IMPACT OF GAMIFICATION IN STAMMERING CHILDREN'S HEALTHCARE

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Abstract

Stammering is a speech disability that makes it difficult to communicate. It is a neurological disease that cannot be cured, but it can be controlled by using a variety of approaches and practices regularly. Video games have grown in popularity in recent years as a great source of education, information, and entertainment. Health games have grown in popularity as a means of preparing them to deal with diseases. The framework of a video game for children who stammer is presented in this study. The online prototyping tool "Figma" will be used to create a working prototype of the game. The game's main page will include buttons for Tips, Play, and Progress. The tips button will give the user instructions on how to control his stammer through a variety of self-training methods. The play button, will have four game levels: level 1: Speak One Word Only, level 2: Speak Multiple Words, level 3: Speak a Sentence, and level 4: Go with Flow. The progress button will show the time that a user consumed playing the game and the score of the user. These levels will train the user to speak fluently by progressing from uttering a single word to multiple words to a complete sentence.

Keywords: Health Awareness, Video Games, Child Health, Stammering Children.

1. INTRODUCTION

Sports including games have been very essential in learning among children since the start of the time. Play enables children to learn ethics, social norms, behavioral skills, physical skills, health benefits, and many others [1]. Some children suffer from chronic diseases which may affect their social, emotional, and physical capabilities. These chronic diseases require an intensive care routine for the children. Games can be helpful for children to achieve health awareness while having fun [2].

With the overwhelming use of technology, games have transferred from physical games to video games. Multimedia video games are very popular among children because of their interfaces and content [3]. According to a survey conducted by two thousand people including children and teenagers (8 years to 18 years), most of them spent 7 hours and 38 minutes of their time in playing video games daily [4].

Multimedia devices play a very important role in the motivation, enhancing imagination, and learning of children. Such games have the same impact as computer-assisted instructions to train children about multiple aspects of their lives [5].

Nowadays, children spend hours on mobile devices playing video games that can be utilized as a means of raising awareness of healthcare problems among children. Healthcare games are very popular in STEM games to teach children daily life practices to maintain their health. Moreover, mobile games may provide medical solutions digitally for the physical, mental, and rehabilitation of children [6].

1.1. Games Promote Health Education

Some games are developed to maximize education, and programs like Cogmed have proven to enhance cognitive abilities in child cancer survivors [7]. Playing games may promote adherence to the essential therapy processes because they seem interesting and motivating. As a result, video games can be a useful supplement to conventional therapies. The game Re-Mission has been the first to demonstrate improved treatment compliance through the use of video games [8].

1.2. Gaming Impacts on Children's Progress

Games can have an impact on child's social, emotional, and cognitive development. Today's games use an immersive social backdrop to assist players learn social skills and pro-social behavior quickly [9]. Indeed, playing a pro-social game has been found to improve, collaboration, empathy, and emotional awareness with time. Individuals who had participated in a cooperative game demonstrated more pro-social behavior in a dilemma task than those who had participated in a competitive game, implying that these behaviors could be transmitted to their social and family connections outside of the game world. Playing video games has been shown to alter both positive and negative emotion processing [10]. Video games, like ordinary ground games, may be realistic enough to make goal attainment meaningful, while also being safe enough to exercise skills for controlling or modulating unpleasant emotions to reach those goals. Even though there are reasons for believing that gaming can benefit a person's development and peer connection, little has been recognized about gaming's long-term effect on feelings and emotions [11]. Several studies, for example, have found that people's moods improve after they play games. Playing video games can improve problem-solving skills and creativity, as well as improve focus and spatial skills. A recent study on the effects of video games found that they have a favorable impact on intellectual functioning, reading, math, spelling, and academic accomplishment [12]. Not only stammering related problems, some of other psychological and personality deficits are also likely to improve through video gaming as show in figure 1 below.

Figure 1 Benefits of Playing Video Games for Children

1.3. Stammering Children

The phenomenon of stammering occurs when the flow of speech is disturbed. It's a neurological disorder that makes talking a challenge. It usually begins in childhood and would last the rest of a human life. It is defined by certain types of interruptions or transformation functions in the generation of phonetics that occur regularly and affect communication. More than 80 million people struggle with their speech. These, on the other hand, are relatively infrequent and do not pose miner problem [13].

Getting old with a stammer, expecting the times when you'll need to speak, the unpleasant reactions, and the constant expectation that you'll need to be fixed or that you'll need to take deep breaths. Humiliation, disgust, anger, nervousness, and panic are all common negative emotions. anxiety— just one thing that almost all stammered children find difficult to speak — will interfere negatively in every interaction. Even not being treated seriously is a source of discomfort. For several individuals who stammer, the experience of having a stammer is the most important element of the situation, and many people switch terms, prevent confrontation, and keep quiet so that others are unaware that they stammer [14].

1.3.1. Challenges of Stammering Children

When a youngster stammers, he or she will repeat, expand, or become stuck on certain sounds or sentences. As the person tries to spread the message, there may be evident indicators of tension. Here are some more facts about stammering:

- Sounds, portions of words, and complete words are all repeated.
- Speech sounds are stretched or lengthened.

- If you're having trouble getting words out, it's because you're blocked. This is when the mouth is positioned to make a sound for a few seconds before making the sound. After some effort, the person might be able to finish the term.

- Stopping over long periods.

- Frustration stems from the fact that speech requires a significant amount of effort.

1.3.2. Measures for Reducing Stammering among Children

Stammering cannot be cured but it can be reduced by practicing and avoiding difficult situations. These concerns can be managed by reassuring the youngster and employing the strategies listed below:

- Allow time for the youngster to consider whatever they want to say.

- Know and understand that they have lots of "airspace" to say whatever they want.

- Slow down your speech when speaking to the child.

- Resist making remarks about the stammer or drawing attention to it.

- Consider encouraging your child to 'think about what you want to say or to stop, slow down, or think about it.

- Just before speaking with a child, get down on their level to show that you are interested in what they have to say.

- Whenever a child speaks fluently, compliment them.

- Breathing techniques, allow you to produce sounds more slowly and with less anxiety.

- Communicating with the youngster to relieve any fear or tension that may be related to the stutter.

- Examining and assessing the child's communication strengths and deficits in all domains, particularly playing and communication skills, concentration, hearing, comprehending vocabulary, utilizing vocabulary, interpersonal interactions, and talking [15].

1.4. Human-Computer Interaction (HCI) and Computer games

Human-computer interaction (HCI) is the study of how humans and computers communicate with one another. The scope of HCI has expanded to include social, organizational, and cognitive aspects linked to computer use because of the increased interaction of computers in businesses and homes [49]. HCI can aid in the prediction of children's behavior as well as their social-cognitive development. Moreover, improving technology in virtual simulation offers an opportunity to create games that will enhance children's organizational skills. Children are also able to develop other skills through video

games like problem-solving and reasoning. The more they fail to complete a task in the game, the more they repeat it to succeed [16].

Children's behavior toward games has shifted dramatically as a result of modern technologies. By the age of 21, the average 8-14-year child has spent more than one hour each day playing video games, accumulating at least 10,000 hours of play. Computer games that have been utilized for purposes other than enjoyment are known as applied games [17]. They have enormous promise for training and teaching new ways of thinking and doing, as well as addressing specific behavioral domains. Indeed, applied games have been shown to effectively reduce anxiety and depression symptoms in teenagers in recent research [18].
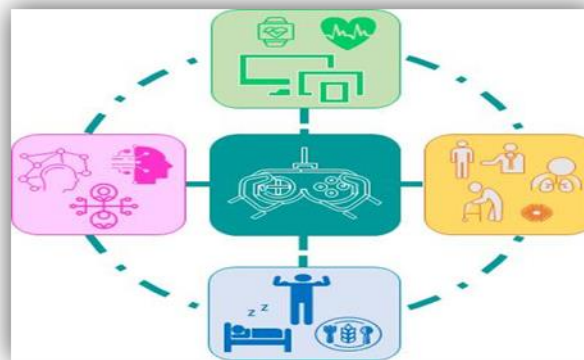

Figure 2 HCI Computer Games for Health Awareness

The figure 2 illustrates that HCI involves multiple domains of human life including social, organizational and cognitive and can be beneficial in developing behavior patterns, social-cognitive, and problem-solving skills among children.

1.5. Problem Statement

Stammering is a condition in which children cannot speak fluently. In this condition, children might be stuck on one word and repeat the word for prolonging. This makes their self-confidence low while also hesitating to speak in public. This condition is linked with neurological problems; when stammered children have an easy and comfortable environment, they might be less stuttered and stammered. While in a crowd and public speaking and conversations they easily lose their confidence. For those children, educational courses are available on the internet. Available courses might bore the children due to their length of period and visual effects. Although, short-timed video games might be helpful to gain children's interest and improve their speech fluency and enhance their confidence.

In the time of modern technology, human health is important in the development of the country. Technology will never disappoint you to get benefits. A prototype-based video game has been developed by the researcher for special and stammered children to

overcome this condition. As there is not much data and information available on the internet. This study will help to minimize the stammering problems in the affected children through the assessment of the topic.

1.6. Research Challenges

- Although several applications and games have been made for stammering children, there is not sufficient research work in this domain.

- Several applications and games have been made for stammering children, but there is still a need for an interesting game-based solution for speech fluency in stammering children to overcome stammering and live a healthy life.

- Applications that have been developed for stammering children are not significant sufficient for the stammering children as most of those applications are learning courses rather than video games.

- Children usually do not take interest in course-based learning applications. The game-based application is more attractive to children.

- It was not easy to find stammering children easily to carry out the research

- The study consists of five sections i.e., (i) Background of the Study, (ii) Methodology, (iii) Experimentation, (iv) Results and Discussion, and (v) Conclusion.

2. RELATED WORK

Health awareness in children using video games is a widespread field. Learning a healthy lifestyle through playing is very attractive for children. They don't only enjoy playing video games but also learn healthy habits through them. Numerous researchers developed multiple video games in this domain.

Talbot in his study argued that mobile games and technology are very helpful in monitoring the real-time diabetes of children as well as beneficial in regulating the eating behavior of kids. He further explained that glucose meters and insulin pumps are not easy to carry everywhere every time and they didn't have attractive interfaces. Rather, mobile games are attractive for kids, and sensors in the mobile games can track the children anywhere anytime, and can update their physicians. The final results showed that mobile games are more effective than traditional medical instruments to monitor diabetic children in real time and raise awareness among them regarding diabetes [19].

Lamboglia et al. reviewed the previous research work in the domain of video games and physical activities. The purpose of this systematic review was to investigate how gaming can be used as a key strategy in the fight against childhood overweight as well as obesity. Knowledge was obtained from multiple database systems in English and French, using the search terms "*e-games*," "*exergames*," "*exergaming*," "*new generation of video games*," "*active video games*," "*energy expenditure*," "*body composition*," and "*physical activity*." The inclusion criteria were met by nine articles. Exergaming has been shown to

continue increasing activity levels, energy expended, maximum possible oxygen uptake, heartbeat, and the ratio of physical exercise participation, as well as to decrease waist size and physically inactive screen time [20].

Andreea Molnar and Patty Kostkova collaborated on instructional Digital Narrative games. The framework was a user-centered evaluation; an evaluation was designed to examine the understanding of improved performance concerning Learning Objectives. This resulted in positive effects on the game perceived by the majority of players. This method of evaluation satisfied 94 percent of the participants. This was proven statistically significant for knowledge improvements of the game [21].

Herbert F. Rodrigues and Ana Maria G. Valença developed a serious oral hygiene game Touch Brush to integrate multiple oral hygiene games through haptic systems. For the development of the game process model "*Serious Game Unified Process*" was adapted which was presented by Rodrigues. The process model was based on the computational aspects of the game and the contents of the game and integrated multiple areas of different games. The game was developed using the Adobe Flash platform and was compatible with Windows, Linux, Android, and IOS operating systems. Moreover, the game resulted in more usable and effective than in previous versions [22].

I.H. Pouw developed a game for monitoring and guiding diabetic children regarding carbohydrate intake. Firstly, an online survey was made to check the prior knowledge about carbohydrates. School children have been chosen for pretesting to assess the game's efficiency. Afterward, the real test was examined through diabetic children. They completed a written test both during gameplay and after playing the game. The game's efficiency and entertainment value were demonstrated [23].

Andreea Molnar and Patty Kostkova in their work presented a mobile game "*MicrobeQuest*", aimed to aware children between the age of 9-12-year-old of microbiology which included antibiotic use and hand hygiene. The main challenge of their application was to transfer the desktop version into the mobile app. The assessment was also made on the education evaluation basis and the impacts of the game [24].

Nilufar Baghaei et al. worked on developing a diabetes awareness game Diabetic Mario Bros for engaging diabetic children in a healthy lifestyle. The developed game was android based. The efficiency of the game was assessed using the heuristic method, which included the use of four heuristics. The game proved effective and usable [25].

Dias et al. reviewed the literature to examine the efficiency of video games for obese children. The studies were gathered from various database systems. The characteristics were computer games and being overweight, with the key phrase being game design. Criteria for inclusion included studies classified as Randomized Clinical Trials written in English, Spanish, or French and involving children as subjects. In the initial search, 2,722 studies have been found, with six remaining in the final sample. The papers emphasized encouraging behavioral changes in players, such as increased physical activity and better eating habits. According to the studies, games are indeed a promising option for promoting positive people coping with child obesity [26].

Hidde van der Meulen et al. mentioned their continued development of the design and assessment of Pesky gNATs, a Cognitive behavioral therapy computer game, in their study. Furthermore, concepts were used to explain complicated concepts such as negative automatic thoughts (NAT) and basic assumptions: prickling living beings identified as Pesky gNATs affected a child's patterns of thinking. Pesky gNATs was a 3D game that used the same analogies as before. The game was developed to use something during the treatment program. The children in the study ranged in age from 9 to 17 years. The game was both appealing and usable [27].

Fátima Gonçalves et al. developed a game "*Barty*" for fat children to learn to adopt a healthy lifestyle by playing the game. In addition, it also facilitated the caregivers to keep in touch with the progress of the child and use multiple tools to help him adopt a healthy lifestyle. The game was android based and the information of users was kept in an internal database using SQL lite. The children aged between 3 years to 6 years, and their caregivers or parents were chosen as the sample. The results proved the game usable and effective [28].

Del Río et al. based on the video game investments and motor games, PROVITAO created a game-based educational program for healthy behaviors. The developed program consisted of an activity plan for developing healthy habits. During the education year, PROVITAO was used on 45 kids with childhood obesity and their caretakers in two stages. The study's design included two control groups (GC) and two experimental groups (EG) (GE). The project developed and evaluated a framework for psychological involvement, able to monitor and examine, health sciences, collaborative, cultural, emotional, and instructional, based on games, for the treatment of obese children using various innovative products (exergames, serious games, web applications, sensors, wearable devices, and so on). The game proved effective and usable [29].

With the use of Filipino Sign Language, Mary Jane C. Samonte et al. detailed the construction of a Game-based E-Tutor System that used voice recognition to teach Mathematics to senior high school students with a stammer (FSL). The stated elements were added to the system to boost students' learning and enhance speech therapy. Data on gaming features may be collected using this E-Learning system to assist to discover the most successful learning components for students with speech impairment [30].

Lisa Afonso et al. developed an Android-based application Fammeal for kids aged between 3 years to 6 years and their caregivers for promoting healthy eating habits. They presented a framework to aid in the management and cure of children in healthcare facilities. The development was based on a creative platform when tried to compare to someone else because a) it guided both caregivers and children and tended to involve them via customizing and gaming techniques; b) it was intended to prevent or assist the care of OB by trying to promote guardians' abilities to alter the way of life, and c) it was designed for use in medical centers. The game has proven usable and effective [31].

Emanuel Rodrigues Morais et al. in their work focused on oral hygiene education through games and application. In this review paper, 12 articles were selected and 11 games on

oral hygiene were chosen. The total number of applications 284 was determined with the dental activities (tooth pain, tooth cavity, and dental office). In their work, a search was made on the website that is IEEE Xplore. This paper resulted in exploring new technological resources for children's oral care through educational activities. 87% of the mothers learned new knowledge about oral care for their babies through a presented game "*An Adventure in the Toothland Forest*" based on the Communicative Approach. This research proved to be an effective learning method when combined with the educational approach by improving the children's knowledge regarding oral care [32].

Alaa Mohammed Moosa et al. developed a game named Qatar Diabetes Game, for children who were suffering from diabetes. The purpose of the game was to educate the children about their disease and made them understand the disease. Children learned more about the disease by spending more time on the game and adopting a healthy lifestyle by avoiding unhealthy food. The framework was based on the arcade technique which enhanced the knowledge of children gradually. The design of the game kept user-centered. MEEGA+ was used to evaluate the effectiveness of the game which resulted in a more usable game than the DEX diabetic game [33].

Oladapo Oyebode et al. presented the structure and progression of TreeCare, a video game for a healthy lifestyle. The strategy was based on the tree analogy, which connected a person's level of activity to the nutrition of a tree. As a result, as the participant became more active and fit, the tree's health also improved. To increase player inspiration and provide an amazing experience, the game utilized multiple strategies based on the Persuasive Systems Design (PSD) framework. The Unity Approach and Android Studio development tools were used to create the game. Nonetheless, future versions of TreeCare will support the iOS platform as well. The game proved to be enjoyable and usable [34].

Oana A. David and others developed a game REThink which worked as a mental therapy game for fighting against negative emotions such as anxiety, anger, etc. The game was created for children between the ages of 10 to 16 years old. The research examined the effectiveness and satisfaction level of the game. The results showed that REThink was highly satisfactory for the user and could reduce the mental disorder in children and adults aged between 10 to 16 years. The model used for the scenarios of the game was REBT and the device used by the selected sample to play the game was Apple iPad version air 2 [35].

Ju-Hui Wu et al. worked on examining the effectiveness of a serious game Virtual Dental Clinic (VDS) through three steps process including the development of the game, verification of the game, as well as game implementation. To determine the effectiveness of the game, both qualitative and quantitative analyses were performed. The testing sample consisted of 92 persons including clerkship students. The game was developed using Unity Game Engine and was proved effective [36].

In their study, Shereen Wong et al. looked into the use of game-based learning in the instruction and acquisition of English-speaking ability. To improve the local students'

English fluency and courage, task-engaging presentations were used. This technology supported the Communicative Approach by allowing learners to perform speaking in a practical situation while the game-based features improved their problem-solving abilities. It was quite useful and cost-effective because it was created entirely with *PowerPoint* slides. It has also been shown to improve students' linguistic abilities by increasing their interest and participation in class, as well as encouraging them to think creatively and critically [37].

Ertas et al. investigated the efficacy of the "*Enriched Stuttering Intervention Program*" (ESIP) on young kids with stammering issues in their study. We looked at the occurrence of stammer, the length of stammering, stammer-related activities, or whether there was a notable change in the effortlessness of speech. A semi-experimental design was adopted in the study. The study included five boys who were enrolled in a Special Education and Rehab Center in 2019-2020 and were identified with stammering by a child psychologist. The researcher developed data forms that were filled out by the parents, the instructor, as well as the student to obtain this information about the individuals. The Stuttering Severity Instrument (SSI-4) tool was used to collect the experimental data. When pre-test and post-test data from the five children were compared, there had been a statistically meaningful variation in the extent of stuttering. These children were helped to stop stuttering by the Enhanced Stammering Treatment Program [38].

Mario Ganzeboom et al. investigated the effects of game-based speech training that provided fully automated comments on sound intensity, pitch, and vocabulary in language skills in this study. Eight persons with dysphonia communicators with Parkinson's disease (PD) managed to complete a 4-week game-based acceptance speech training course in their residences. Each speaker had 24 speech statements audio captured 4 weeks before (Phase 1), instantly before (Phase 2), and instantly after (Phase 3) the training. All particular provided speech samples were managed to score on speech quality by ten unskilled listeners by trying to compare them to the corresponding statements made by a healthy speaker. To investigate changes with time, a finite mixture assessment was used. To evaluate health pleasure with the game and the fully automated feedback, a set of questions was used. In four imaginary situations with different levels of speech and language development, clients' priorities were collected using a coupled comparisons strategy, in which they have been questioned as to if they liked game-based or face-to-face speech therapy. Patients gave the game a rating of 7 or higher on a 10-point scale, indicating that they enjoyed it [39]. Table 1 below has compared the used technologies and addressed health areas in the above-mentioned papers.

Table 1: Comparison of Technologies, Parameters Achieved, and Health Issues

Sr #	Authors	Title	Technology Used	Parameters Achieved	Addressed Health Area
1	Soler et al. (2009)	Molarcropolis: a mobile persuasive game to raise oral health and dental hygiene awareness	Flash CS3 and Action Script 3	Usability (88%)	Oral Care
2	Farrell et al. (2011)	Computer games to teach hygiene: an evaluation of the e-Bug junior game	Android Studio	Usability (8.2%)	Hygiene
3	Molnar & Kostkova (2013)	Seamless Evaluation Integration into IDS Educational Games	IDS game	Effectiveness (94%)	Mental Health
4	Rodrigues et al. (2014)	Applying Haptic Systems in Serious Games: A Game for Adult's Oral Hygiene Education.	Adobe Flash, CyberMed Framework	Satisfaction (98%) Effectiveness (96%)	Oral Hygiene
5	Molnar & Kostkova (2015)	Mind the Gap: From Desktop to App	Android Studio	Satisfaction (97%)	Hygiene
6	Pouw (2015)	You are what you eat: Serious gaming for type 1 diabetic persons	Android Studio	Effectiveness (80%)	Diabetes
7	Molnar & Kostkova, (2016)	Interactive Digital Storytelling-Based Educational Games: Formalise, Author, Play, Educate and Enjoy! - The Edugames4all Project Framework	IDS Game	Effectiveness (66.78%)	Mental Health
8	Baghaei et al. (2016)	Diabetic Mario: Designing and Evaluating Mobile Games for Diabetes Education	Android Studio	Effectiveness (66%), Efficiency (83%), Satisfaction (75%)	Diabetes
9	Van Der Meulen et al. (2018)	Including End-Users in Evaluating and Designing a Game that Supports Child Mental Health	Android Studio	Satisfaction (87%)	Mental Health
10	Andreea Molnar and Patty Kostkova (2018)	Learning about Hygiene and Antibiotic Resistance through Mobile Games	Android Studio	Usability (95%)	Hygiene
11	Del Rio et al. (2018)	Gamified educational program for childhood obesity	Android Studio	Effectiveness (87.5%)	Obesity

12	Thomas Bailey et al. (2019)	FoodKnight: A mobile educational game and analyses of obesity awareness in children	Android Studio, Unity, Bitnam Parse API	Satisfaction (100%)	Obesity
13	Afonso et al. (2020)	Fammeal: A Gamified Mobile Application for Parents and Children to Help Healthcare Centers Treat Childhood Obesity	Android Studio	Effectiveness (70%), Usability (71.4%)	Obesity
14	Alaa Mohammed Moosa et al. (2020)	Designing a Mobile Serious Game for Raising Awareness of Diabetic Children	Arcade Technology	Satisfaction (95%)	Diabetes
15	Oyebode et al. 2020)	Nourish Your Tree! Developing a Persuasive Exergame for Promoting Physical Activity Among Adults	Android Studio and Unity Game Engine	Effectiveness, Usability (87%)	Physical Activity
16	Oana A. David et al. (2021)	Effectiveness of the REThink therapeutic online video game in promoting mental health in children and adolescents	Android Studio	Effectiveness, Satisfaction (100%)	Mental Health Therapy
17	Wu et al. (2021)	Development and questionnaire-based evaluation of virtual dental clinic: a serious game for training dental students	Unity Game Engine	Correctness (100%), Usability (78.6%)	Oral Care
18	Shereen Wong et al. (2021)	Speak up, Mr. Pirate! An interactive game-based learning experience to enhance rural pupils' confidence and fluency in speaking English	PowerPoint Slides	Usability (96%)	Stammering
19	Ertas et al. (2022)	Effectiveness of the Enriched Stuttering Intervention Program Used in Stuttering Children	Semi-experimental design SSI-4 Tool	Effectiveness, Usability	Stammering
20	Mario Ganzeboom et al. (2022)	A serious game for speech training in dysarthric speakers with Parkinson's disease: Exploring therapeutic efficacy and patient satisfaction	Voice and speech recognition, Questionnaires	Satisfaction (75%)	Stammering

3. METHODOLOGY

This research is conducted on stammering children to improve their speech fluency. An interesting video game prototype has been developed by the researcher by taking into view the children's interests. This prototype is developed through the data collected from the survey questionnaire, face-to-face interviews with the special or stammering children, and field visits.

3.1. Proposed UCD Model

- **Research**: In the first phase, research has been made on the previous studies in the domain of health awareness among children through video games. Moreover, previous research in the domain of the impact of video games on stammering children was done. Numerous methodologies and design ideas were explored to design the prototype.

- **Scope**: In this phase, the context of the use of the developed game was examined. The scoping phase proved that the "*Stammerland*" would be beneficial in making stammering children speech proficient. Moreover, children would be able to learn and play together.

- **Analyze**: This phase analyzed user requirements and examined whether those requirements are feasible acceptable and affordable or not. The need for the proposed video game for stammering children was also analyzed in this phase.

- **Design**: In the design phase, all possible designs were carried out, and the best suitable design for the "*Stammerland*" was chosen.

- **Prototype**: In this phase, the working prototype of the "*Stammerland*" was developed by using the "Figma" prototyping tool. The developed prototype was then evaluated to eliminate possible errors in the prototype.

- **Delivery**: At the final stage, the developed prototype of "*Stammerland*" was delivered the conceptual design of the "ToothPower" is based on user-centric design. It is comprised of multiple phases, which are mentioned in figure 3 below.

The figure 3 demonstrates the UCD model of "*Stammerland*" consisting on six phases: research in the specified domain, scope of the *stammerland* game in child's healthcare, analysis of the requirements, developing all possible designs of the prototype, developing the prototype, and delivering the prototype.
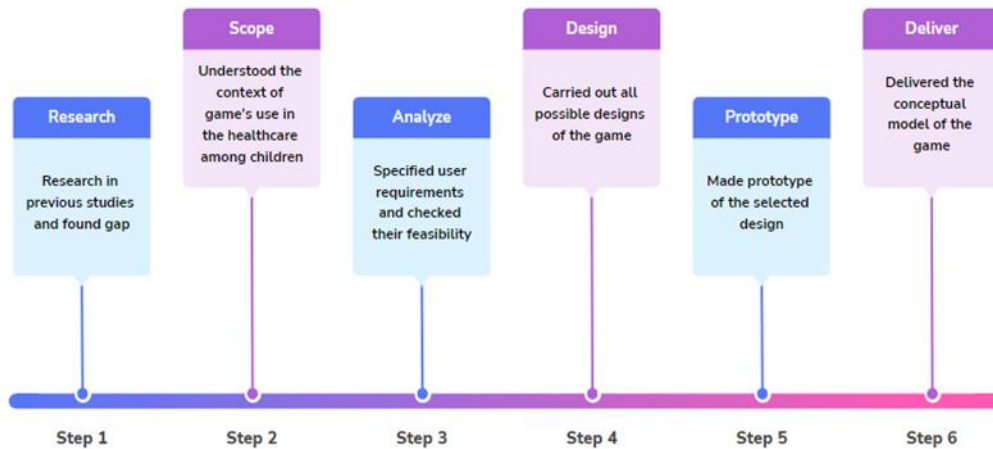
Figure 3: UCD Model of Stammerland

4. EXPERIMENTATION

A prototype is developed in this experimental study to evaluate the usability parameter like its effectiveness, efficiency, and level of satisfaction. In this research work, the prototype was specially designed for stammering children for better speech fluency. This prototype is based on the User Centric Design (UCD) model to fulfill the user's requirements and desired needs. First of all, a welcome page was developed to start the gaming prototype which directs to the main page of the prototype showing its user login area and main components of the prototype.

The below picture, is the main page of the prototype which contains a welcome message and a start button to start the game. The child will click on the start button which will direct it to the starting screen of the game.

Figure 4: Welcome Page of Prototype

The welcome page of the game contains an area for the user log in or register. If a child will already be registered in the game, he will simply log in to his account to save his progress. Otherwise, he will register himself and set a new password and then start

playing the game. The welcome page contains three basic modules including tips, play, and progress.

Figure 5: The main page containing the user sign-up area and three main elements "Tips", "Play", and "Progress"

The three basic pillars have been given in this prototype for the ease of children i.e., tips, level, and progress.

I. Several helpful tips have been given in this prototype for the awareness of children to overcome a stammering problem. By learning and practicing these tips, stammering children can overcome their stammering and enhance their speech fluency.

II. Multiple levels have been developed containing lower level (single word; for instance, crime, acne, lantern) to moderate level (containing two or three words; for instance, ringing bells and thick & thin) to higher level (a short sentence; for instance, mom makes apple pie) to improve the speech fluency. In the final level, short paragraphs have been added to improve the speech fluency of stammering children and were highly helpful to build confidence of stammering children.

The following picture shows the four levels of the game which are developed from easier to expert levels to enhance the learning process to overcome the stammering among children.
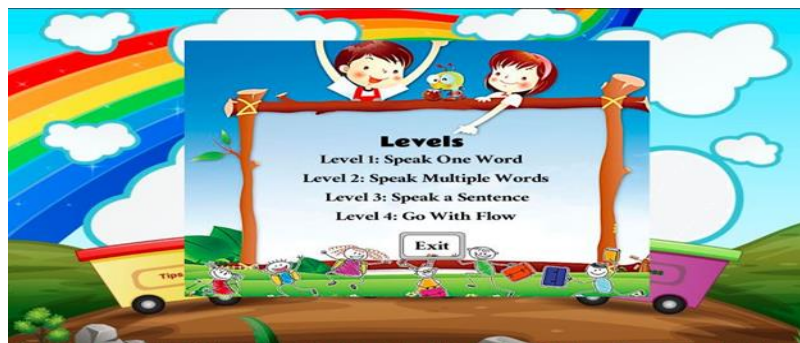

Figure 6: Levels of the Game

III. The progress portion shows the children's achieved scores and the time taken by the child.

Figure 7: User's Progress Screen

The progress screen will show the time consumption and score earned by the player.

4.1. Sample Collection

Several 90 samples were collected from the mayo hospital Lahore during the research period. 90 samples were performed by two genders i.e. 45 were performed by girls and 45 samples were performed by boys. This was performed on the base of gender and age groups; different age groups participated. The first group has an age limit of 5 years to 8 years, the second group with an age limit of 9 years to 12year and the third group of age 13year to 15 years. After categorization, the specially designed prototype has given to the stammered children according to their age group and gender to perform multiple tasks, and performance was noted. Given tasks are given below:

4.1.1. Task

A total of nine tasks were given in the prototype through which results were obtained (based on the performance of the children) and examined for usability evaluation. The tasks were performed according to the age groups which are shown in the table below:

Table 2: Tasks assigned to the every group age-wise and gender-wise

Participants	Gender	Age	Task 1	Task 2	Task 3	Post Evaluation
15	M	5-8	Ask children to start the game and observe if are they Interested in the game	Ask children to identify the pictures that are used in the tips and ask them to practice at least 2 tips	Ask children to start level 1 and speak 10 words of level 1	ASQ
15	F	5-8	Ask children to start the game and observe if are they Interested in the game	Ask children to identify the pictures that are used in the tips and ask them to practice at least 2 tips	Ask children to start level 1 and speak 10 words of level 1	ASQ
15	M	9-12	Open the game, enter the username & password, and observe are Interested in the game	Ask children to identify the pictures that are used in the tips and ask them to practice at least 4 tips	Ask children to play levels 1 and 2 by applying learned tips	ASQ
15	F	9-12	Open the game, enter the username & password, and observe are Interested in the game	Ask children to identify the pictures that are used in the tips and ask them to practice at least 4 tips	Ask children to play levels 1 and 2 by applying learned tips	ASQ
15	M	13-16	Open the game, explore all the tabs, and observe the interest of children in the game	Ask children to identify the pictures that are used in the tips and ask them to practice all the tips	Ask children to speak 3 words of levels 1 and 2. Then, ask them to play levels 3 and 4 by applying learned tips	ASQ
15	F	13-16	Open the game, explore all the tabs, and observe the interest of children in the game	Ask children to identify the pictures that are used in the tips and ask them to practice all the tips	Ask children to speak 3 words of levels 1 and 2. Then, ask them to play levels 3 and 4 by applying learned tips	ASQ

5. RESULTS AND DISCUSSION

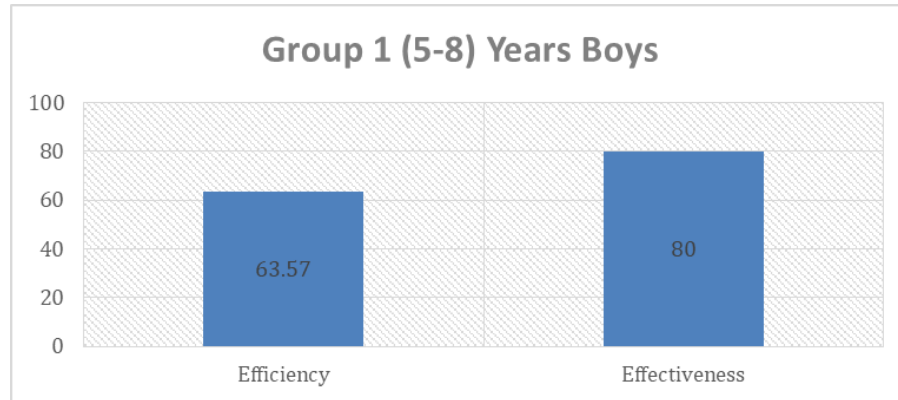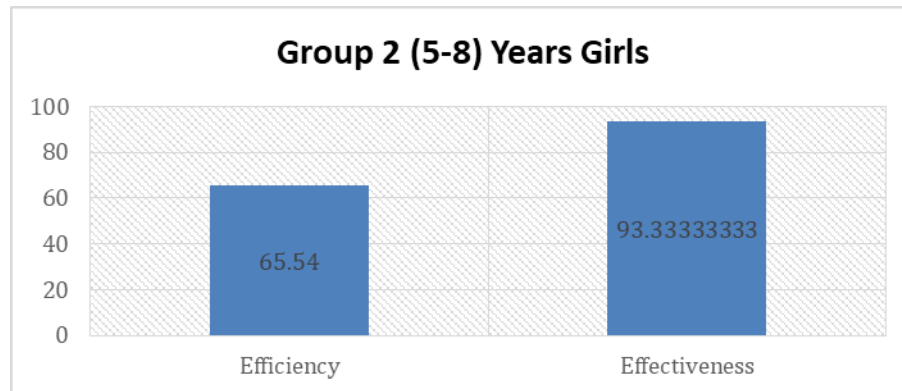### 5.1. Overall efficiency and effectiveness of tasks

Figure 8: Total Efficiency & Effectiveness of Group-1

The first sample group was aged between five years to eight years including fifteen boys. In the first task, children were asked to start the game. In the second task, children were asked to identify the picture that was used in the tips section. Afterward, they were asked to practice at least two tips. In the third task, children were asked to play level 1 of the game and speak at least ten words by applying learned tips. The total efficiency and effectiveness of group 1 are 63.57% and 80% respectively.

Figure 9: Total Efficiency & Effectiveness of Group-2

The second sample group was aged between five years to eight years including fifteen girls. In the first task, children were asked to start the game. In the second task, children were asked to identify the picture that was used in the tips section. Afterward, they were asked to practice at least two tips. In the third task, children were asked to play level 1 of the game and speak at least ten words by applying learned tips. The total efficiency and effectiveness of group 2 are 65.54% and 93.33% respectively.
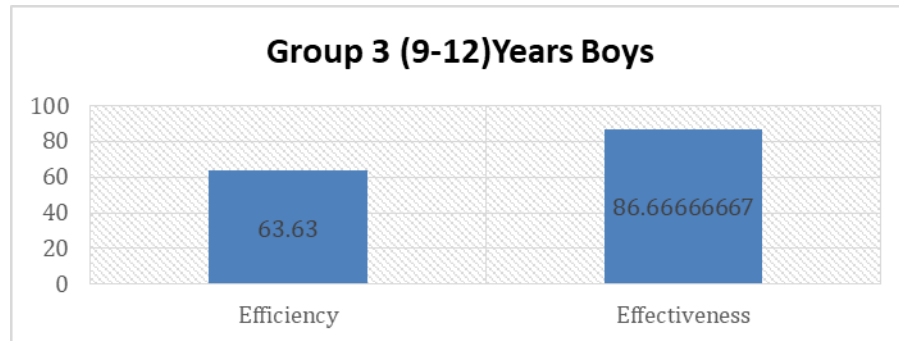
Figure 10: Total Efficiency & Effectiveness of Group-3

The third sample group was aged between nine years to twelve years including fifteen boys. In this first task, children were asked to start the game and enter their names and password to sign up as new users of the game. In the second task, children were asked to identify the pictures used in the tips section so that they can get the idea that the images were given to them. Afterward, they were asked to practice at least four tips to overcome stammering. In the third task, children were asked to level 1 and level 2 of the game by applying learned tips. The total efficiency and effectiveness of group 3 are 63.63% and 86.66% respectively.
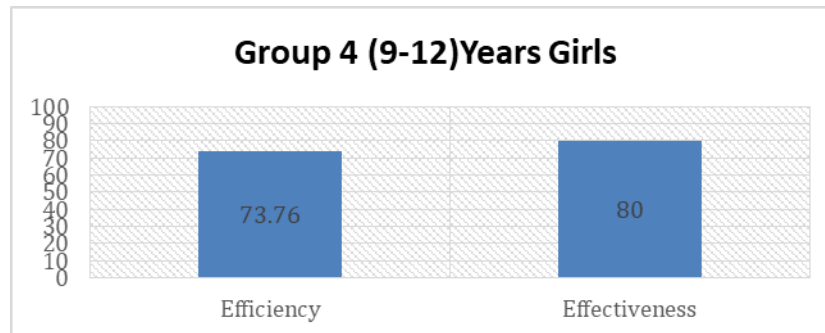

Figure 11: Total Efficiency & Effectiveness of Group-4

The fourth sample group was aged between nine years to twelve years including fifteen girls. In this first task, children were asked to start the game and enter their names and password to sign up as new users of the game. In the second task, children were asked to identify the pictures used in the tips section so that they can get the idea that the images were given to them. Afterward, they were asked to practice at least four tips to overcome stammering. In the third task, children were asked to level 1 and level 2 of the game by applying learned tips. The total efficiency and effectiveness of group 4 are 73.76% and 80% respectively.
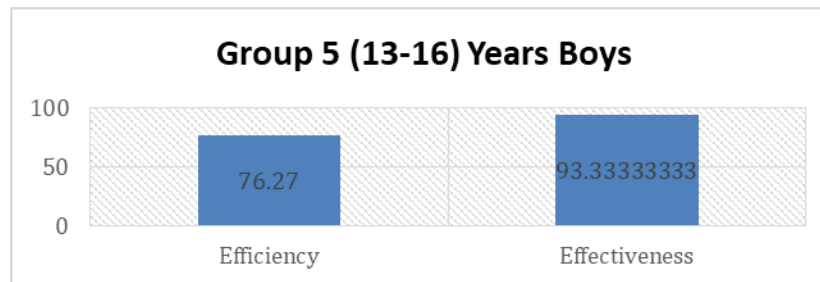
Figure 12: Total Efficiency & Effectiveness of Group-5

The fifth sample group was aged between thirteen years to sixteen years including fifteen boys. In the first task, children were asked to start the game, explore all of its tips, levels, and design tabs and buttons. In the second task, children were asked to explore and identify the picture in the tips section and interpret the message given by the images. Afterward, they were asked to practice all the tips one after another. In the third task, children were asked to speak three words from level 1 and three words from level 2 by applying the given tips. Then, they were asked to complete level 3 and level 4 using the tips given in the game to overcome stammering. The total efficiency and effectiveness of group 5 are 76.27% and 93.33% respectively.
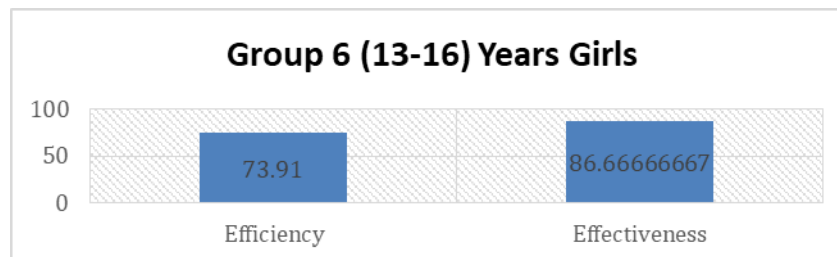

Figure 13: Total Efficiency & Effectiveness of Group-6

The sixth sample group was aged between thirteen to sixteen years including fifteen girls. In the first task, children were asked to start the game, explore all of its tips, levels, and design tabs and buttons. In the second task, children were asked to explore and identify the picture in the tips section and interpret the message given by the images. Afterward, they were asked to practice all the tips one after another. In the third task, children were asked to speak three words from level 1 and three words from level 2 by applying the given tips. Then, they were asked to complete level 3 and level 4 using the tips given in the game to overcome stammering. The total efficiency and effectiveness of group 6 are 73.91% and 86.66% respectively.

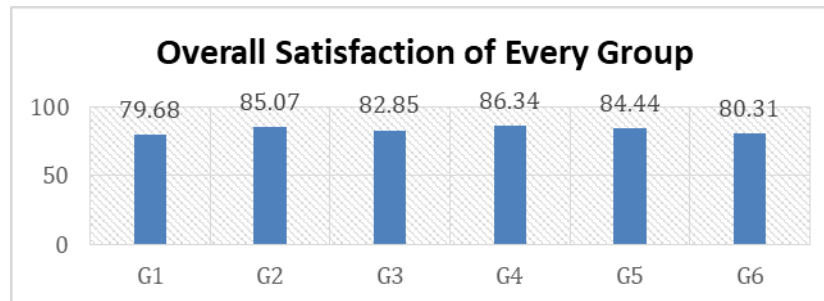## 5.2. Overall satisfaction of tasks group-wise

Figure 14: Satisfaction of All Groups

The satisfaction of the application was conducted through after-scenario questions against 1 to 7 scale values. The recorded satisfaction of each of the six groups was 79.68, 85.07, 82.85, 86.34, 84.44, and 80.31 respectively.

5.3. Overall efficiency and effectiveness of the application

Figure 15: Overall Efficiency, Effectiveness, and Satisfaction

The overall efficiency of the application was recorded as 83.28%, the effectiveness of the application was recorded as 86.67%, and satisfaction with the application was recorded as 83.11%.

6. CONCLUSION

Stammering is a speech related issue that usually starts in childhood and may last throughout an individual's life. To overcome this problem, this experimental study has provided the working prototype of a video game for children who stammer. The prototype is developed using the online prototyping program "*Figma*", include three main sections "*Tips, Play, and Progress*". The user could control his stammering speed using a range of self-training techniques by pressing the tips button. The play button had four different game modes for children so they can control their stammering gradually from one word to one sentence. The progress button showed the user's score and the amount of time they spent playing the game. The efficiency, efficacy, and satisfaction levels of the application have all been considered when determining its usability of the application. Three sample groups of children between the ages of 5-8, 9-12, and 13-16 were created and then split into two sub-groups of boys and girls. Results were obtained through site visits to the

hospitals' speech therapy departments. The application's overall effectiveness, efficiency, and satisfaction scores were 83.28%, 86.67%, and 83.11%, respectively.

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