SUS8	27.76	64.740	.794	.853
SUS9	28.35	64.813	.740	.857
SUS10	27.70	82.719	.003	.906

4.5 Validity Test

The validity test for the data is used for part analysis. Effect elimination is a mechanism by which results are minimised and synthesised, resulting in less factors or elements from a wider range of variables (Pallant, 2014). The factors are then used in further statistical analyses by summarising the tests, such as comparisons or similarities. For this analyses, principal component analyses (PCAs) are employed since they are regarded as a better option for summarizing the data set (Stevens, 1996) and as statistically simple (Tabachnick and Fidell, 2007).

With the use of SPSS a total of 120 elements were analysed for the major component (PCA). The value was set to 0.4 because the data set is small in this analysis. In preparation of PCA, the appropriateness of data was collected for element analyses. Next, the sampling adequacy evaluation (SAAM) of Kaiser-Meyer-Olkin is checked. The KMO rating must be higher or greater than 0.6 and the Bartlett sphericity check value (.05 or lower). Table 4.12 indicates that the value of KMO is 0.876, and that the acceptance value is greater than 0.6, whereas the measure of Bartlett is significant (p=.000) and the measurement is therefore acceptable for the factor. This also means that the variables have certain relationships.

Table 4.12 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.876
Bartlett's Test of Sphericity	Approx. Chi-Square	1400.660
	df	136
	Sig.	.000

In Table 4.13, the PCA analysis shows 3 components with an eigen value of more than 1. The eigen meaning of Component 1 is 9.190, reflecting 44.060% of the variance. Component 3 is 1.673 of its eigen value, explaining 9.842% of the variation. For this analysis, 3 elements are known as parameters for factor collection, thus a total of 77.591 percent of the variation in data can be explained.

Table 4.13 Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.190	44.060	44.060	9.190	44.060	44.060
2	2.327	23.690	67.750	2.327	23.690	67.750
3	1.673	9.842	77.591	1.673	9.842	77.591
4	.689	4.050	81.642			
5	.584	3.437	85.079			
6	.520	3.057	88.136			
7	.439	2.584	90.720			
8	.341	2.005	92.725			
9	.309	1.820	94.546			
10	.225	1.323	95.869			
11	.170	1.000	96.869			
12	.146	.860	97.729			
13	.111	.653	98.381			
14	.097	.570	98.952			
15	.078	.459	99.410			
16	.053	.312	99.722			
17	.047	.278	100.000			

Extraction Method: Principal Component Analysis.

Yet 3 components have already been extracted based on Table 4.13 in this case Therefore, a Component Matrix Table will then be checked. With the reference to Table 4.14, the items indicate a pattern loading inconsistency which makes it difficult to interpret. In order to achieve this, the items clustered together must be rotated in the component matrix.

Table 4.14 Component Matrix

	Component		
	1	2	3
SUS1	.664	.440	-.037
SUS2	.620	.520	-.098
SUS4	.759	.344	-.294
SUS5	.771	.361	-.324
SUS6	.590	.352	.106
SUS8	.687	.536	-.025
SUS9	.655	.415	-.286
E1	.791	-.086	.485
E2	.779	-.188	.475
E3	.713	.008	.603
E4	.732	.047	.561
UF1	.697	-.433	-.240
UF2	.701	-.486	-.252
UF3	.788	-.462	-.224
UF4	.801	-.440	-.161
UF5	.815	-.300	-.125
UF6	.874	-.257	-.163

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

As shown in Table 4.15, it shows that there are 3 components with all variables substantially loading into one component. These 3 components represent the variables of study. In conclusion, this analysis supports the use of the 10 value items as a separate scale.

Table 4.15 Rotated Component Matrix

	Component		
	1	2	3
SUS1	-.084	**.756**	.146
SUS2	-.142	**.851**	.054
SUS4	.217	**.822**	-.128
SUS5	.226	**.859**	-.161
SUS6	-.127	**.563**	.301
SUS8	-.172	**.860**	.163
SUS9	.096	**.848**	-.155
E1	.140	.009	**.845**
E2	.238	-.098	**.834**
E3	-.062	.016	**.957**
E4	-.063	.085	**.911**
UF1	**.895**	-.039	-.042
UF2	**.955**	-.087	-.053
UF3	**.955**	-.039	.008
UF4	**.900**	-.041	.087
UF5	**.749**	.094	.128
UF6	**.760**	.181	.098

Extraction Method: Principal Component Analysis.

Rotation Method: Promax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

4.6 Summary of the Responses

The collective measurement of the normal students and slow learning students on the effectiveness of the module was found to be very good by the majority of the students. As shown in the figure below:

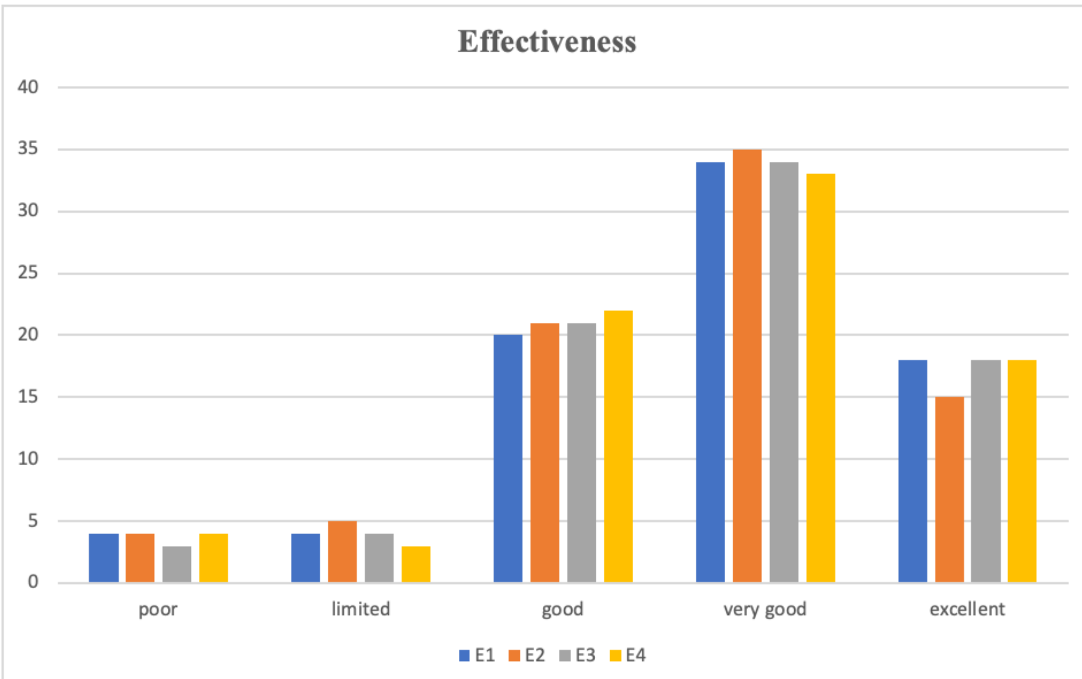

Figure 4.2 Effectiveness

The system usability was measured on 5 point Likert scale which shows that among the normal and slow learning students, the majority responded with strongly agree. As shown in the figure below:

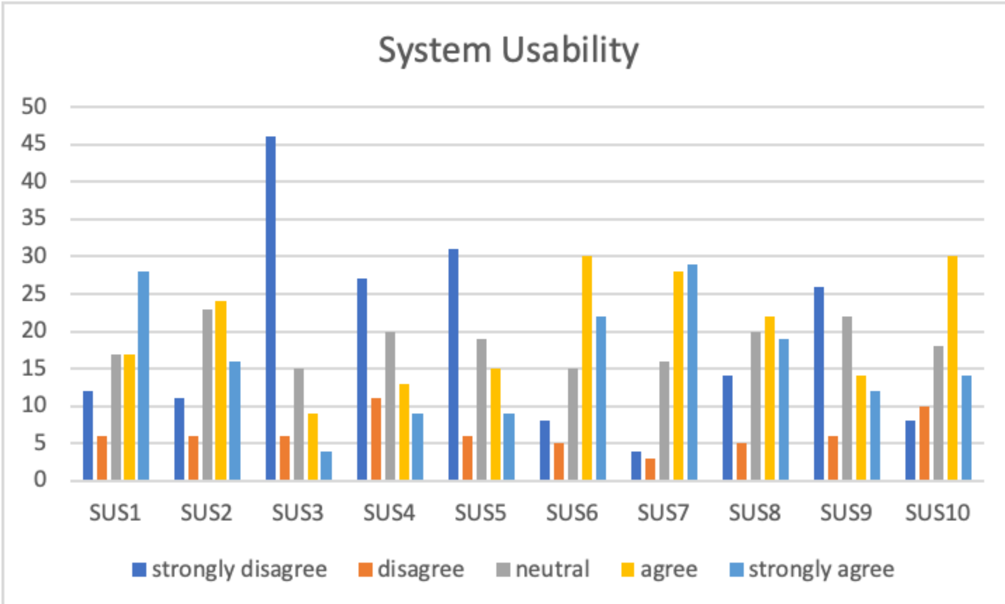

Figure 4.3 System Usability

Physical activity enjoyment scale was filled by the respective teachers, this shows that the majority of the students have been tagged with yes. As shown in the figure below:

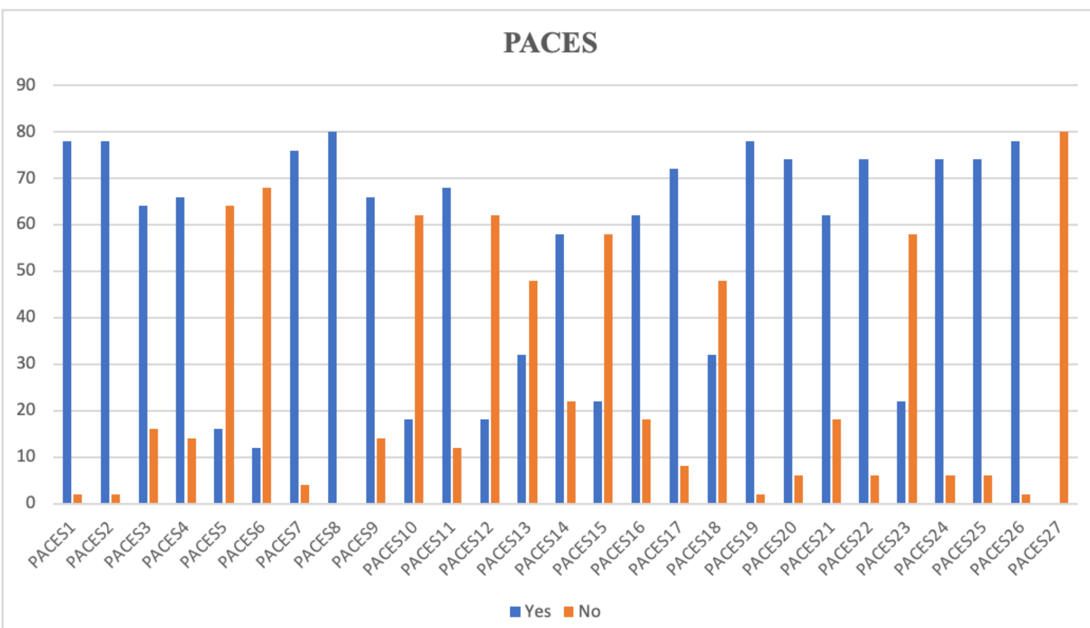

Figure 4.4 Physical Activity Enjoyment

User friendliness and ease of use was measured on 5 point liker scale from poor to excellent. Majority of the respondents recorded that the game system is vey good. As shown in the figure below:

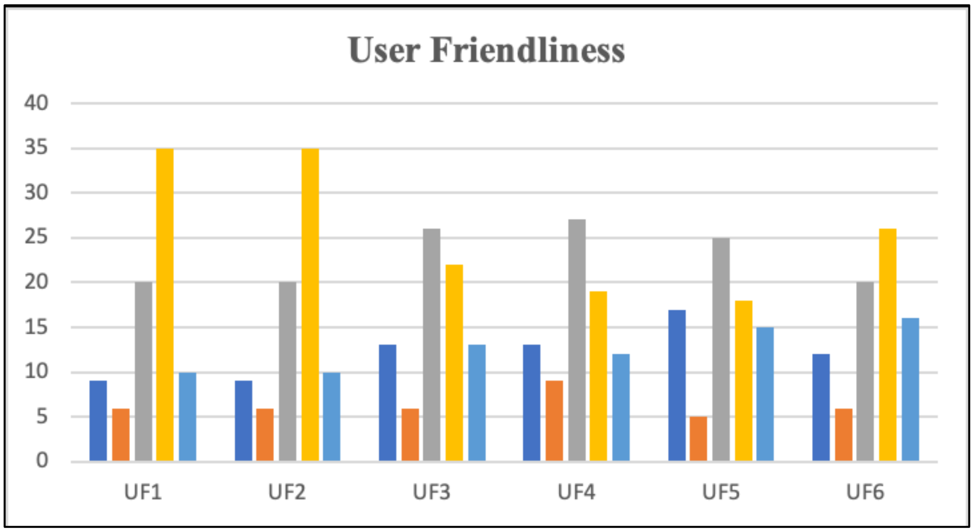

Figure 4.5 User friendliness and Ease of Use

In the next section observational study was recorded by the field manager of the survey, it was observed that 35% of the students were actively focusing on the screen. From the facial expressions of the students while playing the game it was recorded that 40% of the students were smiling and laughing while playing the game. As shown in the figure below:

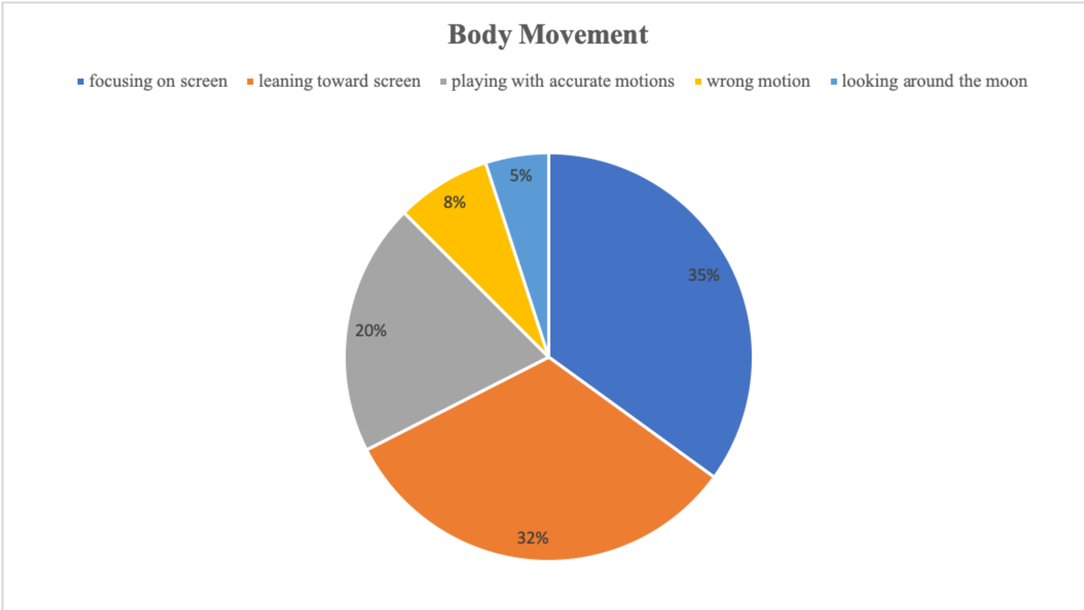

Figure 4.6 Body Movement

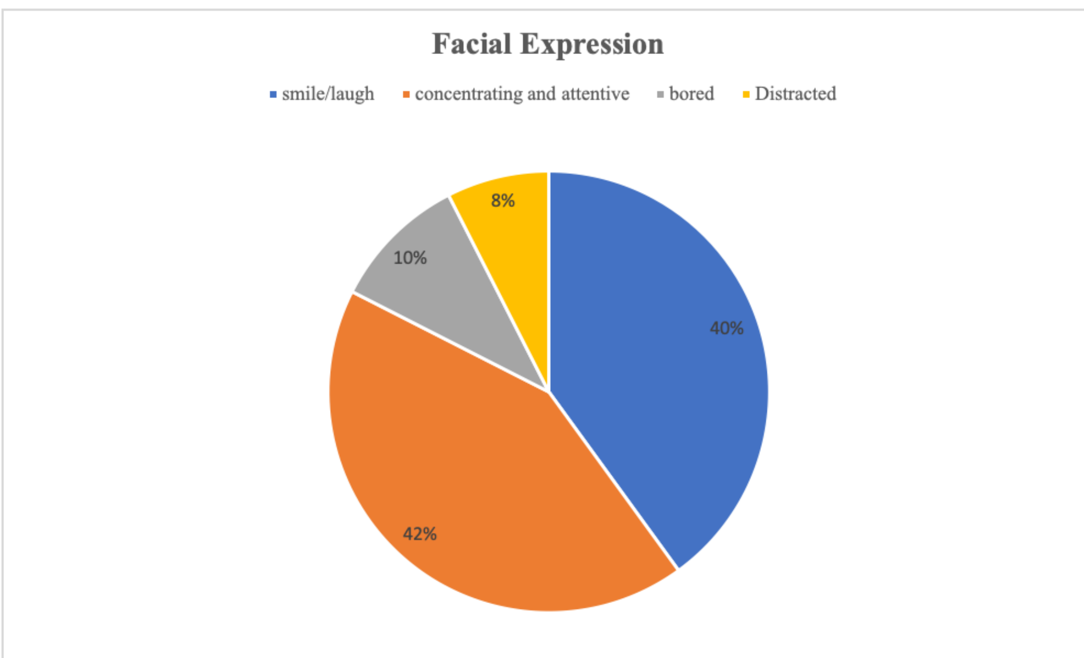

Figure 4.6 Facial Expression

The observational comment from the field manager shows that 35% of the students had comments on game element.

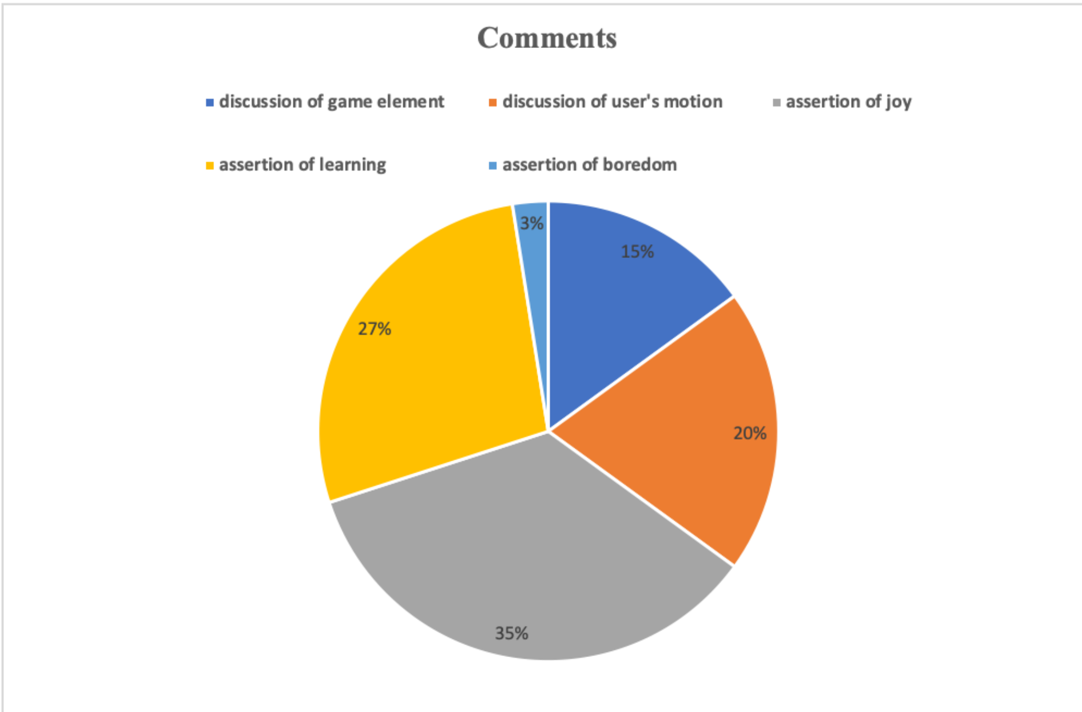

Figure 4.7 Comments

Lastly the observations were made on the in game behaviour, it was observed that 43% of students were following the game instruction.

Figure 4.8 In Game Behaviour

4.7 Correlation Analysis

Correlation analysis is carried out primarily to determine the variables' strength and direction. This analysis is mainly based on the research question mentioned in Chapter 1. Correlations research is performed. As previously described, Pearson product-moment correlation coefficient is represented according to an essentially normal distribution.

According to Table 4.16, the Pearson Correlation result for SUS is $r = .04$, $N= 80$, $p <.05$. The r-value reported is positive and $p < .05$, hence there is a **weak, positive correlation** between System Usability and effectiveness.

Next, the Pearson Correlation result for UF is r = .49, N= 80, p <.01. The r-value reported is positive and p < .01, hence there is a large**, positive correlation** between Uf and effectiveness.

Table 4.16 Pearson Correlation Analysis

		UF	SUS
E	Pearson Correlation	.702**	.199*
	Sig. (1-tailed)	.000	.038
	N	80	80

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

4.8 Multiple Regression

Multiple regression was carried out to investigate whether the independent variables (SUS and UF) could significantly predict Effectiveness. Using the Enter method, the multiple regression analysis method is performed.

The R Square value in Table 4.17 shows the amount of variance in the dependent variable that can be explained by the independent variables. As shown in Table .17, the independent variable SUS accounts for 0.04 per cent of the variance in the ‘Effectiveness’ scores. And UF accounts for 0.492 on effectiveness.

Table 4.17 Model Summary Table

	R	R Square	Adjusted R Square	Std. Error of the Estimate
Model1	.199[a]	0.04	0.027	0.32797
Model2	.702[a]	0.492	0.486	0.24001
Model 1 SUS->E; Model2 UF->E				

The ANOVA table explains the significance of the regression model. Accordingly, the ANOVA table indicates that the model 1 as a whole is significant with (f 3.2 $p < .05$). and for Model 2 it is significant with (f 74.67<0.1).

By referring to Table 4.18, the Standardized Coefficient column displays the contribution that an individual variable makes to the model. The Enter method includes all variables into the regression equation. Under the Sig. column, there are only two variables that make a unique statistically significant influence (less than .05). In order of importance (based on their beta values), they are: SUS (beta = .201), and UF (beta = .278).

Table 4.18 Coefficients

Path	Std. Error	Beta	t	Sig.
UF->E	0.074	0.641	8.642	0
SUS->E	0.075	0.134	1.797	0.076

4.8.1 Effectiveness of Learning Among Normal and Slow Learners

Frequencies of the respondents from the slow learning and normal students were examined through descriptive analysis of the data. Table below shows the responses for slow learners students to normal healthy students in terms of mathematical achievement.

Table 4.19: Responses on Effectiveness by Normal and Slow Learning students

	poor	limited	good	very good	excellent
Normal Students					
E1	2	2	9	17	10
E2	2	2	11	18	7
E3	1	3	9	17	10
E4	2	2	8	19	9
Slow Learning Students					
E1	2	2	11	17	8
E2	2	3	10	17	8
E3	2	1	12	17	8
E4	2	1	14	14	9

4.8.2 Comparison of Multiple Regression between Normal and Slow learners

In this section, Multiple regression was carried out to investigate whether the independent variables (SUS and UF) could significantly predict Effectiveness for slow learners and normal learners. Using the enter method, the multiple regression analysis method is performed.

The R Square value for the normal students shows that the impact of user-friendliness on effectiveness was 0.63. However, the r square for user-friendliness on effectiveness was 0.35. The R Square value for the normal students shows that the impact of system usability on effectiveness was .01, however the r square for system usability on effectiveness was 0.104. The coefficient of determination shows that the relationship between user-friendliness was found significant between both slow learners and normal students. However, the impact of system usability on effectiveness among slow learners was significant but impact of system usability on effectiveness among normal learners was insignificant.

Table 4.20 Regression Results for Normal and Slow learners

Type		Unstandardized Coefficients		Standardized Coefficients		
	Path	B	Std. Error	Beta	t	Sig.
Slow Learner	UF->E	.481	.108	.592	4.463	.000
Normal	UF->E	.812	.100	.795	8.085	.000
Slow Learner	SUS->E	.209	.099	.322	2.100	.042
Normal	SUS-E	.073	.112	.106	.655	.517

4.9 Qualitative Data Analysis

Data analysis in qualitative research is defined as the process of systematically searching and arranging the interview transcripts, observation notes, or other non-textual materials that the researcher accumulates to increase the understanding of the phenomenon. There are various methods used to analyse the qualitative data, however in this study thematic analysis was used to study the themes originated from the research questions and the interview questions. Following is the detailed analysis of the qualitative study. The teachers were selected based on the non-parametric purposive sampling technique. Those teachers who were qualified and have been teaching both SLP and normal students were contacted to respond to the structured interviews.

4.9.1 Respondents Characteristics

A total of ten informants responded to the interview. Majority of the respondents had more than four years of the working experience. However, the background of education for every informant was different. Among the informants 4 of them was with degree in early childhood education. The details of the informants are given below:

Table 4.21 Profile of the respondents

No	**Name**	**Teaching Experience**	**Qualification**
1	T1	4 years	Diploma in Business
2	T2	5 Years	Diploma in Early Childhood Education
3	T3	1 year	STPM
4	T4	1 year	SPM
5	T5	4 years	Degree in Early Childhood Education
6	T6	2 years	Bachelor of Education
7	T7	6 years	APEL
8	T8	4 years	Diploma in Business Management
9	T9	5 years	Bachelor of English
10	T10	7 years	Foundation in special need kids

4.9.2 Interviews context

The researcher conducted 5 semi-structured interviews after the implementation of the gaming module. Interviews lasted between 50 and 85 minutes, with an average duration of around 60 minutes per interview. All the interviews were conducted through face to face. All the interviews were conducted in English. The interviews aimed to provide context for the quantitative data collected earlier by asking the interviewees to explain or provide a personal account on aberrant or anomalous trends, as well as helping understand the wider the effective learning of motion detection for students with inattention and impulsivity disorders on mathematical achievement and compare the outcomes for slow learners students to normal healthy students in terms of mathematical achievement.

I4.9.3 Interviews Responses

a) Teachers' understanding and characteristics of slow learners (Q1, Q2):

The teachers were asked about their understanding for slow learners. There were generic and basic level of understanding observed from the responses of T1-T3 and T7-T9. Slow learners are those who needs more time & effort to learn and their attention period is less as compare to normal students. Sometimes they need to be explained number of times. In contrast the responses of T4, T5, T6, T10 depicts more depth in knowledge about slow learners. Though the essence of responses by T4 & T10 and T5 & T6 are quite similar.

"… is a child of lower than average intelligence whose reasoning skills have grown significantly more slowly than the norm for his or her age…" (T4)

"… are normal kids who are selective to certain learning… have certain challenges in learning numbers… have poor memory, difficulties understanding several steps in a task, longest process which needs memorizing…" (T5)

The understanding of T5 and T6 are contradicting as compare to others, as it claimed slow learners as a normal student but have deficiencies in memory, learning numbers and show lack of interest in most of topics. Moreover, the characteristics of slow learners represented in Figure 4.9.

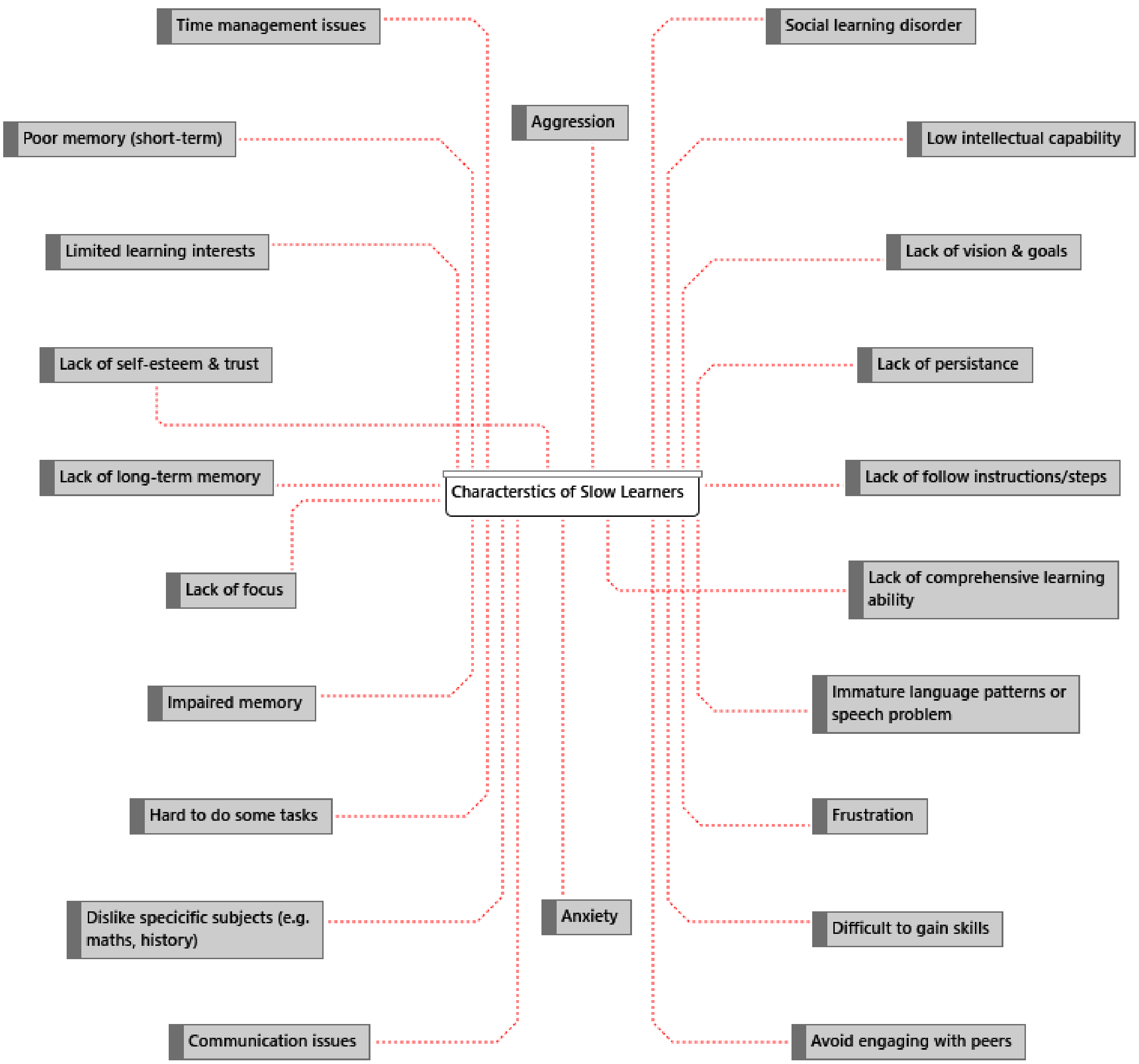

Figure 4.9 Characteristics of slow learners

b) Difficulties in Teaching (Q3)

The teachers have inquired about difficulties they face during teaching slow learners. And the answer of teachers assembled to form a group of difficulties to help educationalists, teachers and researchers recognize well. These are as follows:

- Need to explain things few times (T1, T2)
- Have specific learning disabilities/disorder that demands to show more attention and love (T3, T4, T7, T9)
- Need more assistance for learning (T1)
- They get bored easily or faster than other students (T1, T7)
- Patience and courage is required to handle slow learners (T2, T9)
- Hard to push them to communicate with classmates because they are less social and like to stick in their own circle (T5, T6, T10)
- Less effective in group activities, sometime feel insecure (T5, T6, T10)
- Sometimes, no feedback when inquired a question (T5, T6, T10)

c) Advantages and Limitations of Kinect Game (Q5, Q6):

The assessments extracted from interviews depicted in Table 4.21. confirms a bunch of positive responses on the advantages of Kinect maths games for slow learners. While for its limitations, no one claims on the design of game such as itis not engaging and there is no motivation. Only T1, T7 and T8 reports ease of use because of time to train students play the game. The setup location is the prime limiting factor for Kinect maths game and the responses are of quite technical nature. The T5, T6 and T10 has concerned for coverage constraints of motion detection, this causes failure to detect the activity of students. According to the respondents T5:

“Sometimes kids not used to stand in one place and play the games, if we move the detection may not be accurate, so the devices can be coverage based (for example 50m around) rather than hand detection based.” Besides the range issue, another dimension of technical aspects is feasible lighting of the setup location of the Kinect game as described in T9 response:

“… Kinect needs balance lighting, if its too bright the detection will not be so accurate.” (T9)

Therefore, before implementing Kinect maths game in classrooms the technical requirements of the game infrastructure should be considered.

Table 4.22. Advantages and limitations of Kinect maths game

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	n	%	Rank
Advantages													
▪ Suitable for slow learners?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	10	100%	1
▪ Meet their needs through motion?	✓	×	✓	✓	✓	✓	✓	✓	×	×	7	70%	3
▪ Get their attention?	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	9	90%	2
▪ Kinestethic learning	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	9	90%	2
Limitations													
▪ Ease of use?	✓	×	×	×	×	×	✓	✓	×	×	3	30%	2
▪ Enough motivation to continue using?	✓	×	×	×	×	×	×	×	×	×	1	10%	3
▪ Game design is engaging enough?	×	×	×	×	×	×	×	×	×	×	0	0%	4
▪ Setup location	✓	✓	×	×	✓	✓	×	×	✓	✓	6	60%	1

d) Assisting Slow Learners

In order to dig out more insights to effectively deal with slow learners via “effective learning of motion detection” for students this study keep on with below questions.

1. *What do you think slow learners need in terms of assistive technology (AT)?*

Assistive Technology (AT) is any device, apps or software that lets students deal with learning problems. Since many types of AT is available in the market therefore the right selection should be grounded from expert opinions. Following Table 4.23. describes the expected needs of slow learners from AT.

Table 4.23. Teachers comments for needs of slow learners from AT

Respondent	Needs	For example
T1	Digital devices, interactive tools or game-based learning.	Mobile game, smart board interactive tools, Kinect.
T2	Slow learners need tools that can help them focus, enjoy and learn effectively.	
T3	Use of activities, techniques and practices to enhance attention period, also helpful to eliminate weaknesses or deficiencies.	
T4	AT software or devices that support kids with learning disabilities; physical and cognitive.	Electronic worksheets, Phonetic spelling software, Talking calculators, Variable speed recorders, Videotaped social skills.
T5	Visual or audio support to solve math problem and devices to assist student having severe disabilities; speech, hearing, blindness and other physical.	
T6	Usage of AT tools to aid students with memorizing and speech pattern difficulties.	
T7	Interactive games are replacement of those who frequently like to play with phone.	
T8	Support students to deal with short attention period as well as to overcome deficiencies.	
T9	Needs ease and simplicity in AT tools.	
T10	AT tools that can help students in writing task.	

2. *Have you found the training for slow learner's kids were useful to be able to use and play the game?*

All the respondents has observed constructive outcome after providing slow learners kids familiarization training to play the game. Yet, the time factor is the concern. For instance:

"Yes, it took a bit more time for kids to adopt and adjust, but when t…" responded by T1.

3. *How can the game be improved?*

The majority of teachers' feedback (Table 4.24.) supports the game is beneficial and has met kinaesthetic learning model. Despite the fact a serious consideration has been highlighted for children safety while designing activities. Web-based and story-based game are suggested to track learning activities by teachers and student engagement respectively. Also addition of trendy cartoon/animated character to create more excitement.

Table 4.24. Teachers' feedback for game improvement

Respondent	What additional features should the game have?	Is the game meeting the kinaesthetic learning model?	What other needs of slow learners that need to be met?	UX Design	Motion detection?
T1	Web-based game	Yes	Break time		
T2	Story-based game	Yes			
T3		Yes		Activities should be safe for children	

T4		Yes	Should be protected for children
T5	Add trendy cartoon characters	-	
T6	Animated characters	-	
T7		Yes	Need to improve background animation
T8		Yes	Ensure safe game moves
T9	Bright color and bigger fonts, also addition of famous super heroes.		
T10	Trendy rhythms of children		

4. *One of the issues with slow learners is the period of attention. How do you think this game can grab the attention and motivate them to continue playing with the game?*

From the answers of teachers interviewed, it has confirmed that the game is sufficient enough to overcome this disability (period of attention) of slow learners.

"Game based learning is always an attractive tools which can grab the attention of these students. motion game and kinesthetic learning will help them to interact better. When they interact better, they learn better with spending more time on the game." (T1)

"Since the game is very interactive, the kids will pay attention to sol…" (T2)

While some other (T5, T6, T7, T10) praised break-time during activities. T5 responded *"Each level contains of 5 questions with ample amount of break then con…"* because providing sufficient break in terms of time while progressing to another task in the game saves students from frustration and fuss caused by hurry.

5. *One of the problems of slow learners in general is that they cannot do a task continuously for a period of time. In terms of game strategy, how did you find it as a game which can encourage students to keep continuing the game?*

The comments of respondents are convinced about the effectiveness of game strategy. The game has small tasks and rewarding part that encourage students keep playing.

"… Every level has 3 sub level, after each 5 tasks, there is a interruption which is rewarding part. It motivates kids to move on." said by respondent T1.

Most of teachers are in the favor of physical activities used in the game to grab attention and motivation. For example:

T5: *"This gave encourages them to engage just because it has the fully body…"*

T6: *"This prompted them to interact especially since they have full body movement, whereas smartphone games where they can only use fingers to click or point."*

T8: *"Regular physical activity is important for children because it helps to prevent obesity and improves energy levels…"*

6. *How about the level of difficulties in the Game? Share your thoughts about it.*

The below comments are self-explainatory to conclude that the level of difficulty is acceptable to students. The other perspective is pointed out by T3 and T8, initially the game seems difficult unless students gains familiarity.

T1: *"… Beginner is great. Intermediate also designed well. Advanced is a bit difficult. Some of the questions for multiple and times might be difficult for some of the students. but overall is good."*

T5: *"The level of the difficulties is suitable this range of students, too…"*

T3: "… *In the first stage you will find ITS HARD LATER ON YOU WILL FIND EASY"*

T9: *"The level is suitable for the given group age. In future can add 3 digits numbers too."*

e) Concluding remarks on the use of Kinect game based educational models to aid slow learners:

Finally, it is fair enough to conclude that the Kinect game is supportive for slow learners. Also depicted in below overall rating by teachers.

T1: *"It was a good experience for students."*

T2: *"With these new technologies, we can help our students to learn faster,…"*

T3: *"I am happy to share that it has established itself as one of the prefe…"*

T4: *"This Kintec educational technologies should bring to the classroom inc…"*

T5: *"We need more games like this in our classroom, at this moment AT was n…"*

T8: *"… this is a great asset to every primary school. I strongly recommend it to anyone who is looking for ways to improve the results and the overall experience of students."*

T10: *"We need to give children more games like this. They can learn easily and can improve their intelligence and thinking skills. The children will also be very happy and learn new things every day, so keep a smile on their faces every day."*

The favorable results of this study is in line with the study of Yilmaz & Bayraktar (2018) found the effectiveness of kinesthetic based game to enhance the learnability of students.

Chapter 5. Discussion

5.1 Introduction

The present chapter completes this research. The study is outlined and the key conclusions of this analysis are presented based on the results of Chapter 4. Any results have been taken from the analysis and potential implications have been illustrated. The shortcomings of the research are included in this chapter and guidelines for potential studies are given. The findings will eventually be addressed.

5.2 Recapitulation of the Study

This study was focused on the effectiveness of integrating technology in the education system to provide the assistants to enhance the learning capability of the slow learners' students with educational backwardness. Kinect sensors offer an interactive technology that has the potential to improve teaching and learning methods since it deploys the natural user interface which provides the active involvement of the students while boosting their engaging capability or focus to overcome their impulsive or inattentive nature. The Kinect Sensor as a learning tool sustains the capability to develop interactive games that boost learning motivations and learning proficiency by employing its multimedia and multisensory attributes. This study will focus on the development of a motion-based edutainment application for mathematics, based on the Kinesthetic learning model developed for students with inattention and impulsive disorders, to improve and enhance levels of attention and concentration. Further this study has developed the prototype of Kinect Game for children with Slow learning Kinesthetic

Learning methods applying real-time motion detection. To see the application of developed prototype evaluation was needed therefore, this study evaluated and tested the content design based on motion detection for Kinect Game on the selected elementary school (grades k-5) and middle school (grades 6-8) students based on Kinesthetic Learning Theory. From the feedback this study also tested the effective learning of motion detection for students with inattention and impulsivity disorders on mathematical achievement and compare the outcomes for students with SLP to normal healthy students in terms of mathematical achievement. Based on the problem statement this study formulated four objectives given below:

- To design and develop a motion detection edutainment application for mathematics, based on learning theories and learning strategies developed for students with inattention and impulsive disorders, to improve and enhance levels of attention and concentration.
- To develop the prototype of a motion game for slow learners' children based on Mayer principles of learning integrated with Kolb's learning style by applying real-time game-based motion detection technology.
- To evaluate and test the content design based on motion detection game on the selected elementary school (grades k-5) for learning mathematics for slow learners' children.
- To investigate the effective learning of game-based motion detection application for slow learners' children on mathematical achievement.
- To compare the outcomes for slow learners' children with normal healthy students in terms of mathematical achievement.

The research conceptual framework designed for this research is based on four stages Stage I includes the analysis process. Stage II involved the design process and development of the system. Stage III involved the implementation. Stage IV involved evaluation and testing. At this stage, the designed system went through pilot system testing and also a usability testing; concentrating on the strengths and weaknesses of the system.

The development and implementation of the software was considered as the main objective of the study. Section below will discuss the objectives of the study.

5.3 Discussion

This study has developed the framework to assess the learning ability of the slow learners' children using technology. The research hypothesis is that Edutainment can increase mathematical achievement in slow learners' children. In order to test this hypothesis, the study selected the population as slow learners' students, the sample was taken from the slow learners' students from elementary school (grades K-5) and middle school.

To assess the application of the system two groups were considered in this research mainly slow learners' children who receive Edutainment and normal children who receive Edutainment. Considering these methods, the researcher tested whether Edutainment works for slow learners' children (comparing groups 1 & 2) and see whether Edutainment improves learning more generally as well as investigating whether or not this form of motion detection game is more effective for slow learners children than normal healthy children (comparing the difference between groups 1 & 2).

The objectives of the study are discussed below:

To develop a motion-based edutainment application for mathematics, based on the Kinesthetic learning model developed for students with inattention and impulsive disorders, to improve and enhance levels of attention and concentration.

This section emphasises the differences of the motion based edutainment application developed for the purpose of this study and the previous recent pedagogy models. Prior research on educational pedagogy indicates that pedagogy refers to the instructional design and approaches to teaching practice (Blundell et al., 2020; LaVelle et al., 2020). As such in this study kinaesthetic learning model was utilized in developing the model for the slow learner's students. The principles of Keller model propose that the interest demonstrated by the learner when encountered with learning concepts or ideas (Hall & Lei, 2020). Relevance refers to the adaption of language and examples that are familiar to the learner. The confidence emphasizes the establishment of positive expectations for the accomplishment of success and the last aspect refers to the satisfaction which must be accompanied by the learner or reward from learning outcomes, the researcher has offered 'model of learning' as simply one of the pedagogy criteria to facilitate the learning process. In this respect, the constructivist model of learning as one of the learning theories emphasises the learner-cantered approach, where the learners construct new knowledge by processing their cognitive abilities.

Importantly, recent studies also focused on 'the challenges of changing pedagogy', aiming to develop the quality of education and teaching (Khazanchi, 2020; Tadesse et al.). In this respect, a number of research projects have integrated technological pedagogical science knowledge (i.e. ICT) into the educational pedagogy (Es-Sajjade & Paas, 2020; Tucker & Johnson, 2020; Wahidah et al., 2020). It is important to note that one of the significant pedagogy criteria that has been offered by the motion based model is named medium, which consists of ICT aspects (e.g. video camera, IR sensors, microphone and tilt motor). Unfortunately, teachers have infrequently applied ICT in the classroom in order to support learners constructing knowledge. However, ICT is simply being used for information delivery. However, considering the deeper understanding of the motion based learning using ICT for slow learners children. Little has been discovered in the prior studies.

The research evidence shows that although a vast number of experiments on instructional systems have been carried out, previous scholars have commonly quoted in pedagogical frameworks ICT (e-learning) and/or learning philosophies (e.g. constructivist-learning) (Yong et al., 2019). This illustrates the absence of a clear pedagogy paradigm not only based on a few methods to instruction, but rather on all facets of curricula. As a consequence, the outcomes of recent studies show that there is a research gap for creating a precise pedagogical model. More importantly, this portion of the analysis presented a modern pedagogical paradigm focused on games, consisting of three standards intended to benefit students as well as children in general. The teaching methods model based on the game is regarded as a consequence of a decision on a variety of essential learning aspects which were not defined as a full package in the curriculum. Thus there are essential instructional parameters in the game-based teaching methods model. The first stage contains the feedback for the framework, which incorporates predefined learning targets with game functionality. The second process includes a loop that requires a user appraisal in terms of satisfaction and interest, user behaviour, and device reviews.

Interestingly, the model has been tested in the real environment among normal and slow learners' children in the presence of parents and teachers. Findings from teacher observations (section 4.3) have verified the model as an accurate pedagogy model for slow learners. However, an important pedagogy criterion has been missed from the model which directed the researcher to further investigation on slow learners and impairments.

To develop the prototype of Kinect Game for children with Slow learning Kinesthetic Learning methods applying real-time motion detection

The second objective of this study was to develop the prototype of Kinect Game for children with Slow learning Kinesthetic Learning methods applying real-time motion detection. The game was developed considering the level of the students, in this study the targeted groups were normal students and slow learners students from elementary school (grades K-5) and middle school.

This study gamified the learning outcomes regarding mathematics with the help of Kinect sensors to engage the students exhibiting SLP and to analyze the effectiveness of motion-based games for the objective-based learnings. The integration of gesture recognition technology prevents the students from distracting due to the active involvement and assists them in overcoming their impulsive and inattentive behavior and let them perform well. For experimentation, a room corner in a school was furnished with a projector and screen (can be a wall) to provide an adequate environment to test the effectiveness of the technology. Kinect Setup installed by connecting to the laptop and projecting the game to the wall.

The motion game was structured on 3 levels corresponding to the difficulty and each level has 15 questions. The questions are generated randomly, so each student will get the random questions at each level. Corresponding levels are defined as:

a) Basic level with the numeric operations of plus and minus for number ranged from 1 to 5.
b) Intermediate level which provides the numeric operation of Multiplication and division for numbers ranging from 1 to 5.
c) Advanced level which include all mathematical operations for number ranged from 1 to 10.
d) There is a break after every 5 questions in each level

Results from the qualitative study when asked from the teachers regarding the advantages of the game showed positive results from the respondents.

Children have different learning modes or unique learning styles. They have different ways of learning depending on the way they absorb and assimilate information. In this study the main sample was slow learners' children. For them game-based learning has revealed a significant element of learning through activities. Considering normal students, they recall information well by things that are seen or read (visual), for some auditory input is most valuable, others find it hard to acquire information unless they use them in real-life activities following the concept of Kinesthetic learners. Studies show that most of the school population excels through kinesthetic learning. They prefer a “hands on” or “doing” approach to build understandings. These types of learners also like to participate in practical approach to learn mathemetics. They learn more in small or large groups and enjoy educational games or educational materials such as the game developed for the current study. Prior research showed that hands on teaching are becoming more popular because it addresses not only the needs of slow learners but also the needs of visual and auditory learners. Therefore, motion based game learning is beneficial for all students and can aid in overall cognitive development.

To evaluate and test the content design based on motion detection for Kinect Game on the selected elementary school (grades k-5) and middle school (grades 6-8) students based on Kinesthetic Learning Theory

The third objective of the study was to assess and evaluate the content design based on motion detection for Kinect Game on the selected elementary school (grades k-5) and middle school (grades 6-8) students based on Kinesthetic Learning Theory. The evaluation of the content was based on the learnability, efficiency and the satisfaction level.

Qualitative analysis is made with the help of facial and body movement detection while qualitative evaluation composed of questionnaires attended by specialists and teachers. The results revealed very interesting findings for the study.

Among the total groups 67% of the respondents showed positive results for the content. As the body movement detection showed that 8% of them were not interested and only 5% of them were not playing accurately. This shows that the students were having keen interest in the activity. As they were physically involved in the activity.

This could lead to the better learning as studies shows that motion based learning often includes physical repetition of tasks, which builds muscle memory and further boosts retention (DuPaul et al., 2011; Mautone et al., 2005).

Further the evaluation of the content of the game based learning has included the facial expression of the students while performing the task. 82% of the students were concentrated and was smiling while performing the test. However among them only 10% were bored and 8% was distracted. The qualitative results showed that the math game was interesting and fun for the students and they were actively enjoying the game. In the case of slow learners' students there was little attention required for them to help them in concentrating on the game. However the normal students were actively involved in playing the game.

To investigate the effective learning of motion detection for students with inattention and impulsivity disorders on mathematical achievement and compare the outcomes for students with SLP to normal healthy students in terms of mathematical achievement

The fourth and the last objective of the study was to investigate the effective learning of motion detection for students with inattention and impulsivity disorders on mathematical achievement and compare the outcomes for students with SLP to normal healthy students in terms of mathematical achievement.

In this study, it was found that the effectiveness of the game based learning among the normal students was higher as compare to the slow learners the results has revealed that majority of the slow learners recorded their effectiveness on the scale of very good however, in the case of normal students they had also recorded the effectiveness on very good but as compare to the ratio of excellent there is difference in slow learners and normal students. The possible reason for the effectiveness of the game based model has the physical activity involved in learning the mathematics. Students were keen in performing the activity. Hence they were more interested to learn mathematics through game based learning.

In line, qualitative outcomes indicate that teacher express higher levels of appreciation of the model of slow learners than normal students, especially on slow learners' advantages. Findings explain that sensitivity and emotional perspective of teachers might lead them to agree to slow learners' strengths statements. In the qualitative interpretation, the analysis revealed that the teachers have rated positive significance of the model. It was assessed from the analysis that teacher had good experience in using the technology and understood the convenience of the technology in instructing the mathematical courses. Further, from the perspective of effectiveness they had highlighted the need of the system to be implemented in their classrooms as it assisted them in instructing the lectures.

Further under the objective this study has examined the system usability and user-friendliness impact on the effectiveness of the motion based model. Previously, system usability and user-friendliness impact on the effectiveness has been studied in different settings from the education field to the social science and management sciences (Grier et al., 2013). The impact of system usability and user-friendliness on the effectiveness has been previously found significant in the ICT assisted technology implementation. This study has tested the same process in the different settings that is not been examined in the earlier researches, For the overall impact of system usability and user-friendliness based on the both groups were found significant. The results revealed that the relationship between user friendliness and effectiveness was highly significant with p value less than 0.01 however the system usability was significant with the p value less than 0.05.

Similarly, the impact of system usability and user-friendliness on the effectiveness was separately examined for the both group's normal and slow learners. The results revealed very interesting findings. The impact of user-friendliness and effectiveness was found significant for both slow learners and normal learners with the p value less than 0.01 for both. However, the impact of system usability on the effectiveness was found significant with p value less than 0.05 among the slow learners. But in the contradiction, insignificant relationship was found among the normal students. This shows that the normal students had more focused on the user-friendliness than the system usability. The possible reason could be the learning tendency of the normal students. For them it is easy to learn the mathematical computation without any assisted technology. But for the slow learning students they are more focused on learning through the assisted technology.

5.4 Contribution of the Study

Results from the current research indicate that the researcher has successfully addressed the research questions, research aims, and objectives as promised. Literature investigation in this study represented the mathematical game-based model of slow learners, which was confirmed and validated through both qualitative and quantitative examination. The model has firstly been supported by four groups of experts, coaches, teachers, and parents. Hereafter, two groups of slow learners' professionals and parents verified the motion detection for Kinect Game model of slow learning. Importantly, the model intended to explore efficiency and the usability of motion-based learning among slow learners children as well. In addition, the model expands the understanding of three levels of difficulties such as Beginners, intermediate and expert. This study therefore contributes to the body of knowledge by developing a motion based pedagogy framework which aims to direct special education teachers.

5.4.1 Theoretical Contribution

This research is the first to contribute "motion-based" mathematical game model for slow learners' children. The analytical and practical contributions of this research help slow learners' children to enhance their learning experience and to have useful and relevant experiences in strengthening the existing level of understanding of special education requirements. First this research highlights the characteristics of the slow learners for instance, lack of persistence, frustration, anxiety etc. These characteristics help to define the slow learners, here this study contributed to the definition of slow learners. Therefore, based on the findings on the characteristics this study defines slow learners are "*the individuals who have problem in learning due to time management, limited interest, low self-esteem, lack of focus, low emotional control, and lack of vision".*

In this research the impairments and abilities of slow learners' children in an academic setting are thoroughly and systematically explored. This thesis aims for a specific sector of special education (SEN) children that needs an inclusive interpretation of pedagogical literature both in philosophy and in empirics. As mentioned in chapter two literature review, more experiments are needed to be performed in the area of slow learning (Black & Hattingh, 2020; Hill, 2020; Khamo, 2020; Rapport et al., 2000). This thesis also refers to these appeals both in theory and in practise and has also found motion-based game model in mathematics for slow learning children, which may theoretically modify the testing field. The outcome illustrates the value of game-based instruction, in specific physical activities and their impact on children's mathematics. The current study findings highlighted the suitability, needfulness, attention and enhanced learning through game based instructional design for slow learners. The study answers the advantages of using game based instructional design for the slow learner students

One of the essential elements of instructional literature was the dimension of teaching methods (Hofer & Harris, 2019). In particular, by analysing and evaluating the real environment of classrooms, the researcher improves this field of study to verify the teaching methods model proposed to establish a precise setting. The study contributes to the awareness of instructional aspects by emphasising the diverse positions performed by parents, instructor teacher's in the classroom and affecting the development of children who are slow to learn. Further, findings of current study contributed in terms of highlighting the importance of new technologies used in the class room. The design of the instructional material should be interesting enough to hold the attention of the students. These factors will improve the experience of student by learning through assistive technologies.

5.4.2 Practical Contribution

In order to enable slow learners to benefit from classroom learning materials, effective teaching methods and practises must be followed that encourage certain students to deal with learning demands. The movement-based mathematical teaching scheme incorporated in this research enables designers of lesson plans to conclude reasonably and controlled about the choices of mathematical pedagogy and pedagogy change via a learning episode. This was one of the main substantive contribution of the study.

The implementation of correct teaching methods is much more important to the particular requirements of a community of learners by connecting instructional standards to the abilities and deficiencies of such slow learner classes i.e. inadequate engagement, poor knowledge processing, poor integration and/or co-morbidity such as autism or dyslexia). In order to help instructional planners decide best on teaching methods solutions to help children overcome academic limitations, a preliminary directive has been proposed to benefit children.

Different groups, especially slow students, were considered important by special teachers/teacher assistants in working with children with special needs. During the class that was accepted in this study it is important to push students across diverse skill positions, coaches, teachers and parents, and from multiple viewpoints. This helps children to reach better academic success. Therefore the tasks listed by teachers during the learning episode should be given appropriate consideration by schools and teachers.

5.4.3 Contribution in Methodology

Investigative study reveals that inadequate triangulation methodological experiments are carried out in order to obtain access to and gather the data from all members of slow learning professionals, coaches, special teachers and families by interviews, evaluations and web polls including the secondary review of the qualitative and quantitative approach in the area of special education requires. Previous experiments gathered mainly input from children and parents and employed a single strategy (Trani et al.) in terms of both qualitative and quantitative methods. Thus the empirical contribution to improve the motion-based game model may be made to analyse diverse viewpoints of the model, with varying degrees of person impaired and strengthened. In addition, the model of slow learning has proven to be a novel model for the implementation of appropriately defined instructional plans for children with special education requirements through mathematical pedagogists.

5.5 Limitations

Every research has constraints that defines its potential research weaknesses. According to Marshall and Rossman (2014), “No proposed research project is without limitations; there is no such thing as a perfectly designed study”. However such constraints create openings, which are illustrated, for more study.

The sample size in qualitative and quantitative studies were one of the important limitations of current study. Although the type of sampling was a convenience technique, the investigator was able to meet a small range of experts. In comparison, the experts who participated in the analysis also declined a lengthy interview.

In order to test the slow learning model, the study adapts an exploratory and informative methodology. To this end, the investigator engaged crucial practical understanding," at different levels of slow learning academic limits. It should nevertheless be remembered that the model' cannot be shown by the researcher as 'causal model.'

This research has established the motion-based game model to include assistance and help to slow learners’ children with their academic constraints. The research also emphasizes the application of the concept in the actual classroom where slow learners’ children are present and attempts to approve the model's efficacy as a generalizing pedagogy model. This applies to the constraint of the sample and guides more researchers.

5.6 Recommendation and Implication

The implications of this study will be informed as practical guidance for future studies. The following suggestions originated either from the literature research or were made directly from the study findings.

In order to further evaluate and validate the concept for other forms of special education conditions, such as autism spectrum disorder, dyslexia, auditory processing disorder, children with learning disability, the game cycle model has been established and embraced in the context of slow learners and would further endorse the model's efficacy and evaluate the results of the research as shown in the figure below. This research has focused on three critical roles, normal students, slow learning students and teacher during the teaching process. However, the roles might not end up with these three mentioned roles. In this respect, the researcher recommends future research to look at other roles such as another student or peer in order to help slow learners children with their learning and approach to better results of academic performance.

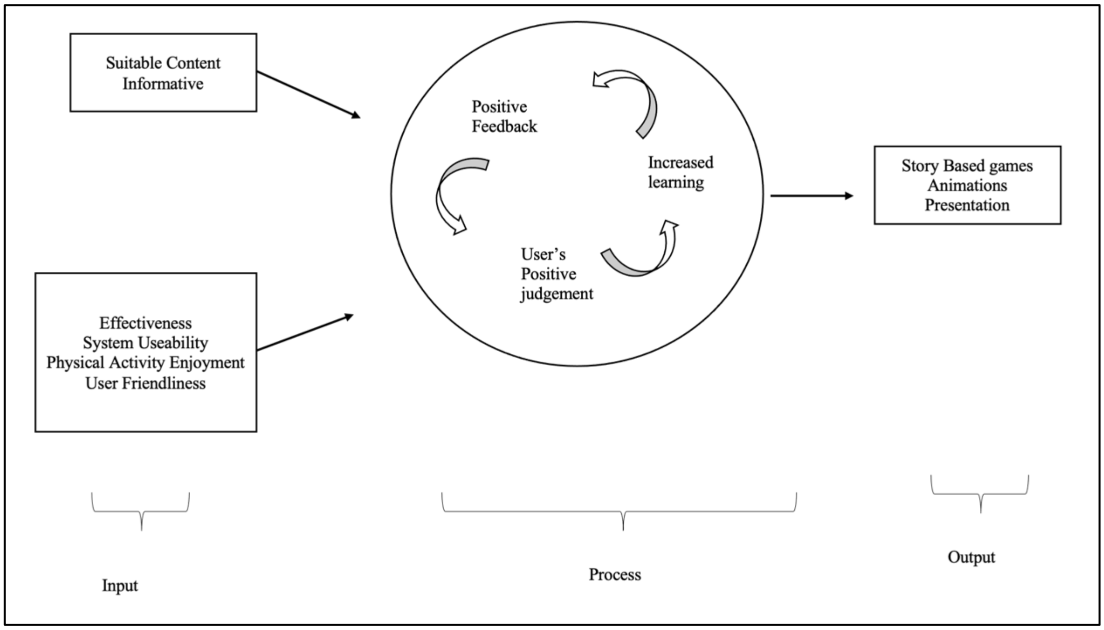

Figure 5.1 Game cycle of Current study

Another overview is whether slow learners' children will study regardless of instruction in a pure constructivist learning environment. In other terms, to decide if a teaching model constructivist may be utilized to better slow learners' students fulfil their instructional needs. This research aims to examine the degree to which the constructional hypothesis holds for students with attention deficit- hyperactivity disorder. The advantages of slow learners and the investigation of whether some weakness or impairment of slow learners can be modified to a beneficial function can be further explored. The investigator has indicated that children with slow learners have talents and that these gifts should be monitored to achieve a larger range of advantages.

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Appendix A Post- test Form

PHYSICAL ACTIVITY ENJOYMENT SCALE (PACES)

Please tick the right answer (respective teacher fill-up for their students)

	YES	NO
1. I liked the game more than regular therapy exercises.		
2. I could see all the things in the game very well.		
3. I could hear the sounds of the game very well.		
4. When I moved, the game knew it right away and gave me points.		
5. To play the games, I had to use movements that are hard for me.		
6. I don't think playing the games often would help improve the way I move.		
7. When I moved, the game did what I thought it should.		
8. The game is easy to learn.		
9. I had the feeling I could score high.		
10. The game was too hard to play.		
11. The game was too easy to play.		
12. The movements I had to do to play the game were very difficult.		
13. The game was more tiring than regular therapy exercises.		
14. I learned to play the game quickly.		
15. It was hard to learn to play the game.		
16. I have to practice a lot more, before I can play this game very well.		
17. The game was easy to understand.		

18. Sometimes when I moved, the game didn’t work.		
19. I liked how the game looked.		
20. I think the scoring was fair.		
21. I like the sounds in the game.		
22. The game was so much fun that time went by very quickly.		
23. I didn’t like the game.		
24. I would tell my friends about the game so they can play too.		
25. I would want to play the game more.		
26. I think the game is fun.		
27. I think the game is boring.		

OBSERVATION CHECKLIST

Please tick the right answer

Type of Observation		Specific actions observed	Tick the answer
BODY MOVEMENT	Positive	• Focusing on screen	
		• Leaning toward screen	
		• Playing with accurate motions	
	Negative	• Wrong motion	
		• Looking around the room	
FACIAL EXPRESSIONS	Positive	• Smile / laugh	
		• Concentrating / attentive	
	Negative	• Bored	
		• Distracted	
COMMENTS	Positive	• Discussion of game elements	
		• Discussion of user's motions	
		• Assertion of joy (time	
		• Assertion of learning (score)	
	Negative	• Assertion of boredom	
		• Requests to stop the activity	
IN-GAME BEHAVIOUR	Positive	• Staying on task	
		• Finishing each level	
		• Following instruction	
	Negative	• Spending too long time on a question	
		• Skipping tasks	
		• Ignoring tasks	

USABILITY TESTING

Sir, Madam,

All information collected is **confidential** and **only for research purposes**. Cooperation from Teachers is highly appreciated.

PART A: BACKGROUND STUDY

INSTRUCTIONS: Please tick □ in the space provided.

1. Gender Male □
   Female □

2. Name of the School you are teaching
   ____

PART B: USABILITY TESTING

Please read the statement and circle the number based on the indication below about how you would perceive each aspect.

Indication

1	2	3	4	5
Poor	Limited	Good	Very Good	Excellent

EFFECTIVENESS

The Kinect Math game can effectively get and retain the attention of players based on your observation.	1	2	3	4	5
The Kinect game is interactive and cane be played by children for sometimes without getting bored or distracted	1	2	3	4	5
The game is matched with the school syllabuses for mathematics	1	2	3	4	5
Does the game help to learn maths better?	1	2	3	4	5

USER FRIENDLINESS & EASE OF USE

The game design and game scenario are properly done and all the contents can be easily identified	1	2	3	4	5
Students with minimum training and briefing can play the game and explore easily	1	2	3	4	5
The text, colours and images used are clear and nicely selected	1	2	3	4	5

The type of the motion designed is easy to follow and use the motion to play?	1	2	3	4	5
It's easy to start the game, interact with it and continue playing	1	2	3	4	5
Players can get stuck while trying to perform an action in the game	1	2	3	4	5

OTHERS

Which part you like the most from this game? Please specify:
Are there any weaknesses in this game? Please specify:

PHYSICAL ACTIVITY ENJOYMENT SCALE (PACES)

Please tick the right answer (respective teacher fill-up for their students)

	YES	NO
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