STD PONG 2.0: AN AFRICAN-CENTRIC PERSUASIVE GAME FOR PROMOTING RISKY SEXUAL BEHAVIOUR CHANGE

by

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DEDICATION

To every young human trying hard to make an honest living.

"Keep hustling. One day, your perseverance would surely pave a path for you."

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ABSTRACT

This thesis presents the design, development, and field evaluation of a persuasive game for health titled *STD PONG 2.0*, aimed at promoting risky sexual behaviour change among African youths. The arcade-style game simulates various risky sexual behaviours that could lead to contracting STDs, their symptoms, how they are transmitted, and how to avoid them. It engages players in an interactive manner using persuasive strategies, with the aim of imparting knowledge and skills about safe sexual behaviours/practices, how to avoid risky sexual behaviours, and hence motivate desirable behaviour change. The game also uses the engaging concept of the popular ping-pong game, making them easy to learn and play, hence attractive to a wider audience.

The results of the field evaluation on 62 African youths showed that *STD PONG 2.0* was effective at motivating risky sexual behaviour change by promoting a positive *attitude, intention, and self-efficacy* against risky sexual behaviours. The game also led to a significant increase in the *knowledge* of the participants about sexually transmitted diseases. The results of the evaluation also showed that players had a positive experience from playing the game (play experience) and that they found the game really persuasive as shown by the overall persuasiveness measure.

LIST OF ABBREVIATIONS USED

ANOVA	Analysis of Variance
STDs	Sexually Transmitted Diseases
STD	Sexually Transmitted Disease
HIV	Human Immunodeficiency Virus
AIDS	Acquired Immune Deficiency Syndrome
STI	Sexually Transmitted Infection
R1	Research Question 1
R2	Research Question 2
R3	Research Question 3
R4	Research Question 4
R5	Research Question 5
R6	Research Question 6
STD PONG	The test version of STD PONG
STD PONG 2.0	The final deployed version of STD PONG
PSD Model	Persuasive System Design Model
IMI	Intrinsic Motivation Inventory
SD	Standard Deviation

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Finally, I thank the Almighty God making this dream a reality!

CHAPTER 1 INTRODUCTION

1.1 The Problem

According to *Centers for Disease Control and Prevention (CDC),* "there were nearly 2.3 million cases of chlamydia, gonorrhoea, and syphilis—200,000 more than in 2016, which was a record-breaking year in its own right" [82]. More than half of all people will have an STD/STI at some point in their lifetime [49]. A statistic by the World Health Organization in 2016, shows that more than one million sexually transmitted infections (STIs) are acquired every day worldwide [56]. The same study shows that each year, there are an estimated three hundred and fifty-seven million (3.57 million) new infections belonging to these four Sexual Transmitted Infections: Chlamydia, Gonorrhoea, Syphilis and Trichomoniasis [56]. This figure is even more alarming in the developing parts of the world. For instance, a recent report by the *Joint United Nations Programme on HIV and AIDS (UNAIDS)* shows that HIV and AIDS have almost become an epidemic in the Eastern and Southern Africa with 19.7 million people living with HIV, 61% adults and 51 children are currently on antiretroviral treatment. In 2016 only, there were 790,000 new infections [36]. A major reason behind the widespread of Sexually Transmitted Disease in Africa is the stigma surrounding sex and sexual behaviours. This makes sex education and its discussions unpopular and even considered as taboos in many African cultures. This is due to the sacredness of sex in most African cultures. In these cultures, sexual issues are regarded as a topic that should never be discussed in public. Most African cultures also regard sex as an activity that should only be practised by married individuals, thereby regarding premarital sexual activity as a taboo. These factors contribute to the discomfort of publicly addressing sexual issues. As a result of this, young adults secretly practice their sexual activity for fear of negative social judgement in their communities. This causes them to be very susceptible to making errors and indulging in risky sexual behaviours that can cause the spread of STDs.

1.2 Motivation

Despite this alarming spread of both STDs and HIV, the African continent has received the least attention from research. Most existing technological interventions targeted at STDs and HIV are focused on people from the western culture, hence may not be suitable for people from the African culture due to the uniqueness in their culture, religion, and other beliefs, especially when it has to do with acceptable sexual practices and approaches to avoiding risky behaviours. On the other hand, Africa has a high mobile phone penetration and adoption rate. More than half a billion people across Africa now subscribe to mobile services, with the number expected to grow to 725 million by 2020 [78]. For example, 90% of Nigerian adults own at least a mobile phone [35].

Digital Games have become one of the popular technological inventions in our society today, with an estimated number of over 2.5 billion gamers worldwide as of 2016 [1]. Aside from being a very common leisure-time activity, people have begun to design games for solving real-life problems in many domains including in the area of health and wellness. Similarly, research has shown that 99% of adolescent boys and 94% of adolescent girls, including all racial/ethnic groups, play video games regularly [50] and Africa is not an exception. There is an increasing number of games that are targeted at solving problems in many domains including healthy eating [68][66][73], sustainable environment [32][38][8][54], disease control [6][40][47][58][12], physical activity [45][31][19][17][24]. Therefore, is it possible to leverage the ubiquitousness of mobile phones among Africans to design games that can promote a change in the risky sexual behaviour among Africans in a fun and engaging way?

Persuasive games for health are designed as interventions with the primary purpose of changing a user's behaviour or attitude in an intended way [70]. Research has shown that persuasive games can be an effective tool for motivating desirable behaviour change [34][71][70][69]. Therefore, Persuasive Games could be an important tool for HIV and STD prevention. However, most existing persuasive games for health are not targeted at the African audience.

1.3 Solution

To bridge this gap, this research presents the design, development, field evaluation of a persuasive game for health aimed at promoting risky sexual behaviour change among African youths called *STD PONG 2.0*. The arcade-style game simulates various risky sexual behaviours that could lead to contracting STDs and their symptoms, how they are transmitted, and how to avoid them. It engages players in an interactive manner using various persuasive strategies, with the aim of imparting knowledge and skills about safe sexual behaviours/practices, how to avoid risky sexual behaviours, and hence motivating desirable risky sexual behaviour change. The game also uses the engaging concept of the popular ping-pong game, making them easy to learn and play, hence attractive to a wider audience. The underlying game storyline (narratives), the linguistic expressions, the characters, and other game elements were intentionally designed to reflect Africanness in collaboration with stakeholders from Africa. This makes it easy for the target audience to identify and relate with the game, hence increasing the potential of the game to persuade and motivate the desired risky sexual behaviour change.

1.4 Contributions

The thesis made two major contributions:

One, we successfully designed, developed, and deployed a persuasive game called *STD PONG 2.0* that aims to motivate change in risky sexual behaviours among African youths using the user-centred design approach.

Two, we conducted a field evaluation of *STD PONG 2.0* on 62 African youths. The results of the field evaluation showed that *STD PONG 2.0* was effective with respect to promoting positive changes in the *attitude, intention* and *self-efficacy* of participants towards risky sexual behaviours. *Attitude, intention* and *self-efficacy* are the three direct predictors of behaviour [4]. The game also led to a significant increase in *knowledge* about sexually transmitted diseases, how to avoid them, their symptoms, and how they are transmitted. The results of the evaluation also showed that players had a positive experience from playing the game (*play experience*) and that they found the game really persuasive as shown by the overall *persuasiveness* measure.

1.5 Overview of Thesis

This thesis contains a detailed description of all the work carried out during the design, development and field evaluation of the STD *PONG 2.0* intervention, in a sequence of 5 chapters.

CHAPTER 1 INTRODUCTION: This chapter introduces the thesis. It states the problem and the issues surrounding the problem addressed in the thesis.

CHAPTER 2 RESEARCH BACKGROUND: This chapter contains a review of research related to this thesis. It presents a review of 51 persuasive games, over the span of 17 years (2001-2018) and classifies them into 6 sub-domains: *Healthy Nutrition, Physical activity, Dental, Disease Prevention, Sustainable Development and Miscellaneous*. It also presents an analysis of these games by their platforms, year, country of research and their study details. We conclude the chapter with a review of work done in the field of persuasive games for risky sexual behaviour change.

CHAPTER 3 STD PONG 2.0 DESIGN AND IMPLEMENTATION: This chapter describes the steps taken in the design and development of *STD PONG 2.0*. From the early development process as proposed by Fogg [29], to the actual design and development of the game. We also present an analysis of the Persuasive Systems Design Model strategies employed in *STD PONG 2.0*'s design.

CHAPTER 4 STD PONG 2.0 PERSUASIVE GAME EVALUATION: This chapter contains details about the field evaluation of *STD PONG 2.0*. It also presents the primary research question, secondary research questions and the detailed user study process.

CHAPTER 5 STUDY RESULTS: This chapter presents detailed data analysis and results. It concludes with a discussion on the results presented.

CHAPTER 6 CONCLUSION: This chapter summarizes the entire work and presents future research directions.

CHAPTER 2 RESEARCH BACKGROUND

Persuasive systems are "*computerized software or information systems designed to reinforce, change or shape attitudes or behaviours or both without using coercion or deception*" [63]. Persuasive systems are "*systems that motivate people to change their behaviours or attitudes, without using coercion or deception*" [28]. Persuasive systems come in various forms. They could be websites, standalone systems, virtual reality systems, or games. In recent times, because of the ubiquitous nature of mobile phones and other handheld devices, and the increasing adoption of games by people from all ages and ethnic groups [72][71], delivering persuasive systems as mobile games has become a common practice. Due to the motivational pull that games offer; they are increasingly becoming the preferred medium to deliver the persuasion contents that can motivate behaviour change. Persuasive games have the capability to motivate behaviour change in a subtle way, while the player is having fun. Persuasive games are, therefore, games that are intentionally designed to motivate players to change their attitudes or behaviour [68][13] using various persuasive strategies. Over the years, various persuasive strategies have been developed to change, modify or reinforce human behaviour.

In this chapter, we present an analysis of 51 persuasive games from the literature that have been developed over a span of 17 years (2001 – 2018), to understand the trends and gaps with respect to their technological platform, target audience and domain, and evaluation approaches employed to assess the efficacy of the persuasive games. We conclude this chapter with a discussion on persuasive games towards risky sexual behaviour.

2.1 Persuasive Games

According to Fogg [29], one of the steps to developing an effective persuasive system is finding relevant examples of persuasive technology. These examples would help to understand what has been successful in that past and what has not, thereby assisting in avoiding previous mistakes by researchers in the field. The relevant examples of persuasive technology for the current research are "Persuasive Games." Therefore, to fully understand the research area, we reviewed existing research in the area of persuasive games. To collect relevant papers, we searched popular

databases including ACM Digital Library, IEEE, and Springer. We also searched Google Scholar as a secondary source for any paper we may have missed.

We used the keywords '*Persuasive Games*' and '*Games for change*.' Initially, we reviewed paper titles, abstracts, and introductions of each retrieved paper, for papers focusing on the design or study of a persuasive game. In total, we were able to extract 31 papers for this purpose. We skimmed through each selected paper to eliminate papers that satisfied our exclusion criteria. Our exclusion criteria were:

- *If the paper is a review paper*
- *If the paper is not a paper about a game or*
- *If the paper is a duplicate of an already chosen paper*.

After going through all the papers, we removed 11 that met these exclusion criteria which left us with 20 papers. From these 20 papers, we skimmed through their reference sections for papers that also discussed the design and/or analysis of a persuasive game. We were able to collect an additional 65 papers and after applying the exclusion criteria again on these 65, we excluded 21 papers from them, leaving us with 31 extra papers. Therefore, in total, we reviewed 51 papers on persuasive game design and evaluation.

We reviewed the 51 papers and coded them using the coding scheme developed and adapted from Orji and Moffat [72]. Specifically, we analysed each paper under the following categories: year of the research, the sub-domain, game title, the technology used, the method of evaluation, the duration of the study, the main persuasive strategies used, the targeted outcomes, the audience, the number of participants, the venue of publication, the effectiveness of their findings, and the countries of the target audience. Figure 2.1 shows the process flow for the inclusion of papers in the Persuasive Games literature review.

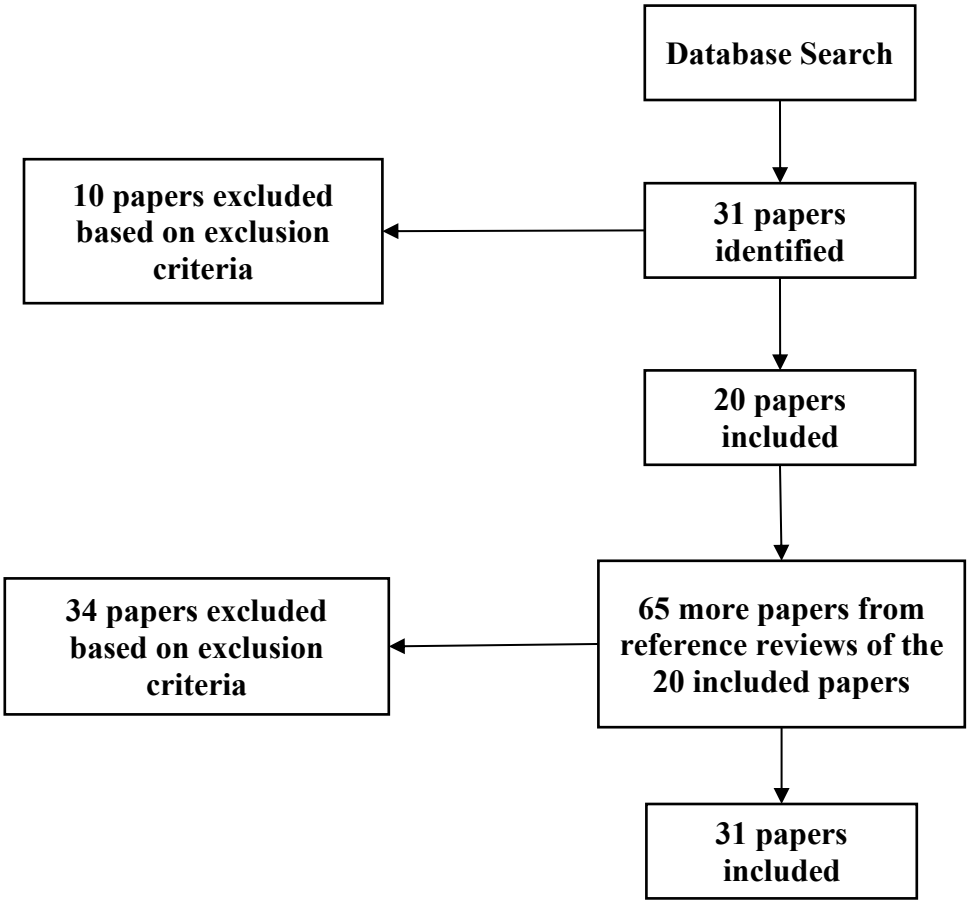


Figure 2.1 - Paper inclusion process

From our analysis, we classified persuasive games into six major domains: Healthy Nutrition, Physical activity, Dental, Disease Prevention, Sustainable Development, and Miscellaneous.

2.1.1 Persuasive Games for Nutrition

This group of persuasive games are designed to motivate people to eat healthily. We identified 9 games in this category. They are 'Hungry Panda 2' [46], 'Playful Bottle' [20], 'OrderUp' [37], 'Time To Eat' [76], 'The smart lunch tray' [53], 'RightWay Café' [74], 'Squire's Quest' [9], 'LunchTime' [68], 'MunchCrunch' [55], JunkFood Aliens [66]. Four of these games were only available on smartphones, three made use of only personal computers, while one was available on both phones and mobile technology.

One of the games, 'The smart lunch tray,' made use of only sensors and a tray. We highlight two of these games. *OrderUp* [37] is a persuasive game that motivates adults to make healthy food choices. The player assumes the role of a server in a restaurant and has to serve healthy food combinations as quick as possible. The healthier the food the player serves, the more likely it is for the player's character to keep his/her job.

Time to Eat [76] is a persuasive game that motivates children to eat healthy food. Players choose a simulated pet and adopt it. The pets send reminders to the player before and after school time, to remind them to eat and drink water. The more breakfast that was eaten by the player, the happier the pet is.

2.1.2 Persuasive Games for Physical activity

Within this category, there are games that motivate people to be physically active. We identified 10 games in this category. They are '*PH.A.N.T.O.M'* [45], *'NEAT-o-Games'* [31], *'LocoSnake'* [19], *'SP-Stretch'* [17], *'UKKO'* [24], *"Fish'n'Steps"* [52], *'Dance Dance Revolution'* [39], *'ClimbTheWorld'* [3], *'Ere Be Dragons'* [22] *and one other game with no title* [7]. Seven of these games were only available on smartphones, one made use of only personal computers, while one made use of an arcade machine and a dance pad. We discuss two of these games here.

PH.A.N.T.O.M [45] is a persuasive mixed-reality game that motivates players to increase the level of their daily physical activity. The game merges the players' physical world with the game world. The player takes on the role of an agent working undercover as a student at a university. Some events unfold over time which would result in missions that would engage the user to get out and solve or execute the missions. A map of the users' surrounding location is presented to the player on his phone, to serve as a guide for getting to the locations where the mission would be completed. Completion is achieved by touching the phone's screen when he gets to the target location. At the end of each mission, the player is shown his score which is determined by how quick the objectives are completed.

Neat-O-Games [31] is a persuasive game to motivate adults to become more physically active. With an accelerometer connected to a mobile phone, the player's movement is tracked and represented as an animation of an avatar in the game. The avatar represents a runner competing

with other runners in a race, who are also users of NEAT-O-Games. At the end of every day, a winner is declared, and points are awarded.

2.1.3 Persuasive Games for Dental Health

This category contains persuasive games that motivate people to practise better dental hygiene. We identified two games in this category. They are '*Molarcropolis'* [84] and *one other game with no name* [43]. One of the games is smartphone-based and the other is designed for PCs. We highlight the two games here.

Molarcropolis is a mobile game that creates awareness of dental hygiene among adolescents. The game simulates a story about the activities of bacteria living inside the mouth. The mouth is simulated as a city called Molarcropolis and the inhabitants of the city are the various bacterium living inside the mouth. These inhabitants overexploited all of the resources in the city (human mouth) and are now causing natural disasters. These natural disasters represent the various medical problems that bacteria from poor hygiene can cause in a human mouth. This game takes an interesting twist away from the usual game stories, where the player always plays as the protagonist. In this game, the player assumes the role of a bacterium that is trying to destroy the city (mouth). While embarking on the mission of destroying the mouth, he gets tips about how to ensure his dental health and the various problems that could arise when the mouth is not cleaned of the bacteria living in it. At the end of each stage, the player is presented with the state of the city (mouth) and the implications of the damage he effected, relating it to the effects in a real human mouth.

The second game in the category is a puzzle-like game, where the player is given different decisions to make that affect his teeth. Whenever he makes a wrong decision, the simulated state of his oral health is depreciated, while a healthy dental decision keeps his simulated teeth shiny and whole. The player is also posed with scenarios where his decisions are not entirely negative or positive but may lead him to make good or bad choices for his simulated teeth in the game. These choices help put the entire game in a real-life context.

2.1.4 Persuasive Games for Disease Prevention

This category contains persuasive games designed to persuade people to avoid behaviours that can cause them to acquire diseases or motivate them to carry out behaviours that can prevent the acquisition of diseases. My research problem is a subset of this category. We identified 14 games in the category. They are *'MACO'* [6], *'Wee Willie Wheezie'* [40], *'Remission'* [47], *'MyPyramid Blast-Off'* [58], *'Packy & Marlon'* [12], *'What Remains?'* [15], *'Bronkie the Bronchiasaurus'* [51], *'Tumaini'* [96], *'Slime-O-Rama'* [97], *'STD PONG'* [62], *'Clot Buster'* [95], *'Birthday Party'* [34], *'smokeSCREEN'* [75], *'PlayForward: Elm City Stories'* [27]. Five of the games were implemented on the Mobile platform only, six on the PC only, one on PC and Mobile, one on the Nintendo, and one on a tabletop. We briefly describe two of the games.

MACO is a game-based persuasive technology intervention that is targeted at preventing child obesity by motivating children to eat healthily and engage in physical activity. MACO consists of two games, 'Healthy Food game' and the 'Physical Activity Game.' The 'Healthy Food game' simulates healthy and unhealthy food objects dropping from the top of the screen. The player has to click on healthy foods before they hit the bottom of the screen. Players get a point for every health food they pick. The 'Physical Activity game' offers the child an opportunity to practice all the lessons learned from a courseware titled 'My Active Kids.' Periodically, the player is given instructions on various activities to carry out, using drawings of children doing the same activity. The player has to carry out that activity and report it on the game, before moving to the next activity. This usually requires the involvement of parents, guardians or their school to support and ensure the child performs those activities.

smokeSCREEN contains a set of mini-games that are targeted at motivating school students to avoid risky behaviours that can lead to tobacco abuse. In the game, players navigate their virtual characters around the school and make decisions for their characters that may put them in areas or situations where tobacco is being used, such as whether or not to throw a party in the absence of the character's parents, encountering a character who persuades him to smoke with how good the smell is. These decisions affect his in-game progress which implies that the more good decisions he makes, the longer he lasts in the game. *smokeSCREEN* simulates real-life scenarios of the daily encounters of a typical school student as it relates to smoking and tobacco use.

2.1.5 Persuasive Games for Sustainable Environment

This category contains persuasive games that persuade people to conserve natural resources such as games that persuade people to save electricity and to dispose of wastes properly. We identified 9 games in this category. They are '*EnergyLife'* [32]*, 'Power Agent'* [38]*, 'Power Explorer'* [8]*, 'LEY'* [54]*, 'Power House'* [79]*, 'Stop Disasters!'* [26]*, 'Shrub Battle'* [23]*, 'Energy Wars'* [30] and *one game with no name* [16]. Four of the games were implemented on the Mobile platform only, three on the PC only, one of PC and Mobile, and one was a board game. We briefly describe two of the games below.

'*Stop Disasters!'* [26] is a web-based persuasive game created by the UN Office for Disaster Risk Reduction. This game was created to help create awareness and motivate people to behave appropriately during natural disasters. It simulates different cities in the world and the disasters that they are prone to. The player picks a city and is given the responsibility to save the lives of members of the city from its corresponding natural disasters like a Tsunami, Hurricane, Wildfire, Earthquake, or Flood by providing defences and optimally upgraded housing. The game shows the cities' population and budget, while the player has to manage the budget wisely on materials that would protect the city from the impending disaster.

'EnergyLife' is a persuasive mobile game that motivates households to save energy by increasing the awareness of their energy consumption behaviours. The game makes use of wireless sensors that can be inserted between plugs and sockets of home appliances. The sensors send data about the appliance usage to a cloud service, which in turn communicates with the smartphone that is running the *EnergyLife* game. The game displays information about the user's electricity consumption in kW/h and also as a saving percentage. This percentage is calculated from a comparison of the current week's consumption to the average consumption during a reference period. There is also a section in the game wherein the user can play quizzes about power consumption and also receive power saving tips. Finally, the game makes use of a community such as Twitter, where different users of *EnergyLife* can share experiences and power-saving knowledge.

2.1.6 Persuasive Games for Miscellaneous Purposes

Some fields of behaviour change were grossly underrepresented in the papers we extracted for this literature review. We classified these papers under miscellaneous purposes. These games ranged from games that motivate a change of people's behaviour towards national peace to games that motivate a change of people's behaviour towards homelessness or the disabled. We identified 7 games in this category. They are *'Zombie Division'* [44], *'EMSAVE'* [14], *'Spent'* [80], *'MoviPill'* [64], *'REXplorer'* [94], *'PeaceMaker'* [5], Birthday Party [34], and *one game with no name* [83]. One of the games was implemented on the Mobile platform only, 4 on the PC only, one on PC and Mobile, and one was on the Wii platform. We shall brief highlight two of the games.

'MovPill' [64] is a game that persuades patients to be more compliant with their medical prescriptions. The game tries to persuade these patients to take their medications at the right time, as prescribed by the doctor. This game is targeted at the elderly, who have the tendency of forgetting to take their medication. When players take their medication on or close to the time prescribed by the doctor, they earn points. These points are determined by using a sensor attached to the inner part of the pillbox that the player uses to store his pills. Whenever the lid is opened, the sensor registers the date and time of this event and this data is sent wirelessly to a device where the *MoviPill* game is installed. This data is sent to the server when the device is connected to the internet, which updates the user's profile with the appropriate points. At the end of each week, the game displays the player with the highest points as the winner of the game, then restarts the tracking for the new week.

'PeaceMaker' [5] is a persuasive game created to cause a change in the attitude of students towards Palestines and Israelis, designed by *Impact Games*. The video game allows the player to take on the role of either the Palestinian President or the Israeli Prime Minister. In either of these roles, the player has the responsibility of responding to various simulated scenarios which involve diplomatic, economic, and military decision making.

2.2 Discussion of Related Work

Based on the analysis of the 51 papers, we were able to draw some insights and conclusions on the trends and gaps in the area of Persuasive Games.

2.2.1 Persuasive games by Platforms

From Figure 2.2, we can see that the Mobile platform is the most frequently used platform for persuasive game development, it is followed by PCs, and then other platforms. This is understandable because according to Oinas-Kukkonen [63], persuasive technology should always be present. Unlike other platforms, owners of mobile devices always carry these devices around almost everywhere they go, hence greatly increasing the potential for persuasion.

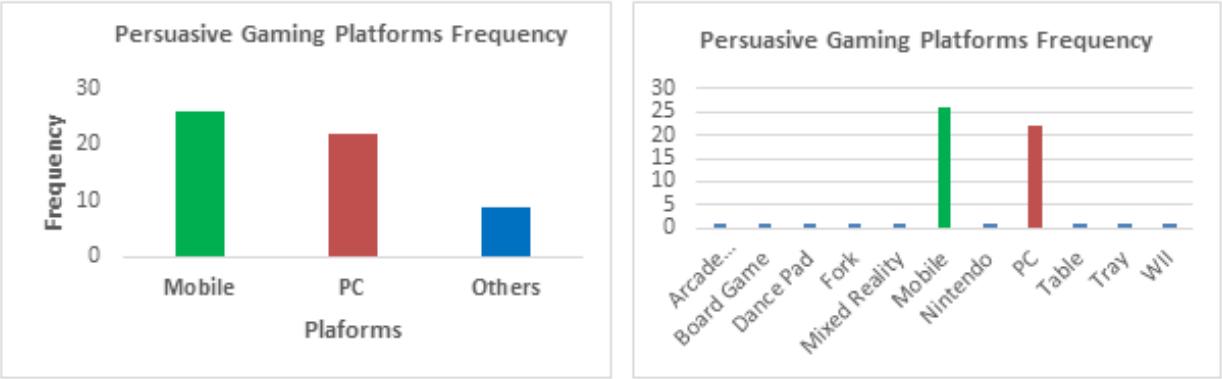


Figure 2.2 - Comparison of all the Persuasive Gaming platforms

2.2.2 Persuasive games by year and country

The persuasive games we analysed spanned a 17-year period, from 2001 to 2018 and targeted a mix of various countries from different continents. Figure 2.3 shows that these persuasive game researches were carried out in 22 countries, with the USA leading with 37% of all the researches. Canada, Italy and Taiwan shared the second-place position with 8%, while Brazil, Finland, Portugal, Sweden and the unspecified countries came in third place with 4% of all the games. Only 2% of the games targeted the African Population. This backs up our claim of persuasive gaming researches not being targeted at the African population.

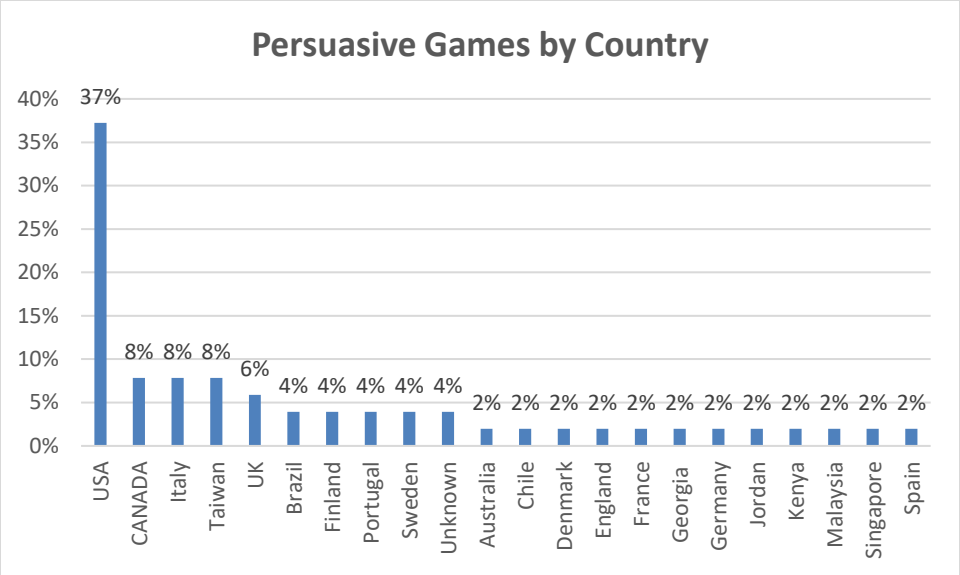


Figure 2.3 - Persuasive Games by Country

2.2.3 Persuasive games evaluation details

The sample size of the persuasive game evaluations within the time span varied significantly, ranging from one participant to 5139 participants. About 13 of these games reported only their design but were not evaluated.

As evident in Figure 2.4, 61% of the studies were targeted at children and teens, 27% were targeted at Adults or their households, 4% were targeted at the Elderly, while 8% did not specify their target populations. It is noticeable that children and teens have the highest percentage of persuasive games research focusing on them. This is no surprise because research has shown that children tend to be more responsive to video games [21].

Looking at the study methods employed in the persuasive game evaluations (Figure 2.5), we found that 37% of the studies used a mixed approach, i.e. combination of quantitative and qualitative analysis, 22% used quantitative analysis only, 14% used qualitative only, while 22% did not do any kind of analysis. We believe that many game researchers tend to prefer collecting log data to use for their analysis than using a self-report approach. The problem with log data is that although the data would not be biased like the self-reported approach tends to be, the richness of the data that can be collected is limited.

Analyzing the success of the persuasive games we extracted (Figure 2.6), we found that 59% of them were successful, 16% were partially successful, 2% were unsuccessful and 24% could not be determined because there was no study carried out. A game was described as partially successful if the game had more than one target outcomes and achieved one or more of the major outcomes but failed to achieve all the major expected outcomes.

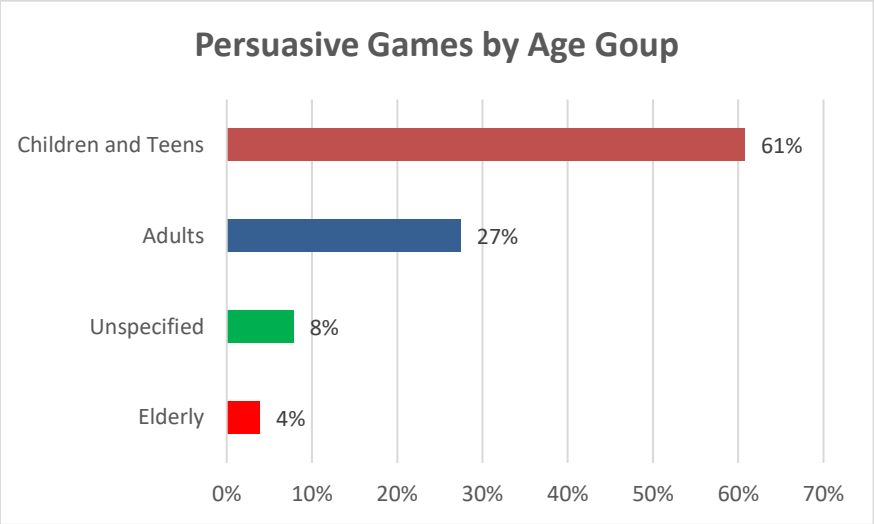


Figure 2.4 - Persuasive game by Age Group

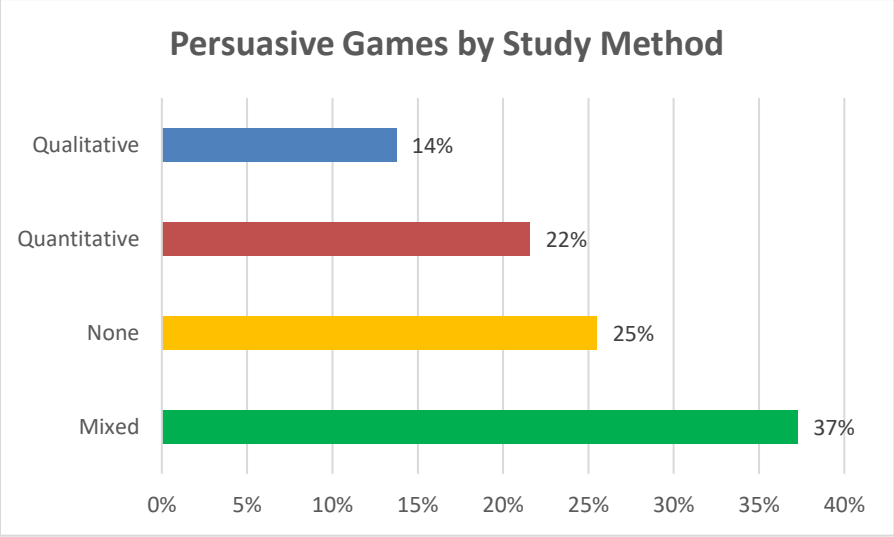


Figure 2.5 - Persuasive Games by Study Method

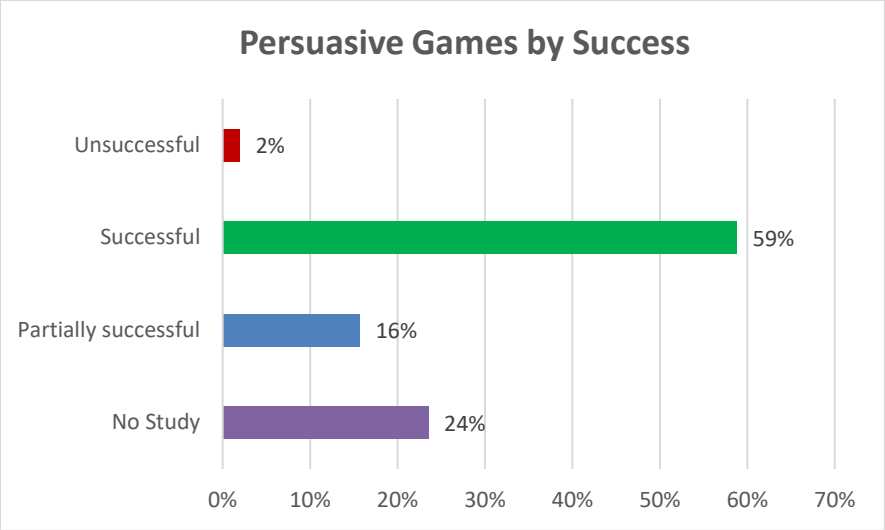


Figure 2.6 - Persuasive Games by Success

2.3 Persuasive Games for Risky Sexual Behaviour Change

A few persuasive games have been developed targeted at promoting risky sexual behaviour change. A typical example of persuasive games for risky sexual behaviour change is a web-based health game called 'Super Nurse: STD Game' [91]. The game helps to educate players about different kind of STDs, their prevention and cures. The game employed several persuasive strategies to facilitate the desired behaviours. For example, players are awarded points for correct choices related to STDs, otherwise, points are deducted. Finally, players are provided with descriptive feedbacks informing them about STD prevention, their effects, and dangerous practices that can lead to contraction of the disease. Similarly, PlayForward: Elm City Stories is a game aimed at imparting American youths with skills and knowledge on how to avoid risky sexual behaviours that could lead to STDs and HIV [48]. The game allows the players to customize their avatar and travel through time while engaging in various risky behaviour-related activities such as pressure by friends to drink alcohol and dangerous sexual activities. The game simulates the long-term impacts of various activities in the players' life. Players also have the ability to go back in time and correct all their 'mistakes' to ensure a better future.

In summary, while designing persuasive games to motivate healthy behaviour change is increasingly attracting attention, most existing persuasive games to date are targeted at people from Western culture. There is a need for African-centric persuasive game interventions that

reflects Africanness. Specifically, at the beginning of this research in January 2018, there are have been no persuasive game research targeted at changing risky sexual behaviours of Young Africans.

CHAPTER 3 STD PONG 2.0 DESIGN AND IMPLEMENTATION

In this chapter, we shall discuss the process that we followed before and during the design of *STD PONG 2.0*.

3.1 Early Development Process

To develop an effective persuasive system, we had to follow an established methodology recommended by BJ Fogg [29] who proposed an eight steps process to follow in the early development stages of a persuasive system. The steps are as follows;

- Step 1: Choose a simple behaviour to target
- Step 2: Choose a receptive audience
- Step 3: Find what prevents the target behaviour
- Step 4: Choose a familiar technology channel
- Step 5: Find relevant examples of persuasive technology
- Step 6: Imitate successful examples
- Step 7: Test and iterate quickly
- Step 8: Expand on success

Table 3.1 shows the outcomes of each of the 8 Fogg's early development steps and the following sections explain what we did in the various stages.

FOGG'S EARLY PERSUASIVE DESIGN STEPS	**OUTCOMES**
Step 1: Choose a simple behaviour to target	*Abstinence from sex*, *Use of condoms during sex* and *occasional blood tests*
Step 2: Choose a receptive audience	*African Youths*
Step 3: Find what prevents the target behaviour	*Limited information,excessive drinking, traditional cutting, tattooing, etc.*

FOGG'S EARLY PERSUASIVE DESIGN STEPS	OUTCOMES
Step 4: Choose a familiar technology channel	*Mobile Persuasive games*
Step 5: Find relevant examples of persuasive technology	*Literature review of 51 Persuasive Game Papers*
Step 6: Imitate successful examples	*STD PONG*
Step 7: Test and iterate quickly	*STD PONG*
Step 8: Expand on success	*STD PONG 2.0*

Table 3.1 - Early Design Steps and the Outcomes

3.1.1 Step 1: Choose a simple behaviour to target

We identified the problem we wanted to solve, which is discouraging risky sexual behaviours. Details justifying why this is a problem is important is contained in Chapter 1. In a bid to solve this problem, we had to understand what behaviours risky behaviours led to the widespread of STDs. To get better insights into these behaviours, we conducted interviews with 12 medical personnel in Nigeria. From these interviews, we gathered that the two major risk factors that promote the spread of STDs are unprotected sex and the use of unsterilized sharp objects. The possible solutions are *Abstinence from sex*, *Use of protectives such as condoms during sex* and *occasional blood tests*. These were identified as the simple behaviour we had to target.

3.1.2 Step 2: Choose a receptive audience

During our interviews with the medical personnel, we discovered that risky sexual behaviours and STDs are predominant among young Adults in Africa. This is understandable considering that young adults tend to be more sexually active than other age groups [90] and are prone to risk-taking [89]. Therefore, we identified our receptive audience as *African Youths*.

3.1.3 Step 3: Find what prevents the target behaviour

To motivate the target behaviour, we first needed to understand why African youths engage in risky sexual behaviours. We gathered from our interviews that the main risk factors that promote the spread of sexually transmitted diseases are *Unprotected Sex* and *the use of unsterilized sharp objects*. Some facilitating behaviours that function as a precursor to risky sexual behaviours include *poor of information about risky sexual behaviours, nightclubbing, excessive drinking, traditional cutting, tattooing*; all these other behaviours often lead to either *Unprotected Sex* or *the use of unsterilized sharp objects.* We identified these as the behaviours that prevent the target behaviours.

3.1.4 Step 4: Choose a familiar technology channel

To create an effective persuasive technology, we needed to pick a technology that is familiar to our target audience. As stated in Chapter 1, one of the most familiar technology among Africans are smartphones. For example, 90% of Nigerian adults own at least a mobile phone [35]. This would make the persuasive technology we would develop to be "always on" and "continually influence behaviours", as proposed by Oinas-Kukkonen [63] in the Persuasive System Design model.

Also, we chose mobile games as the application of choice because of the ability of mobile games to subtly persuade people while they are having fun and during their leisure. Since research has shown that 99% of adolescent boys and 94% of adolescent girls, including all racial/ethnic groups, play video games regularly [50], we believe that using games will attract more audience and hence, would be a creative and exciting way to motivate behaviour change. Therefore, we choose to design *mobile persuasive games*.

3.1.5 Step 5: Find relevant examples of persuasive technology

To be able to create an effective persuasive game, we had to research and study existing games in the domain. This was extensively discussed in CHAPTER 2. We gathered 51 persuasive

games and analysed them to understand what they did and how they did them, what worked and what didn't. This informed us on how to properly develop our game.

3.1.6 Step 6: Imitate successful examples

We took the insights we got from the various persuasive game papers we studied, and we created a quick prototype of *STD PONG 2.0*, titled '*STD Pong*'. This prototype was created using Adobe Animate and Adobe Air. APPENDIX D shows screenshots of *STD Pong*.

Some insights we gathered from the papers we read were:

- A game with a good story easily captivates the users more.
- Users would be easily persuaded if they can relate more to the game elements (Tailoring).
- Persuasive games need to be easy enough to avoid frustration but also challenging enough to cause excitement.

3.1.7 Step 7: Test and iterate quickly

We demoed our work to multiple audiences and allowed them to playtest. For example, we published a short paper titled, "STD Pong: An African-Centric Persuasive game for risky sexual behaviour change" at CHI 2018 Human-Computer Interaction Across Borders (HCIxB). We got people to playtest to get some feedback from them on the design and concept of the game. These feedbacks were not recorded nor analysed since we had no form of ethics approval at this period. The intention was to get a quick general informal feedback about the game and its features.

3.1.8 Step 8: Expand on success

We took all the suggestion from the user playtests and applied some strategies from Persuasive Design Model to develop the final game. The following section illustrates the final design process.

3.2 STD PONG 2.0 DESIGN

As indicated in the previous section, before proceeding to develop the game, we had several unstructured interviews with medical stockholders in Africa, to have a better understanding of the risk factors and issues surrounding STDs in Africa. We identified that the risk factors for spreading STDs are *Unprotected Sex and the use of unsterilized Sharp Objects*; the safe practices for the control of STDs are *the use of condoms, abstinence* and *routine blood tests*; and we identified 10 STDs common among their patients in Africa as; *Scabies, Genital Warts, Herpes, Trichomoniasis, Hepatitis B, Chlamydia, Syphilis, Gonorrhoea, HIV and AIDS*.

3.2.1 The Story

STD Pong 2.0 is an interactive two-dimensional arcade game based on a fictional narrative of a small village (clan) called Okpongidi and an invasion by STDs and HIV. The Clan of Okpongidi has been taken captive by King AIDS and 9 other STDs. King AIDS challenges the entire Clan to choose someone to compete with his henchmen in a game of STD Pong. For every STD the player defeats, he would be rewarded with an *STD Scroll* which would enable him to free his entire clan from that particular STD. Each scroll contains important information about the defeated sexually transmitted disease such as how they are transmitted, how to prevent them, their symptoms and how to manage or treat the infection if applicable. If the player attains the final level, he engages in a final show-down (battle) with the King of the STDs (King AIDS) to earn total freedom from his clutches.

The player plays the role of a young warrior that has been elected by the elders of the clan to defeat King AIDS. The overarching objective of the game is to acquire all the nine knowledge scrolls (corresponding to the nine different STDs) that would free the 'Okpongidi' Clan from the shackles of *King AIDS* and his other STDs. The other STDs in the camp of King AIDS are as follows in descending order of rank: *Prince HIV, General Gonorrhea, General Syphilis, General Cancroid, Captain Chlamydia, Captain Trichomoniasis, Captain Herpes, and Captain Scabies*. We chose to focus on these 10 different STDs because they are the most popular ones especially among our target African population [6].

The game is designed to be played on the Android platform and was developed using Unity Engine, Adobe Animate and Photoshop.

3.2.2 The Game Play

Several persuasive and design strategies, as identified under the Persuasive System Design Model, were employed in the development of *STD Pong 2.0*. Section 3.3 illustrates the various strategies that were employed in the design.

The game can be played in two modes: The Story Mode and Arcade Mode. In the story mode, the player accepts the challenge to battle against King AIDS and his henchmen in the game. There are ten game levels with progressive difficulties. Each level represents a new STD. The STDs are arranged in increasing order of danger as specified in the previous section. The reward at the end of each victory is an STD Scroll containing secret information about of the defeated sexually transmitted disease such as how they are transmitted, how to prevent them, their symptoms and how to manage or treat the infection if applicable. Other rewards exist for completing various milestones like the Quick Victory badge and the Collector badge. The arcade mode allows the player to select any STD to play against, but a level is accessible in this mode only if it has been completed in the Story Mode.

3.2.3 Deconstructing STD Pong 2.0

The story and game sound: The story illustrates a typical original African setting where communities are grouped into clans and tribes led by kings and elders who make decisions for the community. We decided to imbibe this concept to give the game an African feel and hence increase its relatability to the African audience. We also used African Jungle soundtracks to increase the Africanness. The complexion of the player and his attire, as shown in Figure 1, also contributes to giving the game an African feel.

The Pong Ball, movement buttons, the health bars and the player, STD Scrolls: A player is allowed to personalize the character by choosing either a male or female warrior character as shown in Figure 3.1. The player character battles against a game character which represents a particular STD that the player has to battle with. Each game level presents a unique STD. As

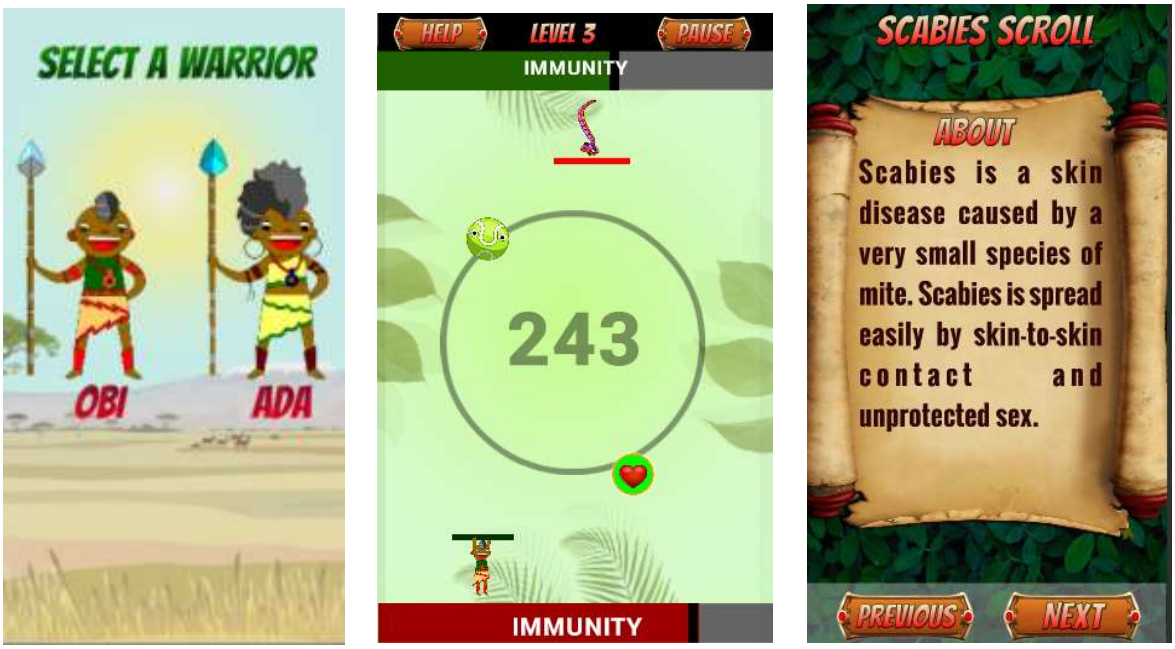
shown in Figure 3.1, the player character is positioned at the bottom end of the game scene while the STD is positioned at the top-end. Both the player and the STD possess a health bar each, located at the top of the stage. Figure 3.1 shows a screenshot of the STD pong game panel. A ball, called the pong ball, bounces in a diagonal manner around the stage. This diagonal movement of the ball introduces some levels of uncertainty and unpredictability with regards to the movement of the ball.

The game also features an STD ball which represents an STD effect or poison. The primary task of the player is to move his character up and down using the arrow keys on the screen, to prevent the ball from hitting his defence system (the wall) and to push the STD ball out of his side of the court to the STD's side of the court. Any time the pong ball hits the player's defence system, he loses 10% of the total health value. Similarly, any time the STD ball hits the STD's side of the court, the STD's health bar reduces by 10%.

A level ends whenever any of the two health bars get to 0%. If the player health gets to 0%, he is given an opportunity to either replay that level or end the game. However, if the STD's health gets to 0%, the player wins and hence gets rewarded with an STD Scroll. The STD Scroll contains important details about the defeated STD including how it is transmitted, its symptoms, how to prevent it, how to get tested, and how it could be treated. Figure 3.1 shows a screenshot of a sample STD scroll gotten after defeating Captain Scabies.

Player Power-Ups: The player power-ups represent various activities that can be used to control or prevent the spread of STDs. To determine the activities to be represented by these power-ups, we interviewed some stakeholders including various medical personnel who provided some expert opinions regarding the best practices and design choices. Based on their suggestions, the top three best practices for our target audience are; *abstinence from sex, condoms use,* and *routine blood tests*. Therefore, to integrate this as part of the game, we modelled them as power-ups as shown in Figure 3.2. The three power-ups appear randomly, and the player could use them to defeat the STDs. Using the abstinence power-up increases the player health bar by 10% of its original size. The Condom power-up doubles the size of the player for 10 seconds, which make it a lot more easier for the player to be able to prevent the ball from hitting his immune system. The Blood Test power-up increases the player health bar by 5% of its original size. This metaphor

conveys how regular testing and early detection of STD is vital in the effective treatment or control of STDs, hence persuading the player to imbibe these safety behaviours and practices.



Warrior Selection *Main Game Play* *STD Scroll*

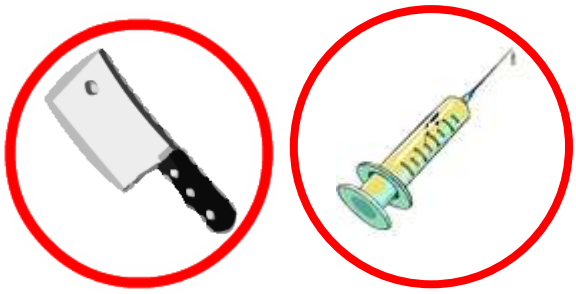
Figure 3.1 - Screenshots of Warrior selection, Main Gameplay and an STD Scroll

Condoms *Abstinence* *Blood Test*

Figure 3.2 - STD Pong Power-Ups

Figure 3.3 - STD PONG 2.0 Enemies

STD Bullets: The STD bullets represent two major behaviours that could lead to STDs common among our target population: *unprotected sex, the use of unsterilized sharp objects*. We modelled them as STD Bullets as shown in Figure 3.4. During gameplay, the STD randomly fire STD bullets with the aim of hitting the player and decreasing his health values. The unprotected sex object reduces the health of the player by 20% each time it hits him while the sharp object reduces the player health bar by 10% of its original size. Through this technique, the player gets to understand that behaviours such as the use of unsterilized sharp objects and unprotected sex (damages) can ultimately lead to getting any of the STDs.



Sharp Objects

Unprotected Sex

Figure 3.4 - STD Bullets in STD Pong 2.0

STD Pong Badges: Asides from the STD Scrolls, the players can gather badges while playing the game, for completing various milestones. There are 10 kinds of badges that can be attained by players as shown in Figure 3.5. They are:

- *Flawless Victory*: This badge is acquired when the player defeats an STD without losing any life.
- *Quick Victory*: This badge is acquired when the player defeats STD in one minute.
- *Collector*: The badge is acquired each time a player collects 10 powerups. E.g. 10 powerups, 20 powerups, 30 powerups etc.
- *STD Polymath*: This badge is acquired when the player answers 15 questions correctly.
- *STD Panthomath*: This badge is acquired when the player answers 40 questions correctly.
- *Grand Master*: This badge is acquired when the player successfully completes the game.

The STD Pong Quiz Mini-Game: Before and after every level of the STD Pong Game, there is a quiz mini-game that tests the knowledge of the player about the STD represented in that current level. The pre-test mini-game quiz (before the game level) tests the players' prior knowledge about that particular STD modelled in that level. This score of the pre-test has no impact on the players progress in the game. The post-test quiz mini-game (after completing the game level) tests the players' knowledge after playing against the STD in that level and acquiring the knowledge embedded into the game. This post-test has an impact on the progress of the player. The player has to get at least 4 out of the 5 questions right in order to progress to the next stage. If the player fails to get at least 4 questions right, he has to replay the stage from the beginning again to proceed. For the purpose of the study, the only first attempts of the player in the pre- and post-test quizzes are stored in our remote database. Figure 3.6 shows a screenshot of the quiz mini-game.

Figure 3.5 - Other STD Pong Rewards

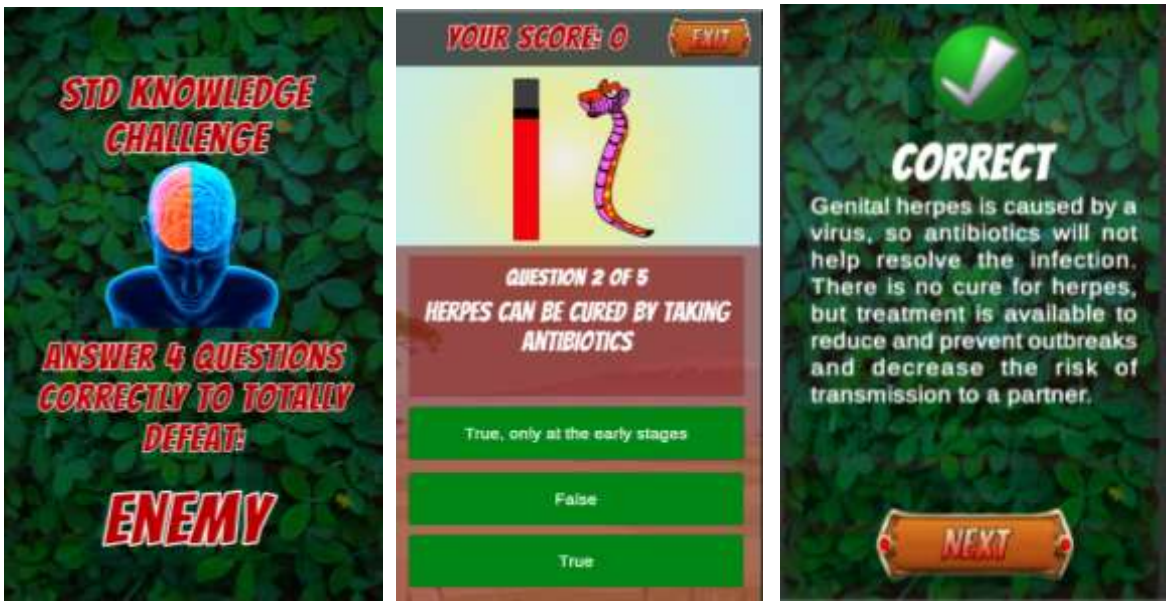


Figure 3.6 - STD PONG Quiz Mini-Game

3.2.4 Improvements from *STD Pong* to *STD PONG 2.0*

Asides from the application of the persuasive system design strategies on *STD Pong* to create *STD Pong 2.0*, we made a few major design changes in *STD Pong 2.0*. They are as follows:

a. We used a different development platform for *STD Pong 2.0*. *STD Pong* was developed using Adobe Animate and Adobe Air. Though this platform allowed for easy creation of animations and frames, it was not very suitable for collecting log data and has some compatibility issues in Android. We decided to use a more stable platform, which made us choose the Unity engine, although most of the game assets were designed in Adobe Animate.
b. We changed the visual representation of the game from landscape to portrait following the feedback from playtesting. We wanted the game to be as casual as possible. We noticed that due to the orientation of *STD Pong*, which was landscape, required the use of two hands to play the game. Since the game had simple controls which were 'clicks' for buttons and 'single swipes' for character control, we decided to change the orientation of *STD Pong 2.0* to portrait to enable the use of only one hand when playing the game.
c. We added a choice of between two genders for the player character. In the first prototype, we had only one male character to use. Based on playtesting which suggested making the main character genderless or allowing plays the ability to choose between a male or a female character. In the new prototype, we created the ability of the player to choose between two characters, Obi (male) or Ada (female).

Other improvements can be identified in the following section which illustrates the application of the PSD model on the STD Pong game.

3.3 The Persuasive Features of STD PONG 2.0

Our goal for making STD Pong is to create a game that can be both enjoyable and persuasive. To ensure that the game is persuasive, we implemented a number of persuasive strategies in the game. Following detailed research, we decided to make use of the strategies illustrated by the

Persuasive System Design model (PSD) developed by Oinas-Kukkonen in 2009 [63]. This model identified the various strategies that can be employed in a persuasive system to make it more persuasive. These persuasive strategies are classified into 4 groups namely; *Primary Task Support, Dialogue Support, System Credibility Support and Social Support*. In the following section, we identify which of these strategies were implemented and how they were operationalized.

3.3.1 Primary Task Support

This category of PSD strategies illustrates the persuasive principles to be implemented in a system, that can effectively support users' primary tasks required to achieve the desired behaviour.

Tunnelling: This strategy states, "using the system to guide users through a process or experience provides opportunities to persuade along the way" [63]. Tunnelling was sparsely used in this game. We operationalized tunnelling using a 'help' screen at the beginning of the game. This 'help' screen contains the actions the player has to perform in order to better the level. We also had a 'help' button available whenever the player needs it during the game. This button pauses the game to enable the player to read it before playing. We could have operationalized the tunnelling better in the game by using a tutorial, but we decided not to because the controls of the game were very simple.

Tailoring: This strategy states, "Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group" [63]. Tailoring was used in *STD Pong*. The target population for the game is African Youths, therefore, we tailored most game elements to reflect Africanness. The main story of the game is set to reflect an African village, the main characters are two young Africans, dressed in African attires. The theme music used in the game was also created using traditional African instruments.

Simulation: This strategy states, "Systems that provide simulations can persuade by enabling users to observe immediately the link between cause and effect" [63]. We made use of simulation by showing how risky behaviours that can lead to contracting STDs and the

advantages of practising safe sexual behaviours that can prevent the contraction of STDs. This was operationalized with the use of three powerups and STD Bullets. The powerups are: *Abstinence* (increases the player's health by 10 percent and gives the player an additional five points), *Condom Use* (multiplies the player's size by two for four seconds, which makes it easier for the player to prevent the STD ball from hitting his immunity), *Blood Test* (increases the player's health by five percent and gives the player an additional three points). These simulations of the effect of the power-ups show how rewarding the three safe sexual behaviours can be in preventing STDs. The STD bullets are *Unprotected Sex* (reduces the player's health by 20% and decreases the player's points by five), *Sharp Object* (divides the player's size by two for four seconds, which makes it easier for the STD ball to hit the player's immunity).

Rehearsal: This strategy states, "A system providing means with which to rehearse a behaviour can enable people to change their attitudes or behaviour in the real world" [63]. Players can allow their immune system to be hit by the STD ball in the game and experience the effect on their health. They can also acquire condoms and other powerups and experience the resulting effects too.

3.3.2 Dialogue Support

This category of strategies addresses the persuasive principles to increase systems interactivity and hence facilitate bi-directional feedback between the player and the persuasive system.

Praise: This strategy states, "By offering praise, a system can make users more open to persuasion." We used praise extensively in the game. The player is praised for every achievement gotten, every level completed, every question answered, and every badge acquired. These praises come in the form of applause sounds and texts such as 'Congratulations!' or 'Good Job'. Figure 3.7 shows the way these praises were implemented.

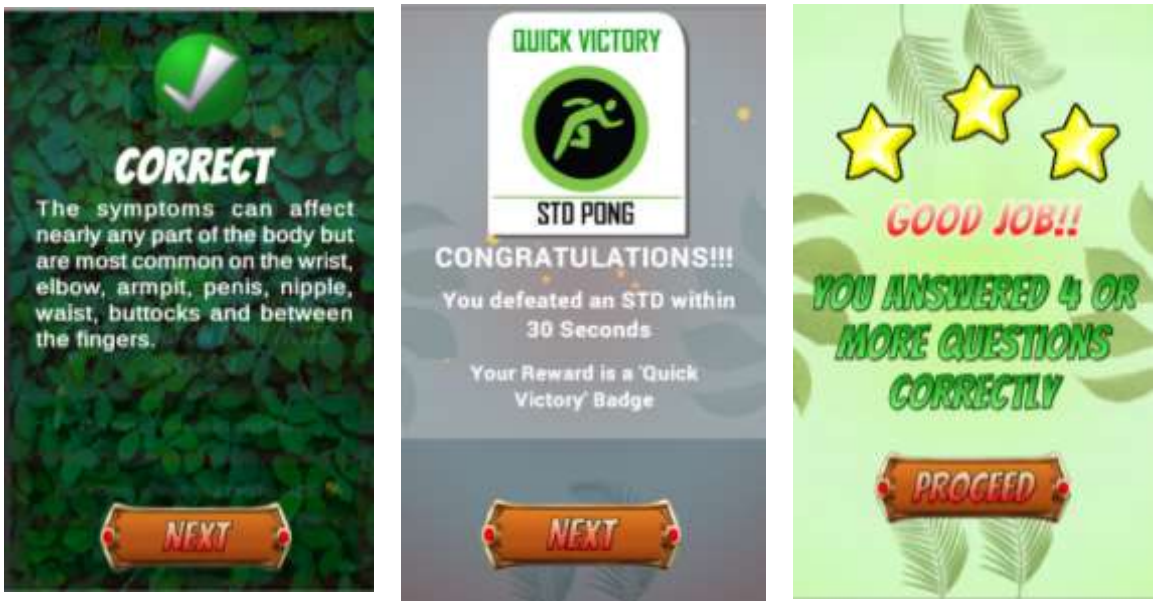


Figure 3.7 - Some scenes of STD Pong 2.0 where praises were used

Rewards: This strategy states, "Systems that reward target behaviours may have great persuasive powers." We employed two different categories of rewards. They are Badges and STD Scrolls. STD scrolls are the major rewards in the game. As indicated in a previous section, a player acquires an STD Scroll whenever a game level is completed. The scroll contains all the information (secrets) about a particular STDs. This implies that there are 10 acquirable scrolls. Players acquired badges when they achieve a specific milestone. The game has six badges which are: Collector badge, Quick Victory Badge, Flawless badge, STD Polymath badge, STD Pantomath badge and the Grandmaster badge. These were added to help motivated players to engage more with the game to achieve these milestones.

Suggestion: This strategy states, "Systems offering fitting suggestions will have greater persuasive powers." In the STD Scroll section and quiz sections, we e suggest safe practices that players can use to prevent themselves from STDs. Figure 3.8 shows some scenes where suggestions were implemented.

Figure 3.8 - Some scenes of STD Pong where suggestions were implemented

Similarity: This strategy states, "People are more readily persuaded through systems that remind them of themselves in some meaningful way." *STD Pong* is targeted at African youths; therefore, we made the game elements to look as similar to the target population as possible. From the attire of the main characters to the theme music and the colours used in the game, they all reflect Africanness, therefore achieving similarity. This would make the player be able to relate more to the contents of the game.

Liking: This strategy states, "A system that is visually attractive for its users is likely to be more persuasive." We tried as much as we could to make the game visually appealing by using animations and nice graphics assets created in Adobe Animate and Unity.

Social Role: This strategy states, "If a system adopts a social role, users will more likely use it for persuasive purposes." *STD Pong 2.0* takes the social role of a sex education teacher for any player of the game.

3.3.3 System Credibility Support

The strategies in this category illustrated how a system can be designed to make its credibility very obvious since a system needs to be seen as credible before it can cause persuasion on the intended user.

Trustworthiness: This strategy states, "A system that is viewed as trustworthy will have increased powers of persuasion." This means that all the information provided by the system should be truthful and sound. We ensure that all the information about the 10 STDs presented in the game is accurate by first using trusted medical websites like mayoclinic.org [81] and webmd.com [92] to get the information required for the game. After assembling this information, we sent them to medical personnel who verified that the information was accurate.

Expertise: This strategy states, "A system that is viewed as incorporating expertise will have increased powers of persuasion." To ensure that the game incorporated expertise, the first step we took before making the game was consulting with medical stakeholders in Africa (Nigeria), to understand the general situation surrounding STDs in Africa. Also, as stated in the trustworthiness section, all the information presented in the game were verified by a medical expert.

Surface Credibility: This strategy states, "People make initial assessments of the system credibility based on a firsthand inspection." We avoided the use of advert or anything that does not logical contribute to the change in risky sexual behaviours.

Real-World Feel: This strategy states, "A system that highlights people or organization behind its content or services will have more credibility." We have a privacy policy and credits section in the game which highlights that Chinenye Ndulue and Dr Rita Orji, who are researchers from Dalhousie University, are behind the contents of the game. We believe that the involvement of an academic leader in the field of persuasive technology (Rita Orji), gives the game more credibility. The game was also approved by the Research Ethics Board of Dalhousie University.

3.3.4 Social Support

This category of strategies illustrates how a system can be designed to effectively support user interaction with other users.

Social Comparison: This strategy states, "System users will have a greater motivation to perform the target behaviour if they can compare their performance with the performance of others." The high scores of players are stored on a leaderboard, which is visible by every other player. Each

player can compare their scores with other players and be motivated to perform better in the game.

Social Facilitation: This strategy states, "System users are more likely to perform target behaviour if they discern via the system that others are performing the behaviour along with them." The leaderboard in the game shows each player that other players are also playing the game and engaging with contents. This would likely motivate the player to play the game more.

Competition: This strategy states, "A system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to compete." The leaderboard also creates an avenue for competition where the player plays the game more to attain the highest possible score in the game and beat other players.

Recognition: This strategy states, "By offering public recognition for an individual or group, a system can increase the likelihood that a person/group will adopt a target behaviour." We used the leaderboard scene and badges to implement the recognition strategy. Players are motivated to play the game more when their achievements are recognized by badges and their top scores are displayed and recognized by other users.

A total of 18 persuasive strategies as specified by the PSD Model were implemented in *STD Pong 2.0*.

PRIMARY TASK SUPPORT
Tunnelling
Tailoring
Simulation
Rehearsal

DIALOGUE SUPPORT
Praise
Rewards
Suggestion
Similarity
Liking
Social role

SYSTEM CREDIBILITY SUPPORT
Trustworthiness
Expertise
Surface credibility
Real-world feel

SOCIAL SUPPORT
Social Comparison
Social facilitation
Competition
Recognition

Table 3.2 - Summary of the implementation of the PSD Model in STD Pong 2.0

3.4 STD PONG 2.0 Implementation

In this section, we highlight the flow of the game design and some of the technical actions we took when developing *STD Pong 2.0*. Due to the complexity of the game design, we would be looking at just a few significant development choices we made while developing the game.

The *STD Pong 2.0* game was developed using the Unity game engine, C# and Adobe Animate. The reason for choosing the Unity game engine was due to its robustness and our familiarity with C#. We also used Adobe Animate for the asset creation because we already started creating some asset in the program when making *STD Pong*. We need to do was created additional assets and export them as png images.

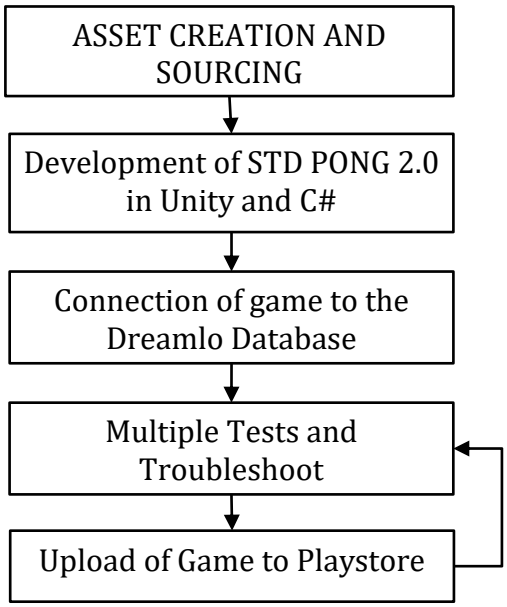


Figure 3.9 – High-Level Design Process of STD Pong 2.0

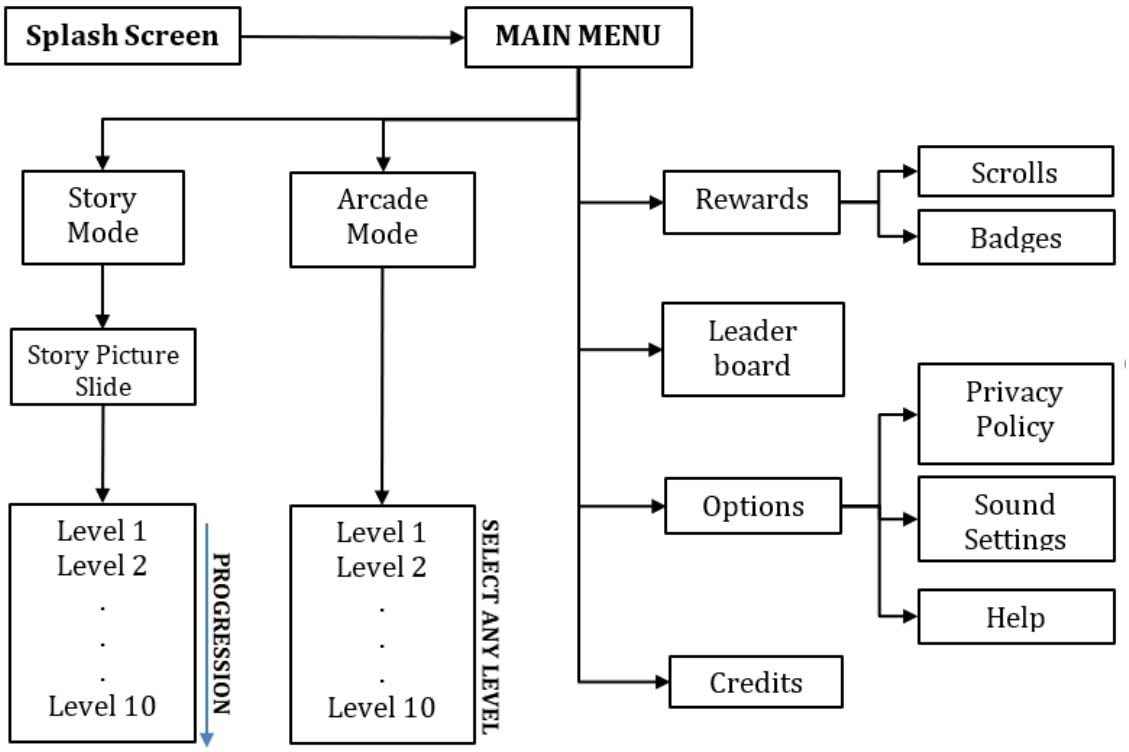


Figure 3.10 - High-Level Overview of Game Flow

In the implementation of *STD Pong 2.0*, the first step we took was to identify the characters, elements and assets we needed the game. We sourced a few generic open access assets like buttons and icons using keyword searches on the internet. Due to the peculiarity of our work, we created the majority of the assets ourselves using Adobe Animate. The major assets include the player characters (Obi and Ada) and the different STDs. For example, we wanted the main characters in the game to look entirely African, with dark skin colours and native African attires. Since we could not find good free games assets for this purpose and with the right postures, we made our own player assets. After creating these assets in Adobe Animate, we imported them into Unity and converted them to sprites while those assets that needed collision were given rigid bodies and polygon colliders.

When the game starts for the first time and the player tries to play the story mode, a prompt appears requiring the player to enter his username. The username is stored in a *playerpref* called 'nickname' which is also stored in the Dreamlo database for the game. For the ping-pong part of the game, we assigned the STD ball variable velocity when it collides with any of the walls, the

player character or the STD character. This implies that the speed of the STD Ball is never constant because it changes based on the collision with various game elements.

As stated in the gameplay section, powerups and STD bullets appeared at different time intervals, which the player can either avoid or catch. We implemented this thus: We instantiated the powerup and STD Bullet objects, when a level loads, outside the boundaries of the game screen. We started a timer for the powerups and STD bullets. Every 3 seconds, the timer is stopped, and an STD bullet is released by the STD. This was achieved by moving the position of a randomly selected STD bullet to the position of the STD and making it move downwards, towards the player. The STD bullet moves downward until it collides with the player or the bottom wall. At this point, we move the position of the STD bullet to its initial position, outside the game screen. After this, the timer is reset and started again. We applied this same process to the movement of the powerups. The only difference is that the powerups are released only every 5 seconds.

Temporary and permanent game data such as scores, questions answered, and badges collected were stored using different player prefabs while the data necessary for our research was stored on a remote server, using a web service, to our Dreamlo database server.

Figure 3.10 shows an overview of the general flow of the game between the various game scenes. After developing the game, we packaged the game using Proguard with the Unity engine. Progaurd helps to remove unused assets in the build and optimize the resulting game package to its smallest optimal size. We also signed it using a local Keystore and versioned the game to identify it from consequent builds.

We encountered a minor issue when we tried uploading the game to the Playstore. Our package was rejected initially because we were collecting email addresses and gender of players, which was considered as either sensitive information or advertising information. Google stated that for our game to be reinstated we needed to create a policy statement webpage. The webpage had to be specified on the game description on Playstore and also as an explicit link within the game. We rectified that by creating a WordPress page for the policy statement and adding a button within the game that links to the webpage. After the first upload, we continued to make changes and updated the app two more times before we began the user study.

CHAPTER 4 STD PONG 2.0 PERSUASIVE GAME EVALUATION

After developing *STD Pong 2.0*, we needed to investigate if it is effective or not, with respect to motivating the desired behaviour change. Therefore, we developed the following research questions to guide our evaluation.

The overarching research question for this study is:

Can STD Pong 2.0 promote a positive change in the risky sexual behaviours among Africans youths?

To be able to answer this research question, one would ideally have to monitor the sexual behaviour of African youths' before playing *STD PONG 2.0* and their sexual behaviour after playing *STD PONG 2.0,* then compare these two variables at various time points over the span of some months or more to see if there is a positive or negative change. This is however not feasible in the context of this research for some reasons: It is not possible to monitor sexual behaviour in most African cultures due to the sacredness of and stigma associated with sex and sexual-related topics as indicated in the first chapter. Also, it is resource-intensive to carry out such research, which is beyond the scope of our work. Therefore, we had to go through literature to understand other ways and other predictors of behaviour change. To effectively answer this question, we had to break it down into smaller question measuring close indicators of behaviour change. The questions border around the factors that determine behaviour change.

According to Ajzen et al. [4] and Orji et al. [73], *Attitude, Self-Efficacy* and *Intention* are the three main predictors of behaviour change. Therefore, to determine the effectiveness of *STD Pong 2.0* we measured its efficacy with respect to promoting a positive change in Intention, Self-efficacy, Attitude against risky sexual behaviour guided by the following research questions;

R1: Can *STD PONG 2.0* motivate a positive change in the Attitude of young African against Risky Sexual behaviours?

R2: Can *STD PONG 2.0* motivate a positive change in the intentions of young African against Risky Sexual behaviours?

R3: Can *STD PONG 2.0* motivate a positive change in the Self-Efficacy of young African against Risky Sexual behaviours?

Knowledge is also an indicator of behaviour change. Research has shown that people with more knowledge of the risks and benefits of a target behaviour are more likely to change their behaviour than those without any knowledge [18]. Therefore, we also investigated if there is a change in participants' knowledge about STDs, with the following research question:

R4: Can *STD PONG 2.0* cause an increase in players' *knowledge* about STDs: their risk factors, symptoms, how they are transmitted, how to avoid them, how to get tested/treated?

Also, for a system to be persuasive, it has to be enjoyable, it has to hold the player's interest and also give players a feeling of competence, among many other attributes. This is because, the main reason why people play games in the first place is to have fun, hence we examined whether players had fun while playing the game by exploring the play experience using the following research question:

R5: What is the experience of the players from playing the *STD PONG 2.0* game with respect to *interest and enjoyment, perceived competence, effort and importance, pressure and tension,* and *value and usefulness?*

Finally, we also examined the perceived persuasiveness of the game with respect to its ability to motivate the desired change in risky sexual behaviour, hence the final research question:

R6: How persuasive is *STD PONG 2.0* with respect to its ability to motivate change in risky sexual behaviour?

Below is a complete list of all the research questions we investigate in this thesis.

R1: Can *STD PONG 2.0* motivate a positive change in the Attitude of young African against Risky Sexual behaviours?

R2: Can *STD PONG 2.0* motivate a positive change in the intentions of young African against Risky Sexual behaviours?

R3: Can *STD PONG 2.0* motivate a positive change in the Self-Efficacy of young African against Risky Sexual behaviours?

R4: Can *STD PONG 2.0* cause an increase in players' *knowledge* about STDs: their risk factors, symptoms, how they are transmitted, how to avoid them, how to get tested/treated?

R5: What is the experience of the players from playing the *STD PONG 2.0* game with respect to *interest and enjoyment, perceived competence, effort and importance, pressure and tension, and value and usefulness*

R6: How persuasive is *STD PONG 2.0* with respect to its ability to motivate change in risky sexual behaviour?

Table 4.1 Shows the research question numbers and their corresponding investigations.

Research Questions	**Investigations**
R1	Attitude Change
R2	Intention Change
R3	Self-Efficacy
R4	Knowledge Change
R5	Play Experience
R6	Persuasiveness

Table 4.1 - Research Questions and their targeted outcomes

4.1 Study Design Overview

To answer these research questions, we conducted a field evaluation of African youths. The study was designed thus:

To understand the effects of *STD Pong 2.0* on the target population, we ran a pre-test and post-test study design. We gathered participants from the target population (African Youths) and had them fill out a pre-test survey. After that, they were instructed to download and play *STD Pong 2.0* for 4 for 7 days, at least 10 to 20 minutes per day. At the end of the 7 days, they were instructed to fill out the post-test survey. Figure 4.1 shows the flow of the processes in the user study. The following section presents the details about the surveys, the participants and study instruments.

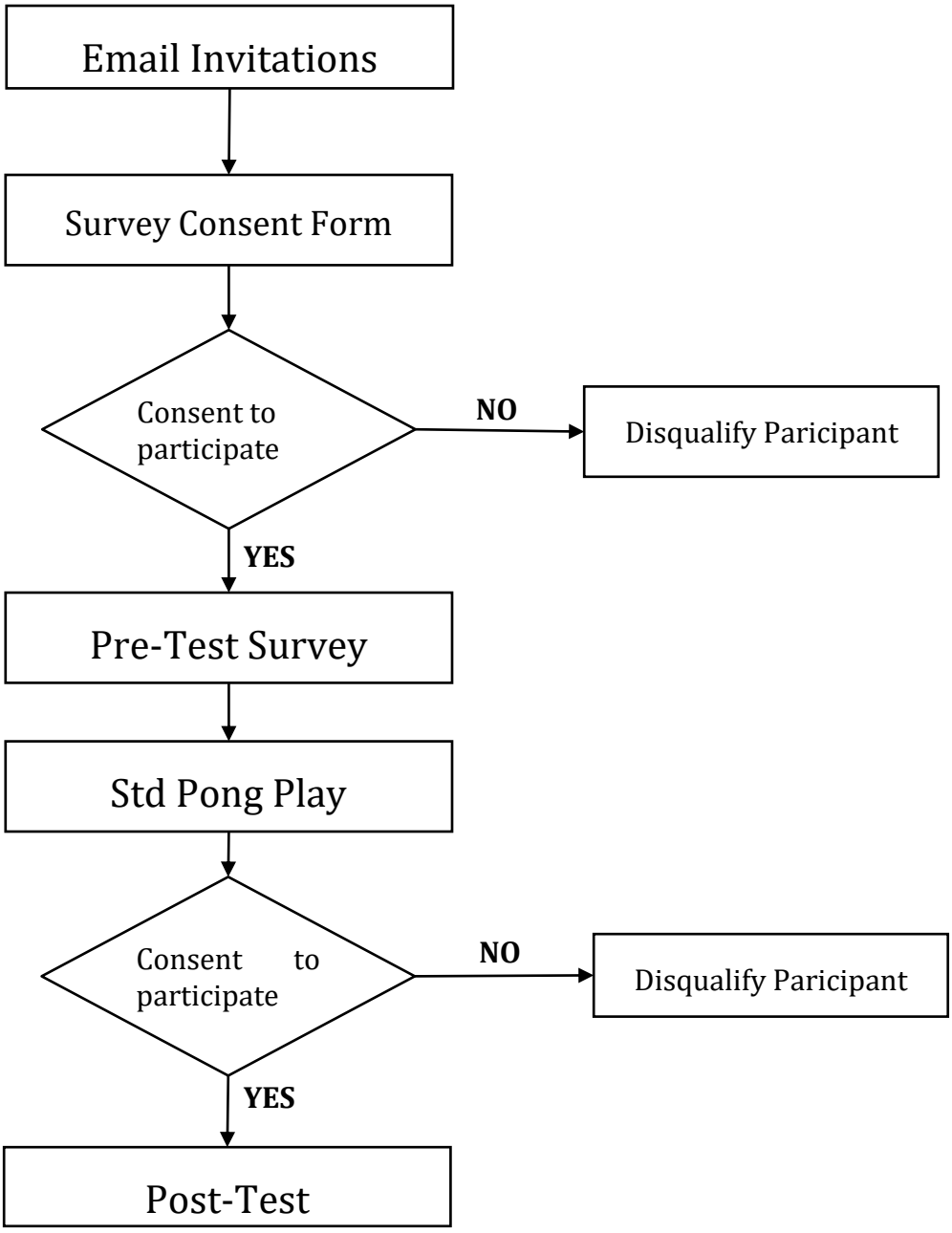


Figure 4.1 - Flow of Processes in the User Study

4.2 Survey/Questionnaire Design

To answer the research questions specified above, we needed to design a study that would collect data about their baseline behaviour and knowledge (pre-study) about risky sexual behaviours and

STDs before playing *STD PONG 2.0*; have them play the game; then collect data about their behaviours and knowledge after playing the game (post-study). This was achieved with the use of online surveys hosted on Dalopinio and game log data from questionnaires (quiz section) within the *STD PONG 2.0* game. The following section addresses how we collected data to answer each question.

4.2.1 Answering the R1:

R1 states "Can *STD PONG 2.0* motivate a positive change in the Attitude of young African against Risky Sexual behaviours?".

To answer this question, we needed to collect data about the participants' attitude against risky sexual behaviours, before and after playing *STD Pong 2.0*. To do this, we adapted the attitude change questions used in the paper titled "Improving the Efficacy of Games for Change Using Personalization Models" by Orji [67] into our pre-test and post-test surveys. The scale consists of 7 questions as specified in APPENDIX H and APPENDIX I. The questions were measured using a 7-point Likert scale ranging from 1=strongly disagree to 7 strongly agree. The difference between the means of the two time points (pre and post) was determined using a Paired-Samples t-test. A greater post-test mean would signify a positive change in the attitudes of the participants against risky sexual behaviours.

4.2.2 Answering the R2

R2 states "Can *STD PONG 2.0* motivate a positive change in the intentions of young African against Risky Sexual behaviours?".

To answer this question, we needed to collect data about the participants' intentions against risky sexual behaviours, before and after playing *STD Pong 2.0*. To do this, we adapted the intention change questions contained in Orji [67] into our pre-test and post-test surveys. The scale consists of 5 questions as specified in APPENDIX H and APPENDIX I. We measured the questions using a 7-point Likert scale ranging from 1=strongly disagree to 7 strongly agree. The difference between the means of the two time points (pre and post) was determined using a Paired-Samples

t-test. A greater post-test mean would signify a positive change in the intentions of the participants to risky sexual behaviours.

4.2.3 Answering the R3

R3 states "Can *STD PONG 2.0* motivate a positive change in the Self-Efficacy of young African against Risky Sexual behaviours?".

To answer this question, we needed to collect data about the participants' self-efficacy against risky sexual behaviours, before and after playing *STD Pong 2.0*. To do this, we adapted the Self-Efficacy change questions from Orji [67] into our pre-test and post-test surveys. The scale consists of 5 questions as specified in APPENDIX H and APPENDIX I. We measured the questions using a 7-point Likert scale ranging from 1=strongly disagree to 7 strongly agree. The difference between the means of the two time points (pre and post) was determined using a Paired-Samples t-test. A greater post-test mean would signify a positive change in the self-efficacy of the participants to risky sexual behaviours.

4.2.4 Answering the R4

R4 states "Can *STD PONG 2.0* cause an increase in players' *knowledge* about STDs: their risk factors, symptoms, how they are transmitted, how to avoid them, how to get tested/treated?".

To answer this question, we needed to collect data about the participants' knowledge about STDs, before and after playing *STD Pong 2.0*. To do this, we developed questions for testing participants knowledge of each of the 10 STDs represented in the game. These questions were developed from the STD information contained in some reliable medical sources such as mayoclinic.org [81] and webmd.com [92], which is also the content of the STD Scroll that is earned at the end of game level (the STD Scroll is the reward gotten for defeating an STD, which contains important details about the defeated STD including how it is transmitted, its symptoms, how to prevent it, how to get tested, and how it could be treated). The questions were gamified into a quiz mini-game in *STD Pong 2.0*. Before playing every game level (against a particular STD), the player must play the pre-quiz mini-game and answer the 5 questions corresponding to the STD (pre-knowledge). The score from the session is stored in our Dreamlo database [25].

Following this, the player plays, the STD pong. If the player defeats the STD in the current level of the game, they are rewarded with an STD Scroll which contains information about the STD. Finally, they must respond to the same set of knowledge questions again in the post-quiz mini-game (post-knowledge). His score from this session is also stored on the Dreamlo database [25]. Ultimately, if the score of the post-quiz mini-game is higher than the score of the pre-quiz mini-game, then we can conclude that the user's knowledge about that particular STD increased. We averaged the pre-knowledge and post-knowledge scores from all the levels. The difference between the means of the two time points (pre and post) was determined using a Paired-Samples t-test. A greater post-test mean would signify an increase in the knowledge of the participants about risky sexual behaviours and STDs.

4.2.5 Answering the R5

R5 states "What is the experience of the players from playing the *STD PONG 2.0* game with respect to *interest and enjoyment, perceived competence, effort and importance, pressure and tension, and value and usefulness*".

To answer this question, we needed to collect data about the participants' *play experience* against risky sexual behaviours, after playing *STD Pong 2.0*. To do this, we employed the popular Intrinsic Motivation Inventory (IMI) scales [42] in our post-test surveys. We used the questions specified in APPENDIX I. We measured the questions using a 7-point Likert scale ranging from 1=strongly disagree to 7 strongly agree. We ran a One-Sample t-test on the means of the individual variables under the player experience against an optimistic neutral value of 4. A mean greater than the neutral value signifies a positive experience from playing *STD Pong 2.0*.

4.2.6 Answering the R6

R6 states "How persuasive is *STD PONG 2.0* with respect to its ability to motivate change in risky sexual behaviour?".

To answer this question, we needed to collect data about the participants' perception of how persuasive the game is with respect to motivating them to change risky sexual behaviours change. To achieve this, we adapted the perceived persuasiveness scale from Orji [67] into our post-test

survey. The scale consists of 5 questions as specified in APPENDIX I. We measured the questions using a 7-point Likert scale ranging from 1=strongly disagree to 7 strongly agree. We ran a One-Sample t-test on the means of the responses from the persuasiveness questions using an optimistic neutral value of 4. A mean greater than the test value would signify a strong persuasiveness of *STD Pong 2.0*.

4.3 Participants Recruitment

The target population for the study is African Youths between the age of 12 and 50. This age restriction of 12 was chosen because the age of sexual consent in Angola is 12 years [2], which is the smallest age of sexual consent among all African countries. This is also in line with the study ethics approval. We targeted recruiting a minimum of 30 participants. Our participants were recruited through emails to students of from Nigerian Universities (Set A) and via snowballing technique with an anonymous Youth Group in Nigeria (Set B). The school and groups were selected as our sources of participants due to the ease of getting participants, as they are located in Nigeria, where we have previously lived and had some interactions. Due to the peculiarities of the two sets of participants, we designed the flow of the study slightly differently for each set, however, the main content and procedure remains intact.

Study Design for Set A:

The study has three stages: The Pre-test Stage, the Game Play stage and the Post-Test Stage.

In the pre-test stage, we advertised our study and collected the email addresses of interested participants. We sent links to the Pre-test online survey to these email addresses, furnishing the participants with the details of the study and asking them to fill out the survey. The pretest contains questions that assessed their intention, attitude and self-efficacy against risky sexual behaviours. Their responses were stored on the DalOpinio server. After filling out this survey, the participant moved to the second stage: the Gameplay stage. Participants got a link to download the STD PONG game on their Android phones from the Google PlayStore. They were advised to play the game for at least one week and 20 minutes per day at least. After one week, they moved on to the final stage of the study, which is the Post-test Stage. At this stage, all participants received another link to fill out an identical Online Survey which would test if a

change has occurred in their intention, attitude and self-efficacy against risky sexual behaviours. The major difference between the post-test and the pre-test survey is the play experience and persuasiveness questions were added to the post-test survey.

Study Design for Set B:

We tweaked the study design a little bit for this set because we wanted to ensure we get some data from the sample. We set up two computers at the gathering place of a youth group and had interested participants take turns to fill out the surveys during the pre-test stage. No email addresses were collected from this set due to the stern agreement of anonymity by the facilitator of the youth group. We assigned each participant with a unique serial id with the following format: 'chstd#' (# represents a number in the series). Immediately after filling out the pre-test questionnaire, the facilitator of the group helped them install the game on their phones and requested that to play it as often as they could for at least 20 minutes each day. After, one week, during their next meeting, the participants were requested to fill out the post-test questionnaire.

This study design tweak for set B proved to be more effective since we got about 70% of our valid participants from this set. This is probably because they had access to free internet access at the centre to complete the pre and post-survey, hence did not have to bother about internet access which set A did not have. Internet is still not as easily accessible and affordable in Africa, although that is fast-changing, the user still has to pay much for that.

4.4 Study Instruments

Below is a list of all the instruments used in this study:

- Pre-test online survey form
- *STD PONG 2.0* game: on Google Playstore, *STD PONG 2.0* game on a private server,
- Post-test online survey form
- Dreamlo server [25] for gameplay data.
- Dalopinio server
- Participants' email addresses or unique ids
- Participants' android phones

- SPSS and MS Excel

4.5 Pilots Studies

Before running the study in the wild, we had to run pilot studies to identify bugs and correct error and assess the overall usability of the game. We ran two types of pilot studies: *The Playtest Pilot* and *the User Study Pilot*.

The Playtest Pilot: This was the first set of pilot testing we ran. This was run to identify and correct error in the gameplay. We got a random set of people to playtest the game to see if it would break at any point. The most significant playtest we ran was with students of African descent in a high school located in Halifax, Canada. Other play-testers were gotten during two of the Faculty of Computer Science's Open Day events. We encouraged them to voice out any issues they experienced during the playtest. This helped us fix any technical and usability issues with the games. Figure 4.2 shows screenshots of a playtest session organized with the Canadian high school.

The User Study Pilot: This was the second pilot testing. We ran this to test the user study design to identify and eliminate any errors in the study. We gathered five participants, four of whom were Nigerian who were students at Dalhousie University, for this study. They had the exact same experience the normal study would have. The only difference was that the participants were only allowed to play the game for 20 minutes instead of one week as designed in the original study. The pilot participants were given sheets of papers to record any study design issues they experienced during the pilot study. All the concerns were addressed and inculcated into the original study. APPENDIX G shows the feedback from the five participants of the study.

Figure 4.2 - Screenshot of a Playtest Session

4.6 Participants' Demographics

We sent email invitations requesting for participation in our study to about 180 prospective participants among African youths who have indicated interest and we received only 62 responses. Only 41 participants completed all 3 stages of the study. Eight participants completed only the first and second part of the study, 5 completed only the first stage of the study while 8 participated in only the second stage of the study. We excluded the data of the participants that did not complete all the parts of the study from the attitude, intention, self-efficacy and play experience analysis. For the knowledge change analysis, we included every participant who

played the game. Figure 4.3 is a Venn Diagram that shows the distribution of our sample between the first, second and third part of the study.

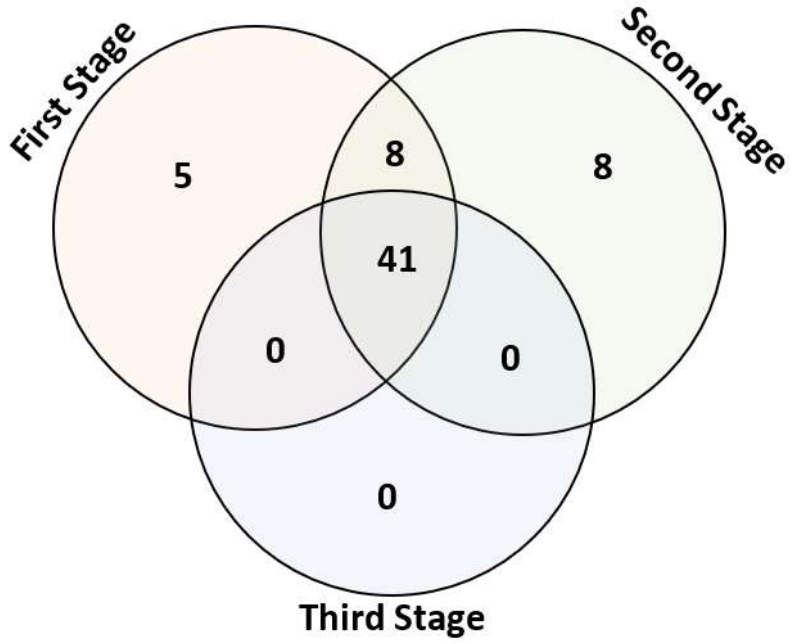


Figure 4.3 - Venn Diagram showing the distribution of participants between the various stages of study

For the included participants, we had 68% males and 32% females (Figure 4.4). By marital status, 85% were single while 15% were married (Figure 4.5). The largest age groups in our sample were the '19-25%' group with 45%, followed by '26-35' with 34%. The smallest age group we had was '36-45' with 5%, followed by '12-18' with 12% (Figure 4.6). This is ideal because our intervention is targeted towards young adults and according to the United Nations Department of Economic and Social Affairs (UNDESA), young adults fall around the age of 15 years to 35 years old as submitted by the African Union in 2016 [93].

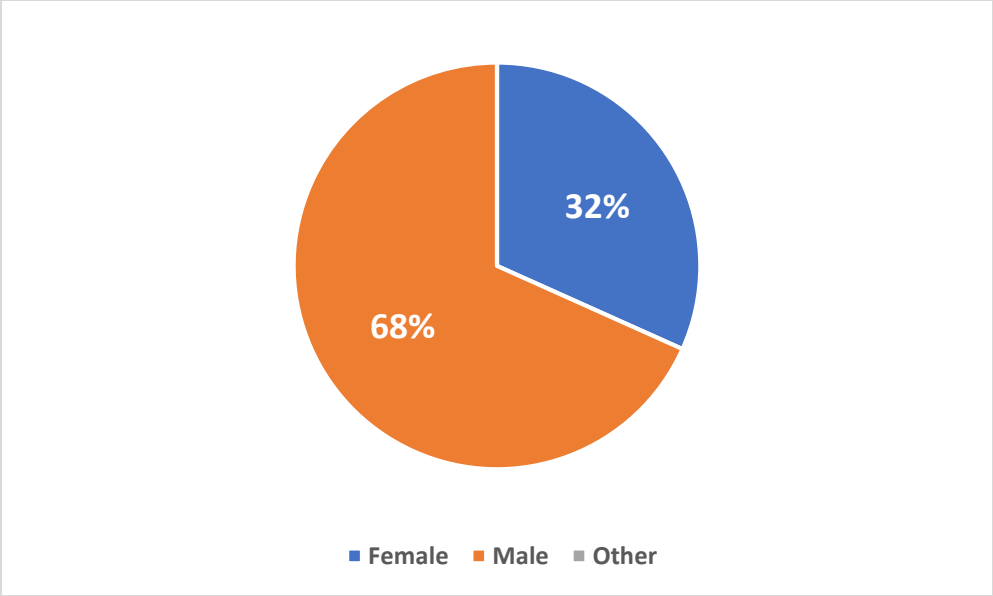


Figure 4.4 - Demographics by Gender

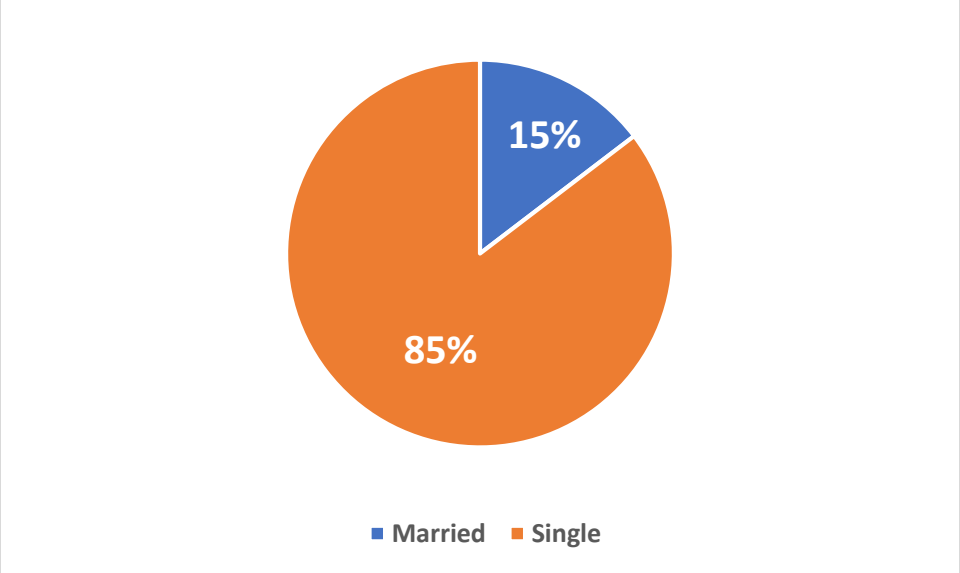


Figure 4.5 - Demographics by Marital Status

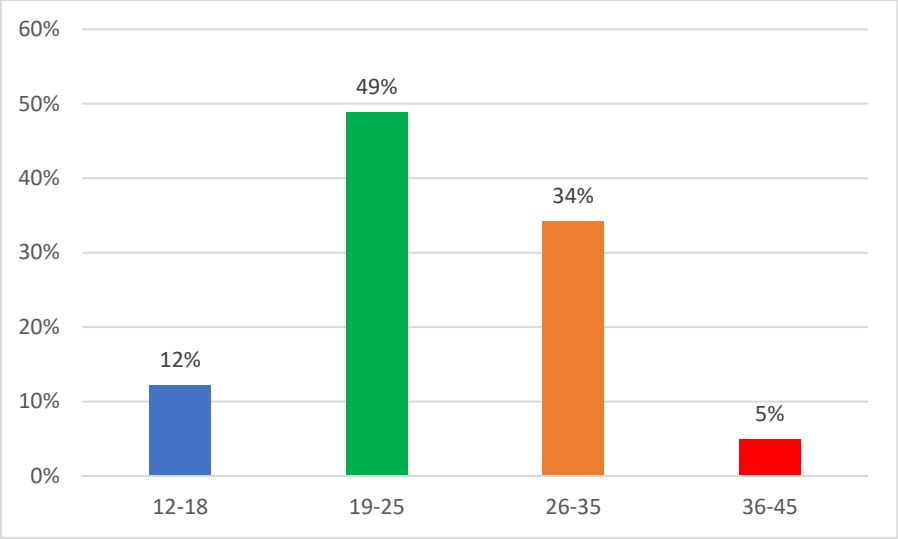


Figure 4.6 - Demographics by Age

By the highest level of education, secondary school education (high school) had the most 49%, followed by a bachelor's degree with 27%, primary school with 15%. Master's degree and Ordinary National Diploma holders had the lowest with 2% and 7% respectively as seen in Figure 4.7.

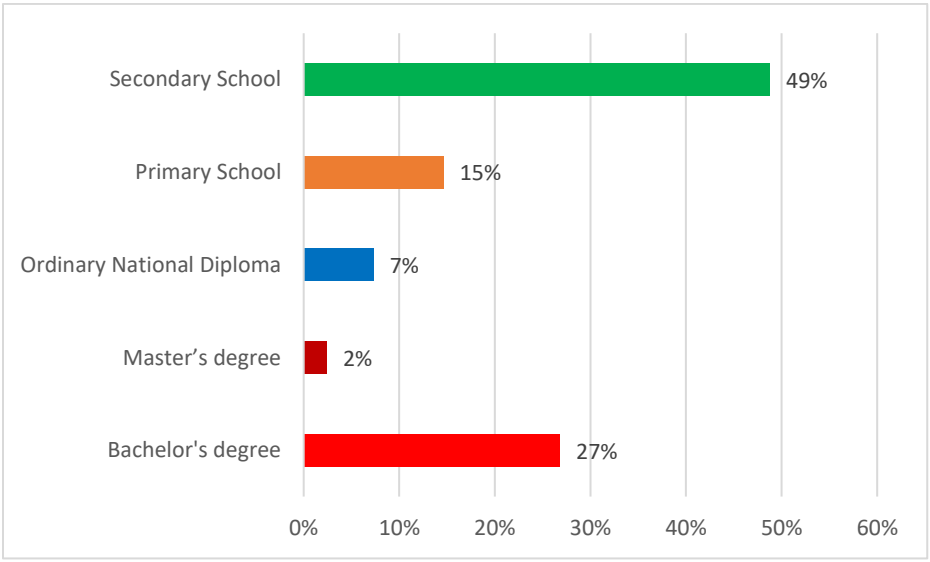


Figure 4.7 - Demographics by their highest level of education

All our participants reported that they have played digital games before (Figure 4.8). 37% of the participants play games a few times a week, while 27% of them played games every day. 15% played games once per week, 12% played games few times per month, 7% played a few times a

year while 2% played games once per year or less, as seen in Figure 4.9. We deduce from this data that our population leaned towards gamers since about 79% of them played games at least once a week and 64% of them played the game multiple times per week.

Figure 4.8 - Demographics by Gameplay

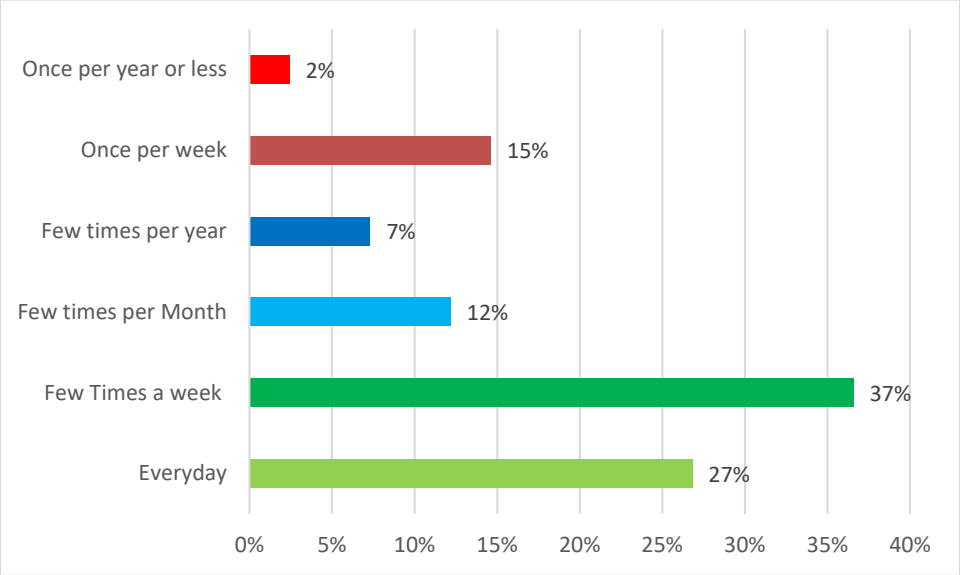


Figure 4.9 – Demographics by Gameplay Frequency

The device used the most in playing games was phones with about 96% of the sample. Computers were used by 2%, while 2% also used tablets the most for their gaming. This is relatively evident from the fact that smartphones are more mobile and can be used for casual gaming. Again, phones are more common among African audience than other devices. They also used less electricity and are less expensive.

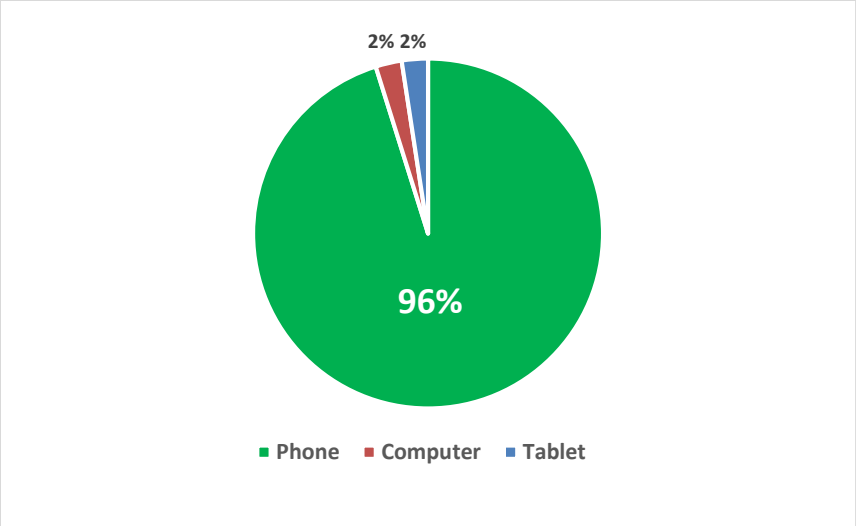


Figure 4.10 - Demographics by Device used the most in playing games

Table 4.2 - Summary of Participants' Demography

Total Participants = 62	
Gender	Males (68%), Females (32%)
Age	'12-18' (12%), 19-25%' (45%), '26-35' (34%), '36-45' (5%), '46 and Over' (0%)
Education	Secondary school education or High school (49%), Bachelor's degree (27%), Primary school (15%), Ordinary National Diploma holders (7%), Master's degree (2%)
Played any Game Before	Yes (100%), No (0%)
Gameplay Frequency	Few times a week (37%), Everyday (27%), Once per week (15%), Few times per month (12%), Few times a year (7%), Once per year or less (2%)
Main Device for Gameplay	Phone (96%). Computer (2%), Tablets (2%)

CHAPTER 5 STUDY RESULTS

In the chapter, we present the results from the field study of *STD Pong 2.0* and the implications of these results. Specifically, in the following subsections, we present the results of the *attitude change, intention change and self-efficacy change* and *perceived persuasiveness* as measured using the scales adapted from Orji [67]. We also present the results of the play experience of *STD Pong 2.0* as measured using the IMI subscales [42] of *interest and enjoyment, perceived competence, effort and importance, pressure and tension, and value and usefulness.* We present the results for the knowledge change as measured using responses from STD Knowledge questions within the game. Finally, we discuss the implications of all these results.

5.1 Attitude Change

We measured players' *attitude* against risky sexual behaviours before and following gameplay (pre and post) using seven questions adopted from Orji [67]. The questions were measured using a 7-point Likert scale ranging from 1=strongly disagree to 7=strongly agree.

Table 5.1 - Descriptive Statistics for Attitude Change

Paired Samples Statistics				
	Mean	N	Std. Deviation	Std. Error Mean
Pre-Attitude	4.60	41	.82	.13
Post-Attitude	6.69	41	.20	.031

Table 5.2 - Paired Samples t-test for Attitude Change

Paired Samples Test								
	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pre-Attitude Post-Attitude	-2.09	.81	.13	-2.35	-1.83	-16.49	40	.000

To analyze the data, we ran a paired-samples t-test to determine if the mean of the responses to the *attitude change* questions by participants differed significantly between the two time points (before and after *STD Pong 2.0* gameplay). The result is as follows: $t(40) = -16.49$, $p < 0.0005$. Due to the means of the pre-attitude and the post-attitude responses, and the direction of the t-value, we can conclude that there was a statistically significant increase in the attitude of participants against risky sexual behaviours, after playing *STD Pong 2.0* from 4.60 ± 0.82 to 6.69 ± 0.20 ($p < 0.0005$); an improvement of 2.09 ± 0.81.

We can, therefore, conclude that *STD PONG 2.0* motivated a positive change in the *attitude* of participants against risky sexual behaviour.

5.2 Intention Change

We measured players' *intention* against risky sexual behaviours before and following gameplay (pre and post) using seven questions adopted from Orji [67]. The questions were measured using a 7-point Likert scale ranging from 1=strongly disagree to 7 strongly agree.

Table 5.3 - Descriptive Statistics for Intention Change

Paired Samples Statistics				
	Mean	N	Std. Deviation	Std. Error Mean
Pre-Intention	4.54	41	1.02	.16
Post-Intention	6.71	41	.21	.03

Table 5.4 - Paired Samples t-test for Intention Change

Paired Samples Test								
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pre-Intention – Post-Intention	-2.17	1.01	.16	-2.49	-1.85	-13.77	40	.000

To analyse the data, we ran a paired-samples t-test to determine if the mean of the responses to the *intention change* questions by participants differed significantly between the two time points (before and after *STD Pong 2.0* gameplay). The result is as follows: $t(40) = -13.77$, $p < 0.0005$. Due to the means of the pre-intention and the post-intention responses, and the direction of the t-value, we can conclude that there was a statistically significant improvement in the *intention* of participants against risky sexual behaviours, after playing *STD Pong 2.0* from 4.60 ± 0.54 to 6.71 ± 0.21 ($p < 0.0005$); an improvement of 2.17 ± 1.01.

We can, therefore, conclude that *STD PONG 2.0* caused a positive change in the *intention* of participants against risk sexual behaviour.

5.3 Self-Efficacy Change

We measured players *self-efficacy* against risky sexual behaviours before and following gameplay (pre and post) using seven questions adopted from Orji [67]. The questions were measured using a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree).

Table 5.5 - Descriptive Statistics for Self-Efficacy Change

Paired Samples Statistics				
	Mean	N	Std. Deviation	Std. Error Mean
Pre-Self-Efficacy	4.55	41	1.09	.17
Post-Self-Efficacy	6.74	41	.23	.04

Table 5.6 - Paired Samples T-Test for Self-Efficacy Change

Paired Samples Test								
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pre-Self-Efficacy – Post-Self-Efficacy	-2.19	1.10	.17	-2.54	-1.84	-12.78	40	.000

To analyse the data, we ran a paired-samples t-test to determine if the mean of the responses to the *self-efficacy* change questions by participants differed significantly between the two time

points (before and after *STD Pong 2.0* gameplay). The result is as follows: $t(40) = -12.78$, $p < 0.0005$. Due to the means of the pre-self-efficacy and the post-self-efficacy responses, and the direction of the t-value, we can conclude that there was a statistically significant improvement in the *self-efficacy* of participants against risky sexual behaviours, after playing *STD Pong 2.0* from 4.55 ± 1.09 to 6.74 ± 0.23 ($p < 0.0005$); an improvement of 2.19 ± 1.10.

We can, therefore, conclude that *STD PONG 2.0* caused a positive change in the *self-efficacy* of participants against risk sexual behaviour.

5.4 Knowledge Change

We measured and stored the existing *knowledge* of participants about risky sexual behaviours and the level of *knowledge* change after playing the *STD PONG 2.0*. Using five questions for each of the 10 STDs, we designed the game to assign a score ranging from 0 to 5 for each set of questions before and after each level in the game depending on a player's response. The mean of each participants pre and post level scores was taken and used for the paired-samples t-test statistical analysis.

Table 5.7 - Descriptive Statistics for Knowledge Change

Paired Samples Statistics				
	Mean	N	Std. Deviation	Std. Error Mean
Pre-Knowledge	1.62	57	.58	.08
Post-Knowledge	4.27	57	.55	.07

Table 5.8 - Paired Samples t-test for Knowledge Change

Paired Samples Test								
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pre-Knowledge – Post-Knowledge	-2.65	.89	.12	-2.89	-2.42	-22.53	56	.000

To analyse the data, we ran a paired-samples t-test to determine if the means of the correct answers to the STD *knowledge* questions by the participants differed statistically significantly between the two time points (before and after *STD Pong 2.0* gameplay)). The result is as follows: $t(56) = -22.53$, $p < 0.0005$. Due to the means of the pre-knowledge scores and the post-knowledge scores, and the direction of the t-value, we can conclude that there was a statistically significant improvement in the knowledge of participants about risky sexual behaviours and how to avoid them, after playing *STD Pong 2.0* from 1.62 ± 0.58 to 4.27 ± 0.55 ($p < 0.0005$); an improvement of 2.65 ± 0.89.

The mean from the pre-test *knowledge tests* scores (pre-test mean = 1.62) shows that it fell significantly below the midpoint which is 3. This implies that the *knowledge* of the sample's attitude was below the midpoint before the *STD PONG 2.0* game was played. The mean from the post-test *knowledge tests* scores (post-test mean = 4.27) shows it was extremely above the midpoint which is 3. The difference between the pre-test and post-test means (difference = 2.65) showed a major positive increase of the *knowledge* of the participants about risky sexual behaviours after the *STD PONG 2.0* game was played and the paired-samples t-test showed that this difference between pre and post knowledge is significant. Hence,

We can, therefore, conclude that the *STD PONG 2.0* was effective at significantly increasing players' knowledge about risky sexual behaviours.

5.5 Persuasiveness

We measured the *persuasiveness* of *STD Pong 2.0*, using four questions on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), after the participants played the game.

Table 5.9 - Descriptive Statistics for Persuasiveness

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
Persuasiveness	41	6.51	.61	.095

Table 5.10 - One Sample t-test for Persuasiveness Change

One-Sample Test						
	Test Value = 4					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Persuasiveness	26.384	40	.000	2.51	2.32	2.71

To analyze the *persuasiveness* of the game, we conducted a one-sample t-test with an optimistic neutral point/mid-point of 4. This was done to determine if the persuasiveness score of participants was different from the neutral score, defined as a persuasiveness score of 4.0. Mean score for the persuasiveness of *STD PONG 2.0* (6.51 ± 0.61) was higher than the neutral persuasiveness score of 4.0, a statistically significant difference of 2.51 (95% CI, 2.71 to 2.32), $t(40) = 26.384$, $p < 0.0005$.

The p-value from the one-sample test of persuasiveness was less than 0.05, therefore we accept the alternative hypothesis which states that there was a significant difference between the test value (neutral = 4) and the mean of the obtained from the persuasiveness score. The result showed a positive score for the persuasiveness of *STD PONG 2.0*. We can, therefore, conclude that the *STD PONG 2.0* was very persuasive with respect to its ability to promote change in risky sexual behaviour.

5.6 Player Experience

To understand the experience of the player while playing *STD PONG 2.0*, we employed the popular Intrinsic Motivation Inventory (IMI) scale [42]. Using a 7-point Likert scale, we collect players' play experience data based on 5 variables. They are:

- The level of *Interest and Enjoyment* the players experienced while playing *STD PONG 2.0*
- The level of the players' *perceived competence* in the game.
- The level of *effort and importance* the player attached to the game.
- The level of *pressure and tension* experienced by the player when playing the game

- The level of *value and usefulness* the players' attached to the game

The following sections show the statistical results for each of the variables under player experience.

5.6.1 Interest and Enjoyment

We measured the level of *Interest and Enjoyment* of *STD PONG 2.0* by participants using 7 questions on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), after playing the *STD PONG 2.0* game.

Table 5.11 - Descriptive Statistics for Interest and Enjoyment

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
Interest/Enjoyment	41	6.57	.28	.04

Table 5.12 – One-Sample t-test for Interest and Enjoyment

One-Sample Test						
	Test Value = 4					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Interest/Enjoyment	59.41	40	.000	2.57	2.49	2.66

To analyse the play experience from playing the game, we conducted a one-sample t-test with an optimistic neutral point/mid-point of 4. We examined if the *Interest and Enjoyment* score from participants was different from the neutral score, defined as an *Interest and Enjoyment* score of 4.0. Mean score for the *interest and enjoyment* of *STD PONG 2.0* (6.57 ± 0.28) was higher than the normal *interest and enjoyment* score of 4.0, a statistically significant difference of 2.57 (95% CI, 2.66 to 2.49), $t(40) = 59.42$, $p < 0.0005$.

5.6.2 Perceived Competence

We measured the level of *perceived competence* in *STD PONG 2.0* by our participants using 6 questions on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), after playing *STD PONG 2.0* game.

Table 5.13 - Descriptive Statistics for Perceived Competence

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
Perceived Competence	41	6.34	.51	.080

Table 5.14 - One-Sample t-test for Perceived Competence

One-Sample Test						
	Test Value = 4					
					95% Confidence Interval of the Difference	
	T	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Perceived Competence	29.266	40	.000	2.34	2.18	2.50

To analyze the play experience from playing the game, we conducted a one-sample t-test with an optimistic neutral point/mid-point of 4. This was done to determine if the *perceived competence* score of participants was different from the neutral score, defined as a *perceived competence* score of 4.0. Mean score for the players' *perceived competence* of *STD PONG 2.0* (6.34 ± 0.51) was higher than the neutral *perceived competence* score of 4.0, a statistically significant difference of 2.34 (95% CI, 2.50 to 2.18), $t(40) = 29.266$, $p < 0.0005$.

5.6.3 Effort/Importance

We measured the level of *effort and importance* that the participants attached to *STD PONG 2.0* using 5 questions on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), after playing the *STD PONG 2.0* game.

Table 5.15 - Descriptive Statistics for effort and importance

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
Effort/Importance	41	5.08	1.09	.17

Table 5.16 - One-Sample t-test for Effort and Importance

One-Sample Test						
	Test Value = 4					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Effort/Importance	6.36	40	.000	1.08	.74	1.43

To analyze the play experience from playing the game, we conducted a one-sample t-test with an optimistic neutral point/mid-point of 4. This was done to determine if the *effort and importance* score of participants was different from the neutral score, defined as an *effort and importance* score of 4.0. Mean score for the level of *effort and importance* the participants attached to *STD PONG 2.0* (5.08 ± 1.09) was higher than the neutral *effort and importance* score of 4.0, a statistically significant difference of 1.08 (95% CI, 1.43 to 0.74), $t(40) = 6.36$, $p < 0.0005$.

5.6.4 Pressure/Tension

We measured the level of *pressure and tension* that the participants experienced when playing *STD PONG 2.0,* using 5 questions on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), after playing the *STD PONG 2.0* game.

Table 5.17 - Descriptive Statistics for pressure and tension

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
Pressure/Tension	41	2.85	1.18	.18

Table 5.18 - One-Sample t-test for Pressure and Tension

One-Sample Test						
	Test Value = 4					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Pressure/Tension	-6.23	40	.000	-1.15	-1.52	-.77

To analyze the play experience from playing the game, we conducted a one-sample t-test with an optimistic neutral point/mid-point of 4. This was done to determine if the *pressure and tension* score of participants was different from the neutral score, defined as a *pressure and tension* score of 4.0. Mean score for the level of *pressure and tension* the participants attached to *STD PONG 2.0* (2.85 ± 1.18) was lower than the neutral *effort and importance* score of 4.0, a statistically significant difference of -1.15 (95% CI, -0.77 to -1.52), $t(40) = -6.23$, $p < 0.0005$.

5.6.5 Value/Usefulness

We measured the level of *value and usefulness* that the participants felt after playing *STD PONG 2.0,* using 7 questions on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), after playing the *STD PONG 2.0* game.

Table 5.19 - Descriptive Statistics for value and usefulness

One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
Value/Usefulness	41	6.51	.42	.07

Table 5.20 - One-Sample t-test for Value and Usefulness

One-Sample Test						
	Test Value = 4					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Value/Usefulness	37.84	40	.000	2.51	2.37	2.64

To analyze the play experience from playing the game, we conducted a one-sample t-test with an optimistic neutral point/mid-point of 4. This was done to determine whether the *value and usefulness* score of participants was different from the neutral score, defined as a *value and usefulness* score of 4.0. Mean score for the level of *value and usefulness* that the participants felt after playing *STD PONG 2.0* (6.51 ± 0.42) was higher than the neutral *effort and importance* score of 4.0, a statistically significant difference of 2.51 (95% CI, 2.64 to 2.37), $t(40) = 37.84$, $p < 0.0005$.

5.7 Discussions of the Results

5.7.1 The Play Experience

The *p* values for all the variables measured under player experience were less than 0.05, therefore we accept the alternative hypothesis which states that there was a significant difference between the means of the variables measured and the test value (neutral = 4). Of the 5 variables measured, 4 of these variables showed a positive score (*interest and enjoyment, perceived competence, effort and importance, value and usefulness*) because they were greater than the neutral value as shown in Figure 5.1. Only one of the variables (*pressure and tension*) showed a negative score as shown in Figure 5.1. A possible reason why *pressure and tension* showed a negative score is because *STD PONG 2.*0 gameplay is very easy, therefore it caused little or no tension or pressure on the players.

Since 4 of the 5 player experience variables tested came out with positive scores, we can conclude that the play experience of *STD PONG 2.0* was very positive.

Table 5.21 - Means and standard deviations of all the variables under play experience

Interest & Enjoyment		**Perceived Competence**		**Effort & Importance**		**Pressure & Tension**		**Value & Usefulness**	
Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
6.57	.28	6.34	.51	5.08	1.09	2.85	1.18	6.51	.42

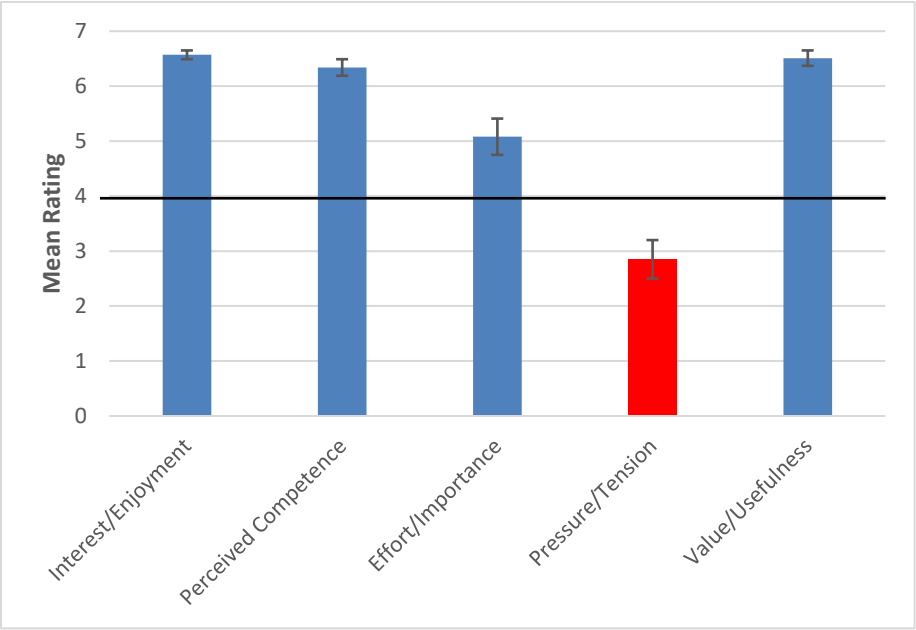


Figure 5.1 - Bar graph of the mean of the IMI subscales for STD Pong 2.0. Error bars represent a 95% confidence interval.

As seen in the bar graph (Figure 5.1), the best attribute of the game as perceived by the players is the Interest and Enjoyment attribute followed by the Value and Usefulness attribute. This implies that the player enjoyed playing *STD PONG 2.0* and also found it very useful to their daily living with respect issues around risky sexual behaviours. This on the long run implies that *STD PONG 2.0* will likely be played for a longer time since players enjoyed it.

We believe that the first characteristics required for a game to be successful are the attributes of interest and enjoyment. If players are not interested in a game and if they do not get a level of enjoyment from it, the game can be described as unsuccessful because enjoyment and fun are some of the main reasons why people play games. Our game showed a significantly high score in interest and enjoyment which implies that *STD Pong 2.0* was really enjoyed by the players. The fact that the game was enjoyed also implies that there is a possibility for a repeat play which would result in it being played for a longer period of time. Long-time engagement is very important for a persuasive game that would promote behaviour change over a long period of time. The intended behaviour change cannot happen unless people play the game.

We were cautious about concluding on long-term engagement through this study since the game was played for only 7 days, which is not long enough to make such a conclusion. However, we believe that there is a high tendency that the player will engage with the game longer since they enjoyed playing it. This is also because it captured the interest of the players, this means that players would be engrossed and engaged more in the game, creating a high opportunity for persuasion and behaviour change.

Again, our results also show that players found the game useful. One of the major challenges faced by persuasive game researchers is how to balance the fun aspect of the game and the usefulness with respect to motivating the desired behaviour change. Many games easily achieve the fun element but not the usefulness. The result of the *STD PONG 2.0* evaluation shows, however, that the game successfully achieved both the fun (interest and enjoyment) and the usefulness element (value and usefulness). This makes it more likely that the game will engage players for a long-term and also motivate the intended change in risky sexual behaviour. We achieved this balance through iterative user-centred design process adopted in this research. This allowed us to work with stakeholders, iteratively design, evaluate, and refine the game to achieve the final design.

This result is supported by an equally high score on perceived importance. Another reason why players might abandon a game is if they do not see any importance of playing the game. If the game does not seem to have any value to them or if it has no sense of purpose, some players may likely abandon such games and seek other games. Our game showed a high score on importance, value and usefulness. This implies that the players saw the importance of *STD Pong 2.0* in their lives. It also means that it adds a lot of value to their individual lives. This is a very important part of our finding because if the player does not see the topic of risky sexual behaviours as simulated in the game as important and valuable, they may not play the game.

One of the reasons why players cease to play some games is because of how frustrating it is to play, due to excessively difficult game challenge, bad controls, or poor graphical representation. This would make the players feel incompetent to play the game. *STD Pong 2.0* showed a high score in *perceived competence*. This implies that the player of the game feels very competent while playing the game. It also suggests that the game was not too hard and that the controls were not frustrating for them.

The only variable that showed a score below the midpoint is the pressure and tension subscale. This is also an important element of a game that can determine if the game would be played for long. Every ideal game has to pose some level of difficulty because if it is too easy, players may easily get bored of the game in the long run. *STD Pong 2.0* showed a low level of pressure and tension. We intentionally favoured interest and enjoyment over tension and pressure because we wanted the majority of the players to finish all the game levels and hence acquire the intended knowledge that would lead to behaviour change.

5.7.2 The Perceived Persuasiveness

Persuasiveness can be described as the ability of an intervention to cause a change in a target behaviour to the desired behaviour [65]. The higher the persuasiveness of an intervention, the more the likelihood of the intervention to cause the desired change in behaviour. From Figure 5.2, we can see that the persuasiveness of *STD PONG 2.0* was far above the normal persuasiveness score of 4.0. This shows that our game has a strong potential of being persuasive. This also validates that the combinations of the selected persuasive strategies we employed in the game design were effective. It does not expose which of the strategies was most effective though.

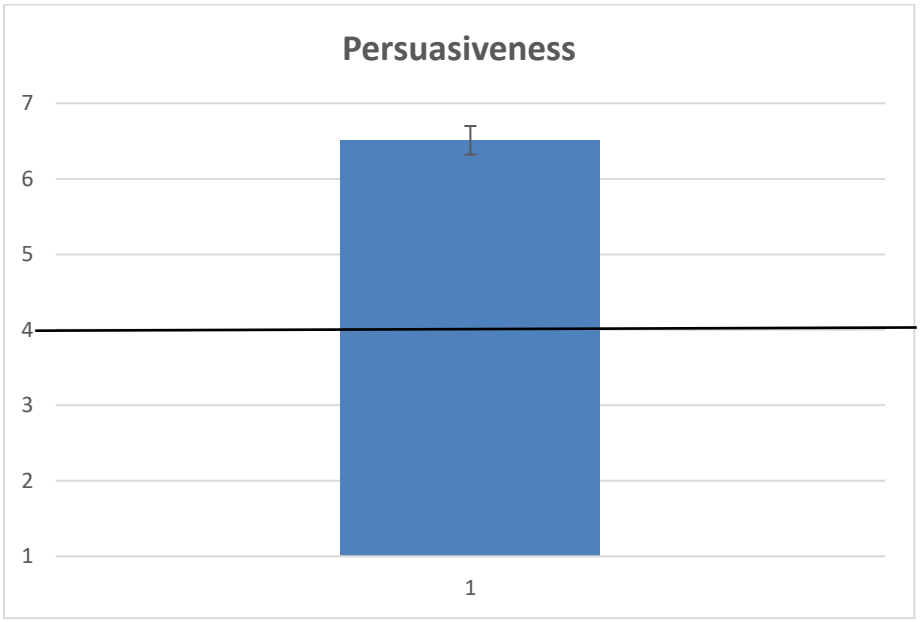


Figure 5.2 - The persuasiveness of STD Pong over the 4.0 normal score. Error bars represent a 95% confidence interval.

5.7.3 Knowledge Change

As stated earlier, knowledge is an indicator of behaviour change and research has shown that people with more knowledge of the risks and benefits of a target behaviour are more likely to change their behaviour than those without any knowledge [18]. This means that the more knowledge an individual has about the STDs, its risk factors and prevention, the more likely he is to change his risky sexual behaviour. As indicated in Figure 5.3, a comparison of the knowledge of the participants before playing the game and after playing the games, showed a great amount of improvement. This means that *STD Pong 2.0* caused a great increase in the knowledge of the participants about STDs and their risk factors. There is also a *domino effect* that can happen from the acquisition of knowledge. If players of the game can acquire enough knowledge about STDs, they are most likely to discuss the information learn within their peers which would promote reflection and lead to some form of social learning among the target population. One possible reason why playing STD pong 2.0 led to a significant increase in knowledge is because of the cultural appropriateness of the game. The game is tailored to the African audience and reflects Africannness in many ways including the game narrative, characters, soundtrack, environment. Research has shown that people learn more and better when the learning material is contextualized and reflects their reality [10][57].

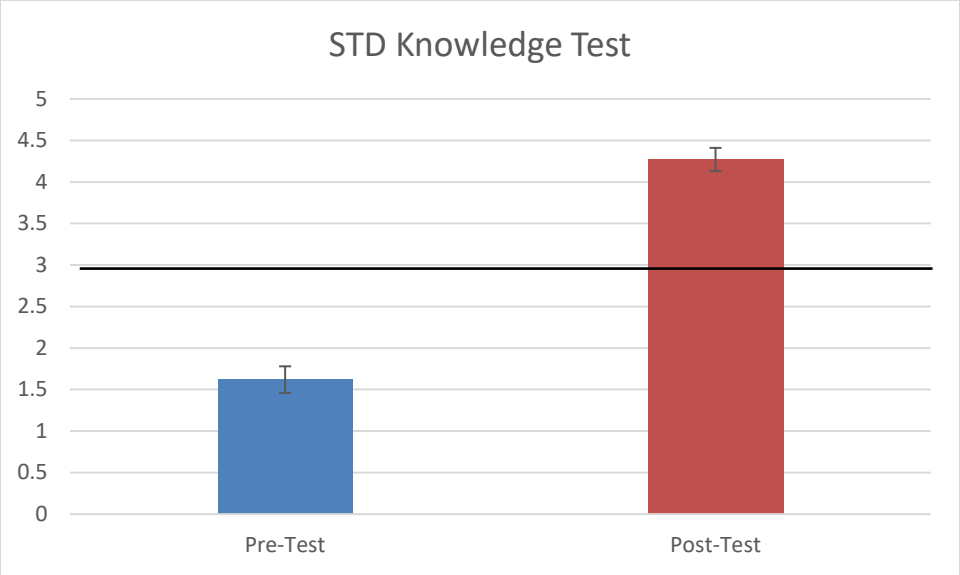


Figure 5.3 – The Pre and Post-test of STD Knowledge. Error bars represent a 95% confidence interval.

5.7.4 Attitude, Intention and Self-Efficacy change

Below is a brief summary of the results from the measure of attitude, intention and self-efficacy change

To recap the results, as shown in Figure 5.4, the means from the pre-test *attitude, intention and self-efficacy* survey responses (pre-test mean = 4.60, 4.54 and 4.55 respectively) show that they fell slightly above the midpoint/neutral score which is 4.0. This implies that the *attitude, intention and self-efficacy* of the participants were slightly positive before the *STD PONG 2.0* gameplay. The mean from the post-test attitude survey responses (post-test mean = 6.69, 6.71 and 6.74 respectively) show they were extremely above the midpoint which is 4. The differences between the pre-test and post-test means of these variables (difference = 2.09, 2.17 and 2.19 respectively) showed a significant positive change in *attitude, intention and self-efficacy* of the participants against risky sexual behaviours after the *STD PONG 2.0* condition was applied on the sample.

From these results, we can draw two kinds of conclusion.

a) Since the attitude, intention and self-efficacy pre-test means were slightly above the midpoint of 4.0, this implies that before the application of the *STD Pong 2.0* intervention,

the participants already had fairly positive attitudes, intentions and self-efficacies against risky sexual behaviours. This meant that the only way the *STD Pong 2.0* could record success with respect to these variables, would be a scenario where the post-test means are not just greater than the midpoint, but also greater than the pre-test means. The initial fairly positive score is probably because of the increasing attention and awareness about the dangers of risky sexual behaviours in the media. The post-study results, however, show that *STD PONG 2.0* effectively reinforced attitude, intention, and self-efficacy change against risky sexual behaviours.

b) Similarly, since the attitude, intention and self-efficacy post-test means were significantly above the midpoint 4.0 and significantly greater than the values of the pre-test means, this implies that the participants experienced very significant positive changes/improvements in their attitudes, intentions and self-efficacies against risky sexual behaviours. According to Oinas-Kukkonen [63], one of the possible outcomes of persuasive interventions on a user is a reinforcement of the user's current attitudes or behaviours, making them more resistant to an opposite behaviour change. We observed from the results that *STD Pong 2.0* improved the attitude, intention and self-efficacy of participants after its usage.

These results illustrate the power of persuasive games in helping people to not only change their behaviours but also to reinforce their existing behaviour. This is very important in many cases of behaviour change since human are very susceptible to falling back to their old ways, even after successfully overcoming the undesirable behaviour. For example, a chronic smoker who just stopped smoking may fall back to that behaviour if proper measures are not taken to maintain the behaviour. In our own case study, a person who stopped practising risky sexual behaviours may begin those behaviours again if the persuasive system does not promote sustenance or reinforcement of good behaviours when the desired safe sexual behaviour is achieved. Our intervention improved the behaviour indicators of our participants against risky sexual behaviours.

Interestingly, our results show that our participants had a positive attitude, self-efficacy, and intention against risky sexual behaviours. However, there has been a consistent increase in risky sexual behaviour and hence associated STDs. A possible reason is that they lack adequate knowledge on how to avoid risky sexual behaviours. This is supported by the results of the

knowledge test which shows that our participants scored very low on the baseline knowledge about STDs (pre-study: 1.62 (0.58)) and related risk factors, see Table 5.22. This result suggests, that people may have a positive attitude, self-efficacy, and intention but without adequate "how-to knowledge," they may not be able to enact the desired behaviour. The result is not surprising considering that sex is still being considered as a sacred practice that should never be discussed in the public in many African cultures. People are stigmatized if they discuss sex openly, hence, most African youths lack adequate knowledge about sexually-related topics. As a result, even with good intention to avoid risky behaviour, they often engage in it due to lack of adequate knowledge.

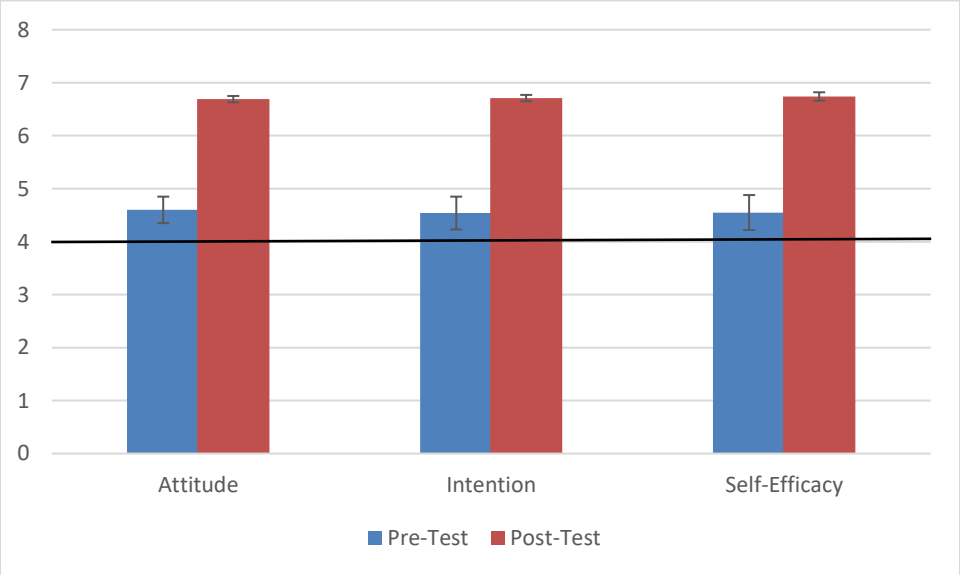


Figure 5.4 - Pre and Post-test of Attitude, Intention and Self-Efficacy. Error bars represent a 95% confidence interval.

Table 5.22 – The Means and Standard deviations for pre and post-tests of Attitude, Intention and Self-Efficacy

	Attitude	**Intention**	**Self-Efficacy**	**Knowledge**
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
Pre-Test	4.60 (0.82)	4.54 (1.02)	4.55 (1.09)	1.62 (0.58)
Post-Test	6.69 (0.20)	6.71 (0.21)	6.74 (0.23)	4.27 (0.55)

CHAPTER 6 CONCLUSION

In this chapter, we summarized the thesis and highlight the limitations, contributions, and suggested potential directions for future work.

6.1 Limitations

The main limitation of the research is the issue of self-reporting. Although, before the user study, we instructed the participants to answer the questions sincerely and to make their answers a representation of their individual states of mind, it is common knowledge that human perception is not always perfect, and bias would most likely be present. There is no way to ensure that participants were actually answering the attitude, efficacy and intention questions without bias. Nevertheless, self-report is still the valid and predominant approach for assessing beliefs and attitudes in the area of HCI.

Majority of our participants came from a youth social group and my recruiter was the leader of the group. This confounding factor may have affected the responses from participants, as the recruiter was the head of the group, who wields a some degree of power over them as a figure of authority. Since the messages of the leader are mostly about moral uprightness, which includes abstinence from sex until marriage, the responses on the survey may likely be affected by the expectations of their leader. This effect has been illustrated in the Milgram experiment [11].

We made *STD Pong 2.0* only for Android devices. Although research shows that Android devices possess the most smartphone penetration in Africa [59], this does not mean that there are no users of other smartphone platforms like iPhone, Windows Phone and the Blackberry. This means that this intervention does not cater for these other minority smartphone populations.

We also believe that this study had some other external validity issues since we did not check if the observed behaviour change identified in this user study is a temporary change or a permanent stage. The time for the study was too short and the time point of data collection was too few. A more detailed study would possess more than two time points for collecting data about the

players' behaviour, over a longer period of time. The transtheoretical model suggests about 6 months [77].

Players identified that the game was not long enough for them to enjoy. It had only 10 levels and after that, they could either reply their levels of choice in the arcade mode or start the story mode over again. We believe that this could cause players to lose interest in the game after a couple of weeks or months. We plan to extend the game by adding sub-levels for each level to give players more challenges to encounter before a level ends. We believe the short length of the games was ideal for this particular study to ensure that people played a large chunk of the game and learn about the associated STDs.

Some players also identified the fact that the game was too easy. This fact was also evident in the low score for tension and pressure under the player experience data collected. The difficulty of the game was made equally for all player for the purpose of the study. The final game would have an option to choose between three levels of difficulty; easy, medium and hard.

Our intervention, though tailored for Africans, was developed in the English Language. This may not be as effective in some non-English speaking African countries. We have plans in the future to make the games multi-lingual, accommodating all the major languages in Africa. Another route to solve this problem would be to use less text and more culturally-meaningful icons as discussed in one of our publications [59].

6.2 Study Summary

In a pre-test post-test design study of 62 participants, with 68% males and 32% females among the population of Nigerian Youths ranging from age 12 to age 45, we effectively examined if *STD Pong 2.0* motivated a positive change in the attitude, intention and self-efficacy of participants against risky sexual behaviours. We were also able to examine if the game led to an increase in the knowledge of participants about STDs and associated risky behaviours. Finally, we examined our participants' overall experience from playing the games and also the persuasiveness of *STD Pong 2.0* with respect to motivating change in risky sexual behaviours.

The findings are summarized in Table 6.1 below:

TESTED VARIABLES	OUTCOMES
Attitude	Positive Reinforcement
Intention	Positive Reinforcement
Self-Efficacy	Positive Reinforcement
STD Knowledge	Positive Change
Persuasiveness	Positive
Player Experience	Positive except for Pressure and tension

Table 6.1 - Summary of the tested variables and their outcomes from the User Study

6.3 Contributions

We successfully designed and developed a game that can persuade African Youths to change their risky sexual behaviours, closing the research gap that has been existing in that area. We successfully conducted a short-term field evaluation and showed that *STD Pong 2.0* promotes a positive change in attitude change, intention change, and self-efficacy change of individuals against risky sexual behaviours. We also showed that players had positive experiences from playing the game and the game successfully increased plays knowledge about risky sexual behaviours. Finally, the results show that players found our game to be highly persuasive with respect to its ability to promote change in risky sexual behaviour. More importantly, we show that persuasive game can be effective in none-Western population and none-Western culture. Hence, they can be used to address real-life issues among marginalized populations.

So far, the research has led to three publications and additional papers under preparation. This research has gained a lot of media attention. It has been featured on MetroUk News [41], CBC news [87] , Dal News [33], LabNearby [88], Worshipmedia.ca, EScience News [86]. It also sparked up a discussion thread on Reddit in 2018 [85], where one comment asked a funny

question, *"Do they (Africans) actually have mobile phones? like are they going to be able to use it (the game)?"*

We also presented earlier forms of this research as poster papers at the HCIxB CHI 2018, Persuasive Technology Conference 2018 and the Black Research Symposium 2019.

PAPER 1 [60]	
Paper Title	STD PONG: A Personalized Persuasive Game for Risky Sexual Behaviour Change in Africa.
Origin	This paper was developed from the design and development of *STD PONG,* with an emphasis on the game design.
Conference	Persuasive Technology 2018

PAPER 2 [61]	
Paper Title	STD PONG: Changing Risky Sexual Behaviour in Africa through Persuasive Games
Origin	This paper was developed from the design and development of *STD PONG,* with an emphasis on the entire game design and its Africanness.
Conference	AfriCHI 2019

PAPER 3 [59]	
Paper Title	Developing Persuasive Mobile Games for African Rural Audiences: Challenges implementing the Persuasive Techniques
Origin	This paper was developed from the observations and feedback from the playtests

	of *STD Pong 2.0*.
Conference	UMAP 2019

PAPER 4 (In Progress)	
Paper Title (Tentative)	Games on a Mission: A systematic review of persuasive games from 2001 till 2018
Origin	This paper is being developed from an extended version of the Literature Review of this paper.
Conference	NILL

6.4 Future Work

In the future, we plan to run a more comprehensive study with a bigger sample size, for a longer duration. The participants for this study would come from various countries in Africa. This would help us understand differences in culture and how they affect the variables being examined in the game. The study duration would be longer, ideally 6 months or more. There would be a minimum of three time points for collecting data about the behaviour of participants. One time point at the beginning (baseline), one time point immediately the end, and the third time point one month or more after the study. This would help to keep track of the participants' progress and the effectiveness of the game with respect to motivating and sustaining behaviour change.

We also plan to allow for an individual-level personalization of some game contents to each player. Players should be able to customize features in the game like attires, game theme colour and personally relevant data.

We also plan to tailor the game for various populations that were not catered for in the game. As stated earlier, the game is developed in the English Language, which means that the game may

not be as effective in non-English speaking countries. We plan to make the game multi-lingual, to cater for the major languages in Africa. This would be done by creating an option for players to select languages of their choice when playing STD Pong. As identified in one of our published papers from this work [59], there are many rural communities in the African that would benefit from this persuasive intervention but these communities are highly populated with people that are not literate and cannot read. Therefore, this intervention may not be very effective for them. To solve this issue, we plan to implement a voice-over option for this category of people. The STD Scroll and quiz section of the game would have the option of audio and textual information.

We also plan to investigate if persuasive games targeting Africans would be effective in domains other than risky sexual behaviour e.g. physical activity, climate change, corruption, and sustainable environment.

Also, as part of our future work, we are developing a more comprehensive systematic review of persuasive games from diverse domains, following a more rigorous process. The review would involve games from various sources like the Playstore, online game sources and reputable research databases.

6.5 Conclusion

This thesis contributes to an important research field of Persuasive Technology within the Human-Computer Interaction domain by developing persuasive interventions for the underserved African population. It demonstrates how persuasive games can be designed to discourage risky behaviours with a specific focus on risky sexual behaviours that lead to the spread of Sexually Transmitted Disease (STDs. Specifically, we designed and developed a persuasive game, titled *STD Pong 2.0*, for discouraging risky sexual behaviours among African youths. The results of a one-week field evaluation on 62 African youths answered our overarching research questions: "*Can STD Pong 2.0 promote a positive change in the risky sexual behaviours among Africans Youths?*". Specifically, the results show that the *STD Pong 2.0* promoted a positive change in the *Attitude*, *Intention* and *Self-efficacy* of participants against risky sexual behaviours. The results also that our participants found the game to be highly persuasiveness and also had a really positive play experience from playing the game as shown by

the significant score in *interest/enjoyment*, *interest and enjoyment, perceived competence, effort and importance, value and usefulness.* Finally, we observed that *STD Pong 2.0* led to a significant increase in player's knowledge about STDs and associated risky behaviours. Considering the positive score of all indicators, we can conclude that *STD Pong 2.0* was effective at promoting a positive change in the risky sexual behaviours among Africans Youths. More importantly, we show that persuasive games can be effective in non-Western populations and non-Western culture. Hence, they can be used to address real-life issues among marginalized populations.

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APPENDIX A. List of My Publications

1. **Chinenye Ndulue** and Rita Orji. 2019. Developing Persuasive Mobile Games for African Rural Audiences: Challenges implementing the Persuasive Techniques; In Proceedings of UMAP '19: 27th Conference on User Modeling, Adaptation and Personalization, June 09-12, 2019, Larnaca, Cyprus. ACM, New York, NY, USA. 6 pages. https://doi.org/10.1145/3314183.3323857

2. **Chinenye Ndulue,** Rita Orji. 2019. Personal EEG devices with Persuasive Games: Another Frontier for Stroke Rehabilitation In 27th Conference on User Modeling, Adaptation and Personalization Adjunct (UMAP'19 Adjunct), June 9–12, 2019, Larnaca, Cyprus. ACM, New York, NY, USA. 5 pages. https://doi.org/10.1145/3314183.3325008

3. **Ndulue C,** Orji R 2018. STD PONG: Changing Risky Sexual Behaviour in Africa through Persuasive Games. In Proceedings of AfriCHI conference (Windhoek'18). https://doi.org/10.1145/3283458.3283463

4. **Ndulue C,** Orji R STD PONG: A Personalized Persuasive Game for Risky Sexual Behaviour Change in Africa. In: Int. Work. Pers. Persuas. Technol. pp 1–7

5. Nkwo M, Orji R, Nwokeji J, **Ndulue C** 2018. E-Commerce Personalization in Africa : A Comparative Analysis of Jumia and Konga. In: Int. Work. Pers. Persuas. Technol. pp 1–9

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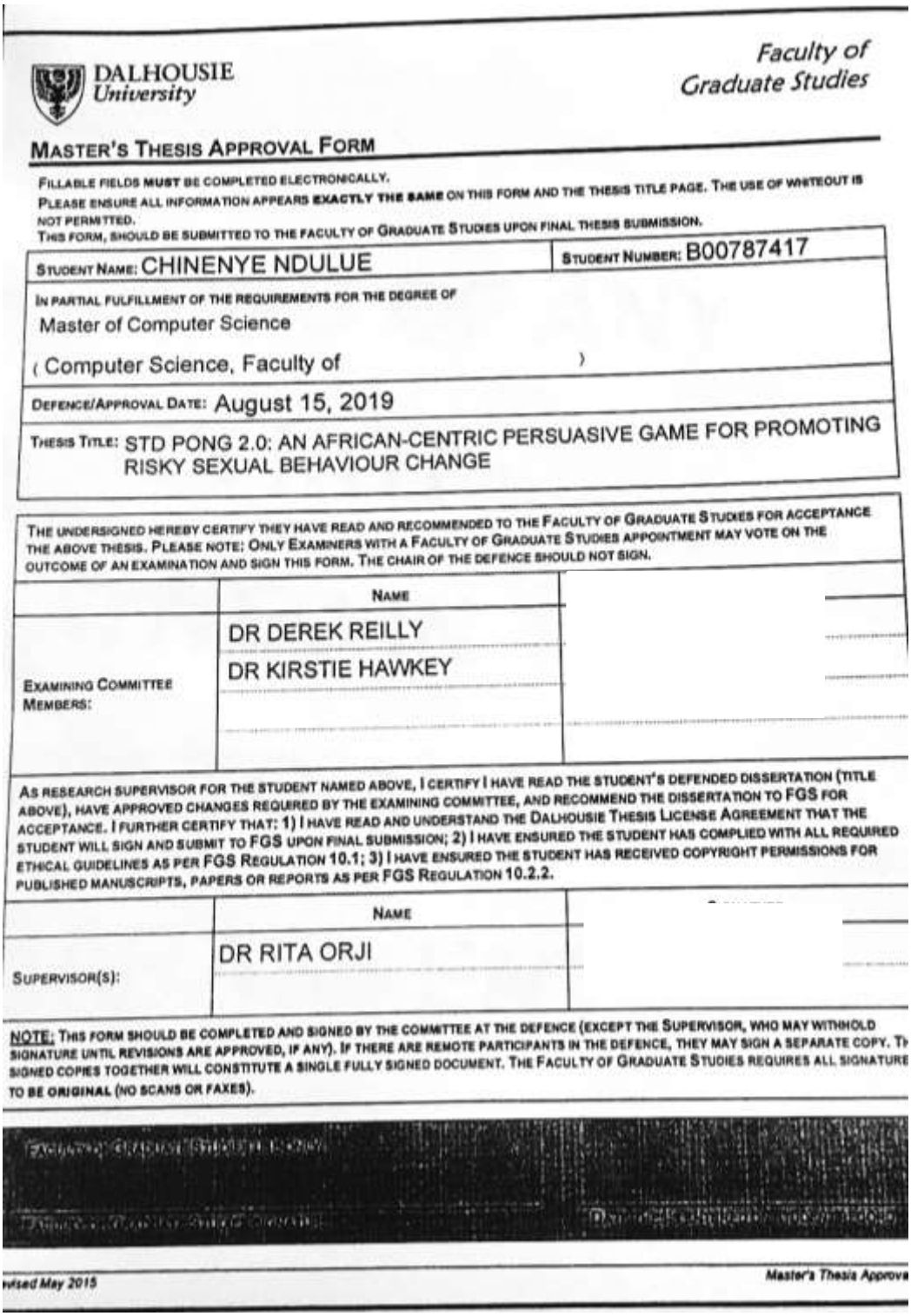

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF Master of Computer Science	
(Computer Science, Faculty of)	
DEFENCE/APPROVAL DATE: August 15, 2019	
THESIS TITLE: STD PONG 2.0: AN AFRICAN-CENTRIC PERSUASIVE GAME FOR PROMOTING RISKY SEXUAL BEHAVIOUR CHANGE	

THE UNDERSIGNED HEREBY CERTIFY THEY HAVE READ AND RECOMMENDED TO THE FACULTY OF GRADUATE STUDIES FOR ACCEPTANCE THE ABOVE THESIS. PLEASE NOTE: ONLY EXAMINERS WITH A FACULTY OF GRADUATE STUDIES APPOINTMENT MAY VOTE ON THE OUTCOME OF AN EXAMINATION AND SIGN THIS FORM. THE CHAIR OF THE DEFENCE SHOULD NOT SIGN.

	NAME	
EXAMINING COMMITTEE MEMBERS:	DR DEREK REILLY	
	DR KIRSTIE HAWKEY	

AS RESEARCH SUPERVISOR FOR THE STUDENT NAMED ABOVE, I CERTIFY I HAVE READ THE STUDENT'S DEFENDED DISSERTATION (TITLE ABOVE), HAVE APPROVED CHANGES REQUIRED BY THE EXAMINING COMMITTEE, AND RECOMMEND THE DISSERTATION TO FGS FOR ACCEPTANCE. I FURTHER CERTIFY THAT: 1) I HAVE READ AND UNDERSTAND THE DALHOUSIE THESIS LICENSE AGREEMENT THAT THE STUDENT WILL SIGN AND SUBMIT TO FGS UPON FINAL SUBMISSION; 2) I HAVE ENSURED THE STUDENT HAS COMPLIED WITH ALL REQUIRED ETHICAL GUIDELINES AS PER FGS REGULATION 10.1; 3) I HAVE ENSURED THE STUDENT HAS RECEIVED COPYRIGHT PERMISSIONS FOR PUBLISHED MANUSCRIPTS, PAPERS OR REPORTS AS PER FGS REGULATION 10.2.2.

	NAME	
SUPERVISOR(S):	DR RITA ORJI	

NOTE: THIS FORM SHOULD BE COMPLETED AND SIGNED BY THE COMMITTEE AT THE DEFENCE (EXCEPT THE SUPERVISOR, WHO MAY WITHHOLD SIGNATURE UNTIL REVISIONS ARE APPROVED, IF ANY). IF THERE ARE REMOTE PARTICIPANTS IN THE DEFENCE, THEY MAY SIGN A SEPARATE COPY. TH SIGNED COPIES TOGETHER WILL CONSTITUTE A SINGLE FULLY SIGNED DOCUMENT. THE FACULTY OF GRADUATE STUDIES REQUIRES ALL SIGNATURE TO BE ORIGINAL (NO SCANS OR FAXES).

[redacted]

vised May 2015 Master's Thesis Approva

APPENDIX D.Screenshots of STD Pong Prototype

Poster Image

Main Menu

Game Start Screen

STD Scroll

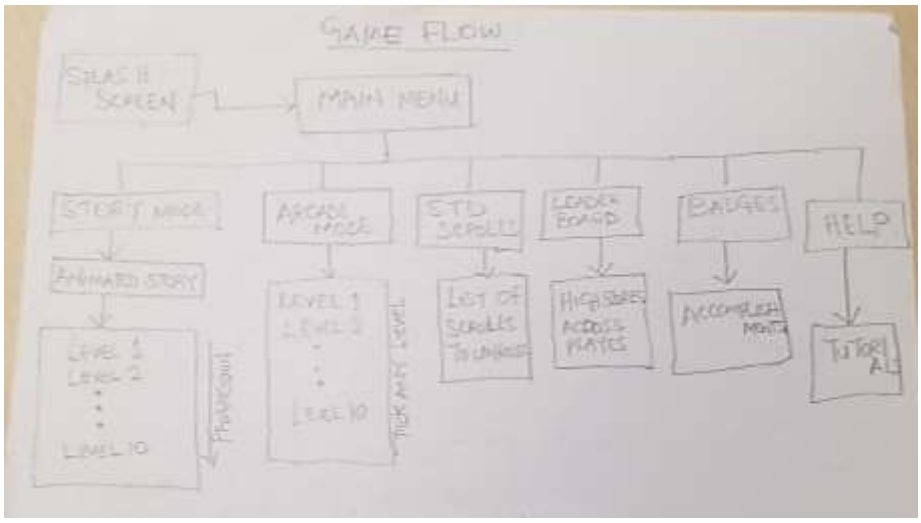
Pause Menu

GamePlay Scene

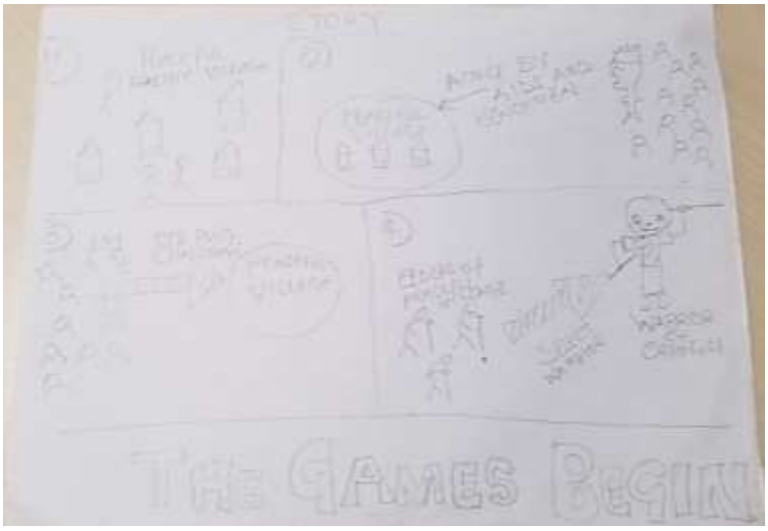
GamePlay Scene

Defeated STD Scene

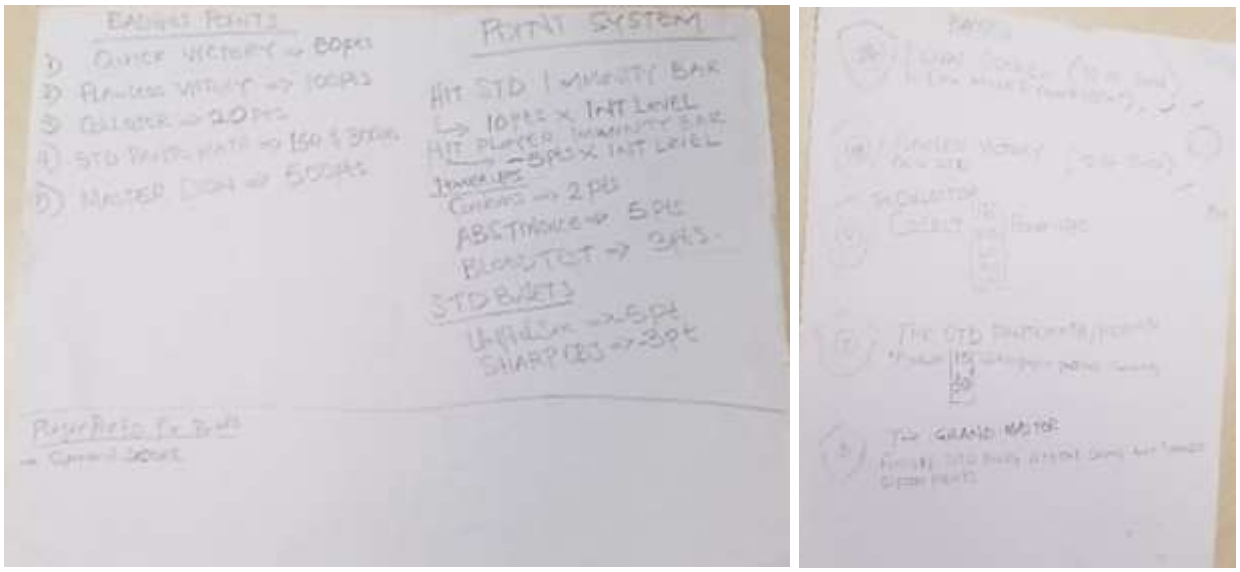
APPENDIX E. Low-Level Prototype for the STD PONG 2.0



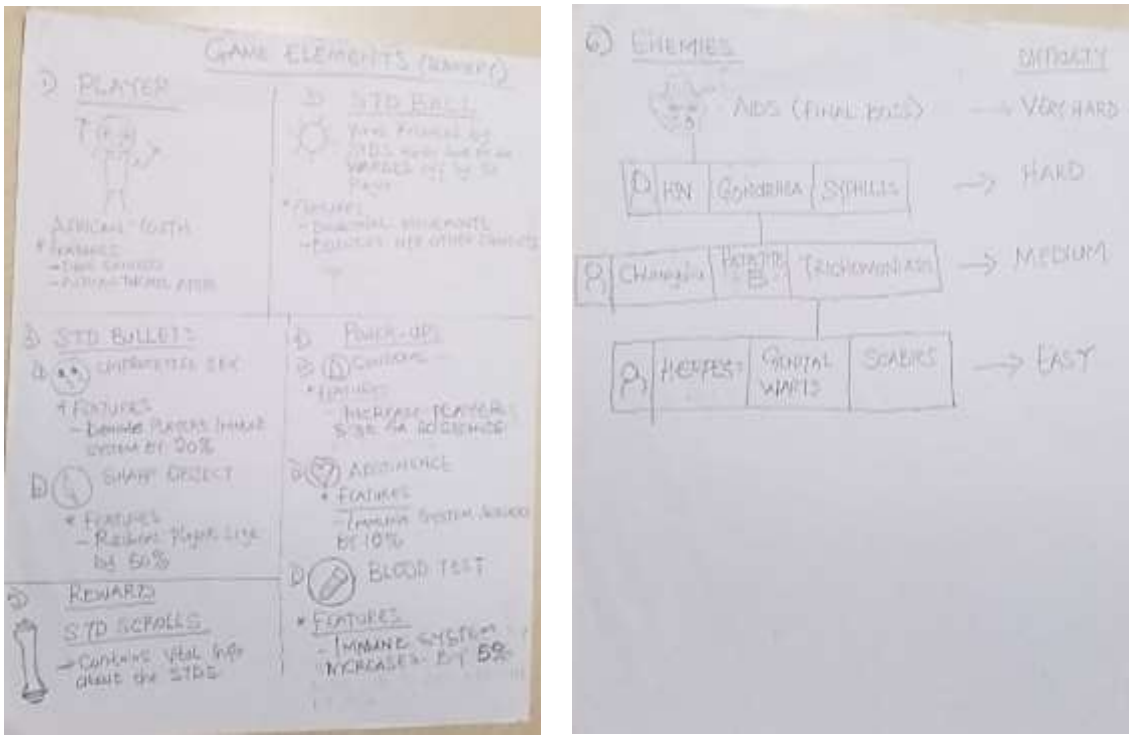
Game Flow



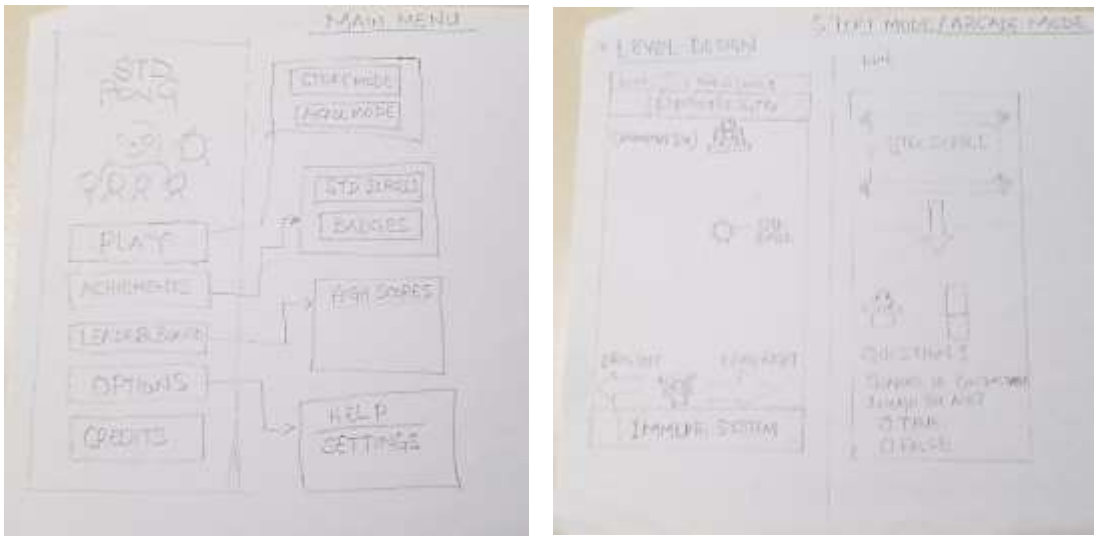
Game Story



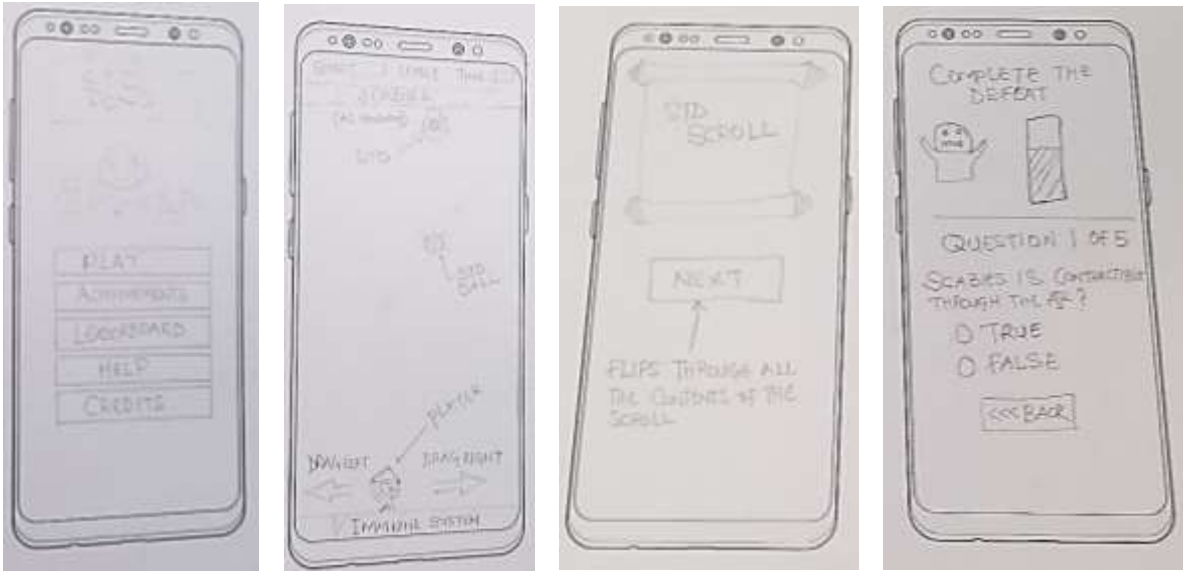
Point System Brainstorm



Game Elements Brainstorm



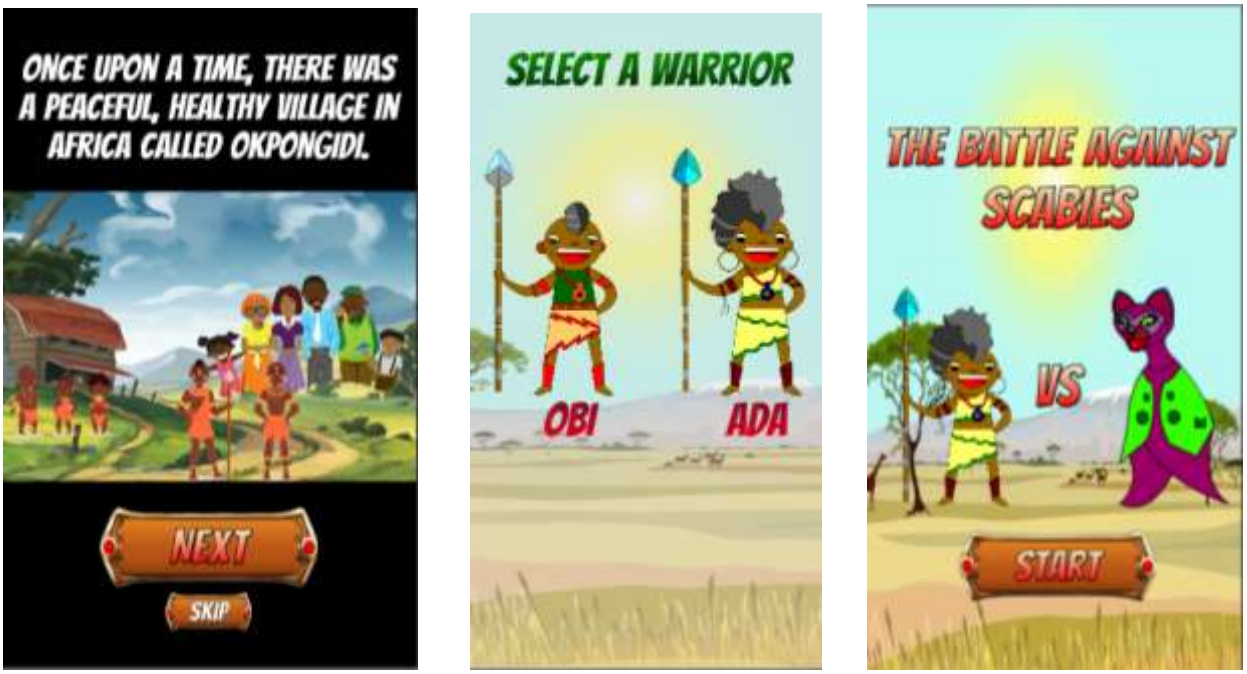
Gameplay Brainstorm



Game Interface Brainstorm

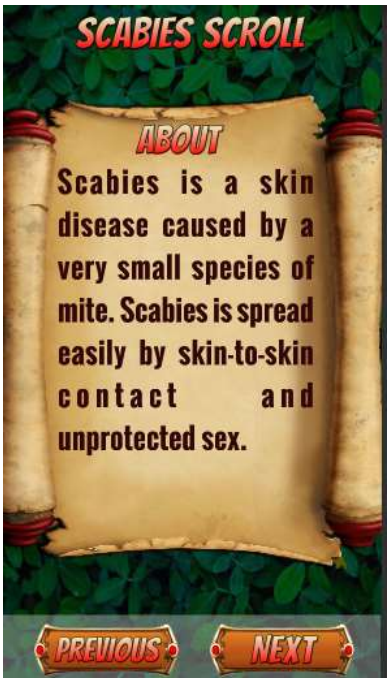
APPENDIX F. Screenshots of STD Pong 2.0

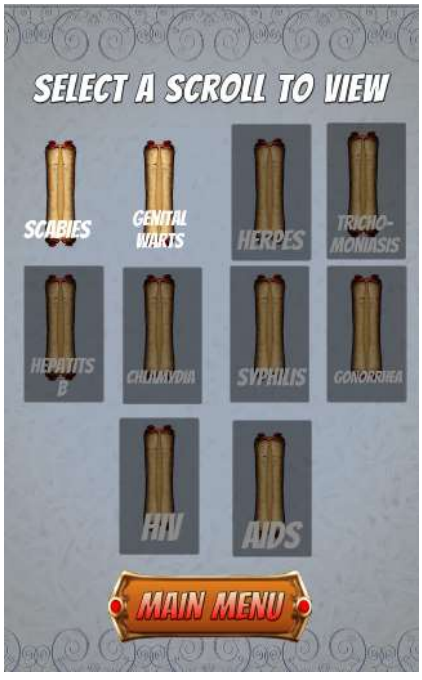
The start screen and game mode selection buttons.



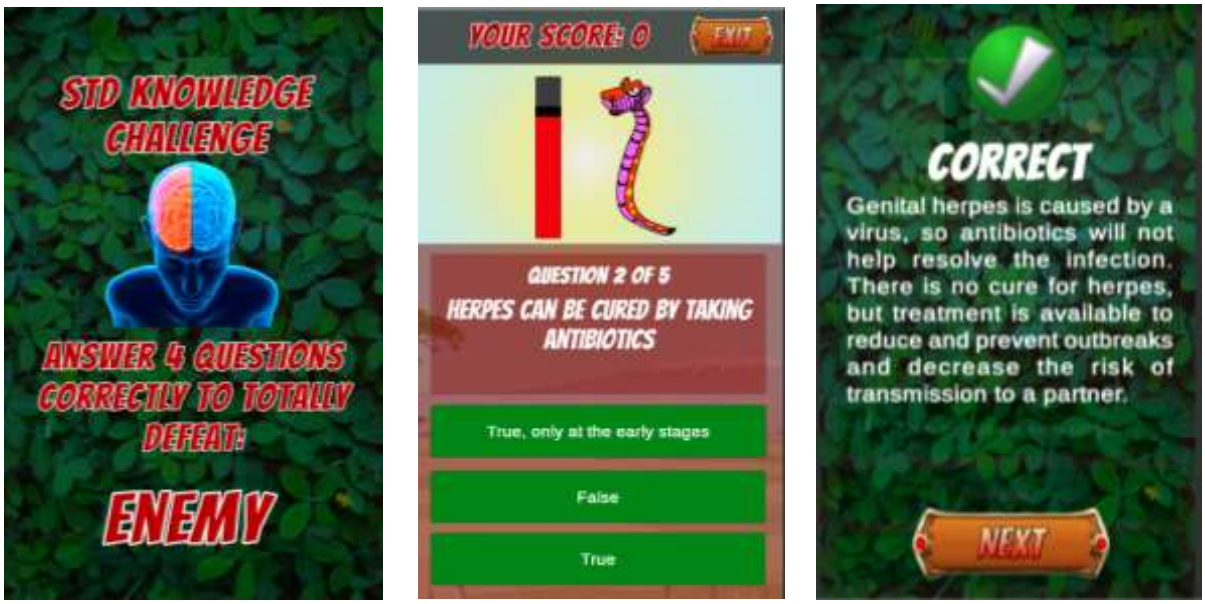
The Story Screen, Player select and Game Start.

The Main Game Screen and the Scroll win screen.

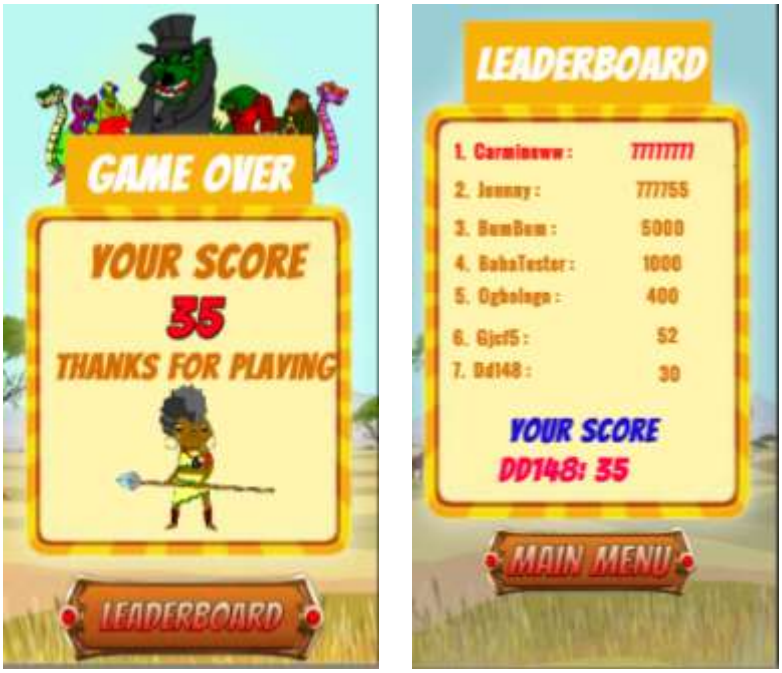




STD Scrolls



STD PONG QUIZ MINI GAME



The Game Over Screen and the Leaderboard Screen

Badges Acquired and Help Scene

The Enemies(STDs), Power-Ups and STD Bullets

APPENDIX G. Pilot Test Observations

STD PONG OBESERVATIONS

NAME: [redacted]

STUDY OBSERVATIONS

- Mobile Version of the Survey is hard to read (Pre-test)
- It feels like the survey questions are directed to only people who are not married. (Pre-test)

GAME OBSERVATIONS

- Why is my email needed 2 play the game?
- I am not sure the aesthetics of the game represent what safe sex is about.
- I don't understand why I have to fill a questionaire before playing the game on the story board mode.
- Also, I don't get to see if my answers are right or wrong, this defeats the purpose of gaining knowledge playing the game.
- The game was too fast for a first time player
- I did not know what to expect, no instruction to play the game for first attempt [Rehearsal PSD]
- The information about Scabies should come right after the quiz.

STD PONG OBESERVATIONS

NAME: [redacted]

STUDY OBSERVATIONS

- First study: I know the questions are in a way different but they are still all in a way similar. Thereby kind of generates similar answers. (first page) ✓
- 2nd page: From sex questions, then 1 question about sharp objects and back to sex questions.

No back button to change an answer. ✓

- Rephrase question 21*
- I don't thing there is any need for the strongly disagree and strongly agree at both end sc

final study

questi

GAME OBSERVATIONS

- Mistake in the some words (to to)*
- I know its an African name ☺
- Why is it compulsory to enter an email address?
- I didn't see my score or know which questions i got wrong.
- Overall i like game and the story behind it.

//

STD PONG OBESERVATIONS

NAME: [redacted]

STUDY OBSERVATIONS

Q1. Typo error: "Not" instead of not on the email request page.

Q9: I think for scale values it should be noted that 1 is the least and 7 the best/most

OR

* Worthless 1 2 3 . . . . 7 N/A valuable

*

Q16-20: Bkg Picture makes ~~on bkgd~~ the font blend in and a bit invisible

Post survey!:

GAME OBSERVATIONS

* Warrior selection: Just a dark overlay around chosen character. What of using a frame instead

* Knowledge of Scabies!: "Tap Next to continue" might be a good addition (Maybe) (before the actual Pong Game)

After replaying the game in arcade mode, I battled against scabies again & after the * cutscene in post-game questionnaire it remains on Question 5 of 5 does it go back home or anything.

STD PONG OBESERVATIONS

NAME: [redacted]

STUDY OBSERVATIONS

Pre-test: 1. email address field is short - 2 characters

Template of study will be difficult for some people to read especially the color scheme

GAME OBSERVATIONS

Consent form: All bold (other text)

Story: He issued a challenge to to

Scabies question: Scroll info different → body parts

Testing before and after is good. I pay more attention to content. Answers on test before game needed.

* Pictures of symptoms might help - if someone already has infection...

Test: On correct answer, green bar decreases - which is confusing.

STD PONG OBESERVATIONS

NAME: [redacted]

STUDY OBSERVATIONS

Pretest: Question 1
- Typo error: Change "Not" to "Note"
- Box for email address is too small

Pretest: Question 2
- Remove "please" (I think it is not necessary)

Pretest: Question 7, option 2
- Change "Times" to "times"

Pretest: Questions 9-15
- A brief definition of "protected sex" may be necessary, but not compulsory.

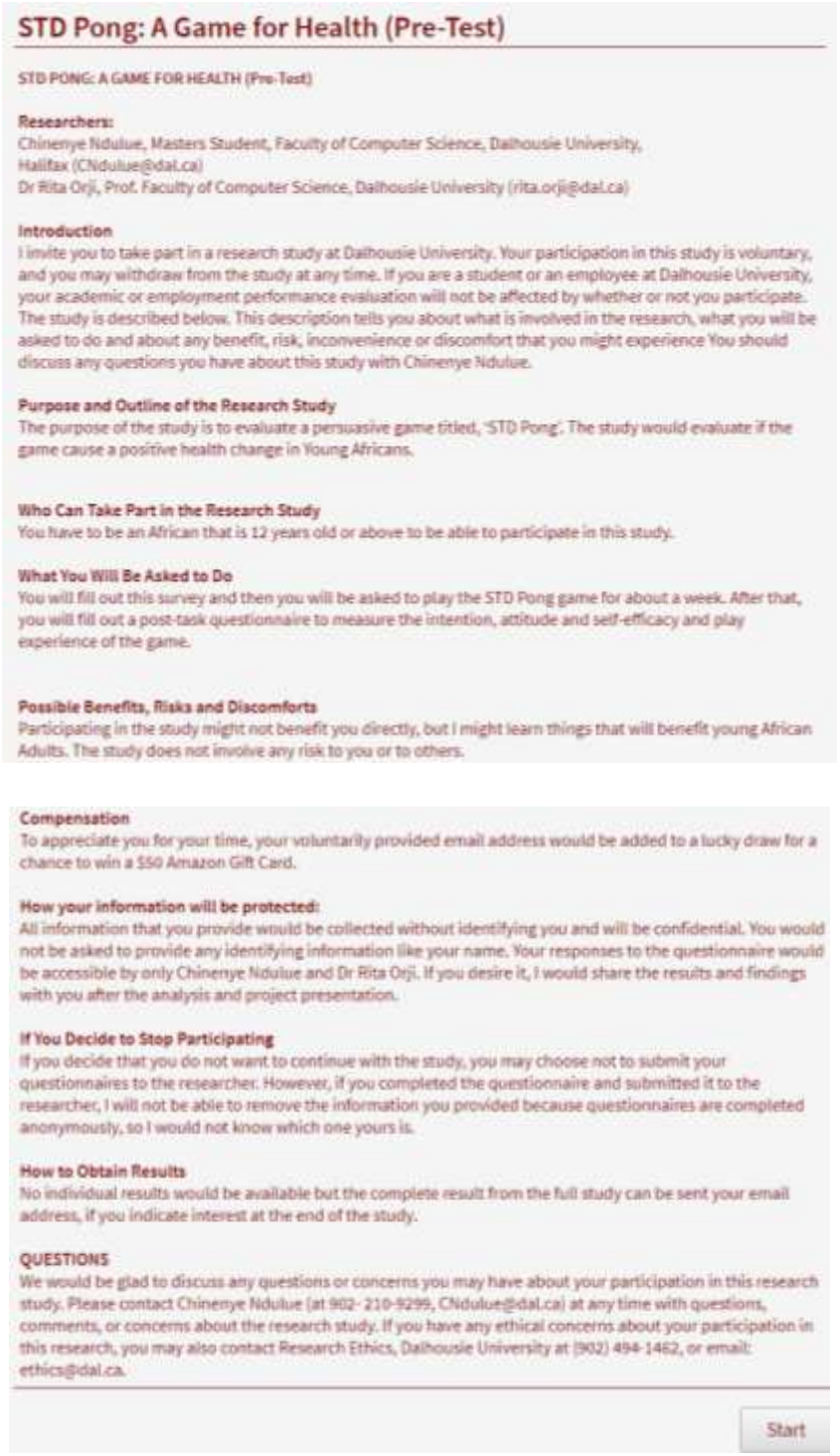
Pretest: Questions 16-20
- "Extremely likely" and "Extremely unlikely" are repeated twice

Pretest: Questions 21-25
- "Strongly agree" and "strongly disagree" are repeated twice

GAME OBSERVATIONS

- Leaderboard: alignment of numbering and scores
- Scabies Quiz! Question 3 of 5
  - Including "within a week" means you require a yes or no response. Maybe you can restate the question as "Scabies typically develop within ~~how many~~ what period of infestation?" or something related
- Scabies Scroll (after reading all) (pre Test)
  - continue and next buttons showed at the same time. Are they serving the same purpose?
- Answering questions (post-scroll)
  - "You answered 4 or more questions correctly". If I answered all questions correctly, why not state it? It makes the praise stronger.

APPENDIX H. Pre-Test Survey Questions



STD Pong: A Game for Health (Pre-Test)

STD PONG: A GAME FOR HEALTH (Pre-Test)

Researchers:
Chinenye Ndulue, Masters Student, Faculty of Computer Science, Dalhousie University, Halifax (CNdulue@dal.ca)
Dr Rita Orji, Prof. Faculty of Computer Science, Dalhousie University (rita.orji@dal.ca)

Introduction
I invite you to take part in a research study at Dalhousie University. Your participation in this study is voluntary, and you may withdraw from the study at any time. If you are a student or an employee at Dalhousie University, your academic or employment performance evaluation will not be affected by whether or not you participate. The study is described below. This description tells you about what is involved in the research, what you will be asked to do and about any benefit, risk, inconvenience or discomfort that you might experience You should discuss any questions you have about this study with Chinenye Ndulue.

Purpose and Outline of the Research Study
The purpose of the study is to evaluate a persuasive game titled, 'STD Pong'. The study would evaluate if the game cause a positive health change in Young Africans.

Who Can Take Part in the Research Study
You have to be an African that is 12 years old or above to be able to participate in this study.

What You Will Be Asked to Do
You will fill out this survey and then you will be asked to play the STD Pong game for about a week. After that, you will fill out a post-task questionnaire to measure the intention, attitude and self-efficacy and play experience of the game.

Possible Benefits, Risks and Discomforts
Participating in the study might not benefit you directly, but I might learn things that will benefit young African Adults. The study does not involve any risk to you or to others.

Compensation
To appreciate you for your time, your voluntarily provided email address would be added to a lucky draw for a chance to win a $50 Amazon Gift Card.

How your information will be protected:
All information that you provide would be collected without identifying you and will be confidential. You would not be asked to provide any identifying information like your name. Your responses to the questionnaire would be accessible by only Chinenye Ndulue and Dr Rita Orji. If you desire it, I would share the results and findings with you after the analysis and project presentation.

If You Decide to Stop Participating
If you decide that you do not want to continue with the study, you may choose not to submit your questionnaires to the researcher. However, if you completed the questionnaire and submitted it to the researcher, I will not be able to remove the information you provided because questionnaires are completed anonymously, so I would not know which one yours is.

How to Obtain Results
No individual results would be available but the complete result from the full study can be sent your email address, if you indicate interest at the end of the study.

QUESTIONS
We would be glad to discuss any questions or concerns you may have about your participation in this research study. Please contact Chinenye Ndulue (at 902- 210-9299, CNdulue@dal.ca) at any time with questions, comments, or concerns about the research study. If you have any ethical concerns about your participation in this research, you may also contact Research Ethics, Dalhousie University at (902) 494-1462, or email: ethics@dal.ca.

Start

STD Pong: A Game for Health (Pre-Test)

1. **Please, enter your email address.**

   (Not: Please, remember to use the same email address for the final survey).

Next

2. **Please, what is your gender?**
   - Male
   - Female
   - Other

3. **What is the highest level of education you have completed?**
   - No Education
   - Primary School (Less than High school)
   - Secondary School (High School)
   - Ordinary National Diploma 'OND' (Other College Diplomas)
   - Bachelor's degree
   - Master's degree
   - Doctoral degree
   - Other

4. **What is your marital status?**
   - Single
   - Married
   - Widowed
   - Divorced
   - Separated
   - Registered Partnership
   - Other

5. **Please, what is your age?**
   - 12-18
   - 19-25
   - 26-35
   - 36-45
   - Over 46

On a scale from 1 to 7, tell us your opinion on the following questions:

2. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Unpleasant	○	○	○	○	○	○	○	Pleasant	○

3. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Worthless	○	○	○	○	○	○	○	Valuable	○

4. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Harmful	○	○	○	○	○	○	○	Beneficial	○

5. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Useless	○	○	○	○	○	○	○	Useful	○

6. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Unenjoyable	○	○	○	○	○	○	○	Enjoyable	○

7. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Unimportant	○	○	○	○	○	○	○	Important	○

8. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Bad	○	○	○	○	○	○	○	Good	○

Next

On a scales below, please tell us how you feel about the following statements:

9. **I intend to ensure that my partner practices safe sex.**

	1	2	3	Neutral	5	6	7		N/A
Extremely Unlikely	○	○	○	○	○	○	○	Extremely Likely	○

10. **I intend to maintain one sex partner within the next 6 month**

	1	2	3	Neutral	5	6	7		N/A
Extremely Unlikely	○	○	○	○	○	○	○	Extremely Likely	○

11. **I intend to always ensure that sharp objects are sterilized or new before using them.**

	1	2	3	Neutral	5	6	7		N/A
Extremely Unlikely	○	○	○	○	○	○	○	Extremely Likely	○

12. **I intend to completely abstain from sex within the next 6 month**

	1	2	3	Neutral	5	6	7		N/A
Extremely Unlikely	○	○	○	○	○	○	○	Extremely Likely	○

13. **If I ever want to have sex with someone else aside from my partner, I intend to use a condom.**

	1	2	3	Neutral	5	6	7		N/A
Extremely Unlikely	○	○	○	○	○	○	○	Extremely Likely	○

Next

On a scales below, please tell us how you feel about the following statements:

14. **If I want, I could reject a sex offer from someone I am sexually attracted to.**

	1	2	3	Neutral	5	6	7		N/A
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree	○

15. **I am confident that I would always insist on using a condom even if my partner refuses to.**

	1	2	3	Neutral	5	6	7		N/A
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree	○

16. **I am confident that I can always use a condom when having sex.**

	1	2	3	Neutral	5	6	7		N/A
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree	○

17. **If someone I am sexually attracted to wants to have unprotected sex with me, I can reject the offer.**

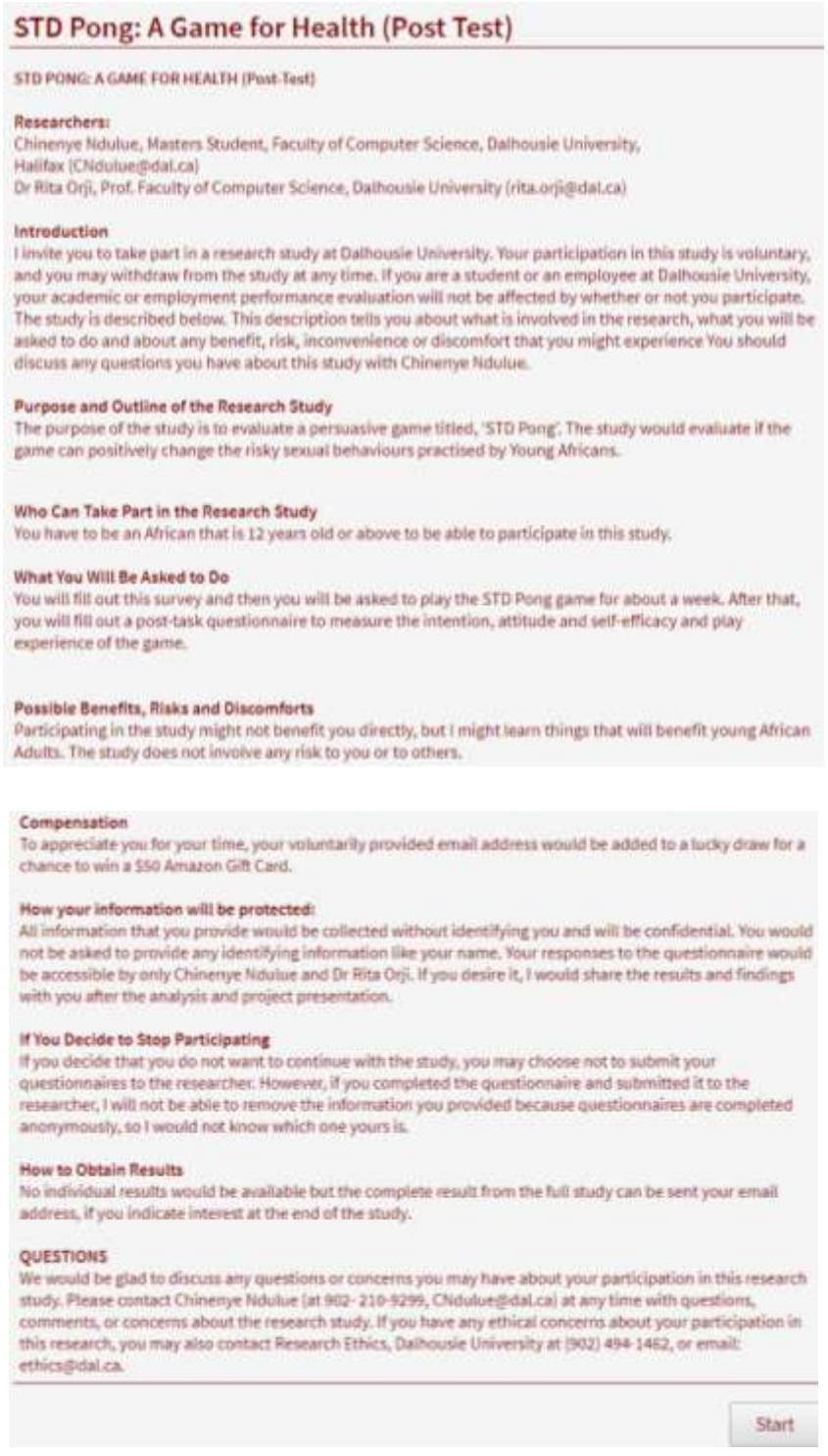
	1	2	3	Neutral	5	6	7		N/A
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree	○

18. **If I want, I can completely abstain from sex**

	1	2	3	Neutral	5	6	7		N/A
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree	○

Next

APPENDIX I. Post-Test Survey Questions



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Start

STD Pong: A Game for Health (Post Test)

1. Please, enter your email address.

(Not: Please, remember to use the same email address you used for the previous survey).

Next

STD Pong: A Game for Health (Post Test)

On a scale from 1 to 7, tell us your opinion on the following questions:

2. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Unpleasant	○	○	○	○	○	○	○	Pleasant	○

3. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Worthless	○	○	○	○	○	○	○	Valuable	○

4. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Harmful	○	○	○	○	○	○	○	Beneficial	○

5. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Useless	○	○	○	○	○	○	○	Useful	○

6. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Unenjoyable	○	○	○	○	○	○	○	Enjoyable	○

7. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Unimportant	○	○	○	○	○	○	○	Important	○

8. **Having Protected Sex is:**

	1	2	3	4	5	6	7		N/A
Bad	○	○	○	○	○	○	○	Good	○

Next

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On a scales below, please tell us how you feel about the following statements:

9. **I intend to ensure that my partner practices safe sex.**

	1	2	3	Neutral	5	6	7		N/A
Extremely Unlikely	○	○	○	○	○	○	○	Extremely Likely	○

10. **I intend to maintain one sex partner within the next 6 month**

	1	2	3	Neutral	5	6	7		N/A
Extremely Unlikely	○	○	○	○	○	○	○	Extremely Likely	○

11. **I intend to always ensure that sharp objects are sterilized or new before using them.**

	1	2	3	Neutral	5	6	7		N/A
Extremely Unlikely	○	○	○	○	○	○	○	Extremely Likely	○

12. **I intend to completely abstain from sex within the next 6 month**

	1	2	3	Neutral	5	6	7		N/A
Extremely Unlikely	○	○	○	○	○	○	○	Extremely Likely	○

13. **If I ever want to have sex with someone else aside from my partner, I intend to use a condom.**

	1	2	3	Neutral	5	6	7		N/A
Extremely Unlikely	○	○	○	○	○	○	○	Extremely Likely	○

Next

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On a scales below, please tell us how you feel about the following statements:

14. **If I want, I could reject a sex offer from someone I am sexually attracted to.**

	1	2	3	Neutral	5	6	7		N/A
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15. **I am confident that I would always insist on using a condom even if my partner refuses to.**

	1	2	3	Neutral	5	6	7		N/A
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree	○

16. **I am confident that I can always use a condom when having sex.**

	1	2	3	Neutral	5	6	7		N/A
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree	○

17. **If someone I am sexually attracted to wants to have unprotected sex with me, I can reject the offer.**

	1	2	3	Neutral	5	6	7		N/A
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree	○

18. **If I want, I can completely abstain from sex**

	1	2	3	Neutral	5	6	7		N/A
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree	○

Next

STD Pong: A Game for Health (Post Test)

For each of the following statements, please indicate how true it is for you, using the following scale:

19. **I enjoyed doing this activity very much.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

20. **This activity was fun to do.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

21. **I thought this was a boring activity.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

22. **This activity did not hold my attention at all.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

23. **I would describe this activity as very interesting.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

24. **I thought this activity was quite enjoyable.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

25. **While I was doing this activity, I was thinking about how much I enjoyed it.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

26. **I think I am pretty good at this activity.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

27. **I think I did pretty well at this activity, compared to other students.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

28. **After working at this activity for awhile, I felt pretty competent.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

29. **I am satisfied with my performance at this task.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

30. **I was pretty skilled at this activity.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

31. **This was an activity that I could not do very well.**

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

32. I put a lot of effort into this.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

33. I didn't try very hard to do well at this activity.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

34. I tried very hard on this activity.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

35. It was important to me to do well at this task.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

36. I did not put much energy into this.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

37. I did not feel nervous at all while doing this.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

38. I felt very tense while doing this activity.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

39. I was very relaxed in doing these.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

40. I was anxious while working on this task.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

41. I felt pressured while doing these.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

42. I believe this activity could be of some value to me.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

43. I think that doing this activity is useful

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

44. I think this activity is important to do.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○

45. I would be willing to do this again because it has some value to me.

	1	2	3	Somewhat True	5	6	7		N/A
Not at all true	○	○	○	○	○	○	○	Very True	○


46. I believe doing this activity could be beneficial to me.
1 2 3 Somewhat True 5 6 7 N/A
Not at all true Very True
47. I think this is an important activity.
1 2 3 Somewhat True 5 6 7 N/A
Not at all true Very True
48. I think doing this activity could help a lot.
1 2 3 Somewhat True 5 6 7 N/A
Not at all true Very True
Next


STD Pong: A Game for Health (Post Test)
On a scales below, please tell us how you feel about the following statements
49. The game influenced me to change my risky sexual behaviours or reinforce safe sexual behaviours.
1 2 3 Neutral 5 6 7 N/A
Strongly Disagree Strongly Agree
50. The game convinced me to change my risky sexual behaviours or reinforce safe sexual behaviours.
1 2 3 Neutral 5 6 7 N/A
Strongly Disagree Strongly Agree
51. The game is personally relevant to me
1 2 3 Neutral 5 6 7 N/A
Strongly Disagree Strongly Agree
52. The game made reconsider my sexual behaviour.
1 2 3 Neutral 5 6 7 N/A
Strongly Disagree Strongly Agree
Next


STD Pong: A Game for Health (Post Test)
53. Overall, tell me what aspect of the game you really like?
54. Overall, tell me what aspect of the game you did not like so much?
55. Please, suggest how you would like to see the game improved or extended
56. Provide any other comments
Finish

APPENDIX J. Research Ethics Board Approval Letter

Social Sciences & Humanities Research Ethics Board
Letter of Approval

April 05, 2019

Chinenye Ndulue
Computer Science\Computer Science

Dear Chinenye,

REB #: 2019-4726
Project Title: STD PONG: An African-Centric Persuasive Game for Risky Sexual Behaviour Change

Effective Date: April 05, 2019
Expiry Date: April 05, 2020

The Social Sciences & Humanities Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans.* This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,

Dr. Karen Beazley, Chair

Post REB Approval: On-going Responsibilities of Researchers

After receiving ethical approval for the conduct of research involving humans, there are several ongoing responsibilities that researchers must meet to remain in compliance with University and Tri-Council policies.

1. Additional Research Ethics approval
Prior to conducting any research, researchers must ensure that all required research ethics approvals are secured (in addition to this one). This includes, but is not limited to, securing appropriate research ethics approvals from: other institutions with whom the PI is affiliated; the research institutions of research team members; the institution at which participants may be recruited or from which data may be collected; organizations or groups (e.g. school boards,

Aboriginal communities, correctional services, long-term care facilities, service agencies and community groups) and from any other responsible review body or bodies at the research site

2. Reporting adverse events
Any significant adverse events experienced by research participants must be reported **in writing** to Research Ethics **within 24 hours** of their occurrence. Examples of what might be considered "significant" include: an emotional breakdown of a participant during an interview, a negative physical reaction by a participant (e.g. fainting, nausea, unexpected pain, allergic reaction), report by a participant of some sort of negative repercussion from their participation (e.g. reaction of spouse or employer) or complaint by a participant with respect to their participation. The above list is indicative but not all-inclusive. The written report must include details of the adverse event and actions taken by the researcher in response to the incident.

3. Seeking approval for protocol / consent form changes
Prior to implementing any changes to your research plan, whether to the protocol or consent form, researchers must submit a description of the proposed changes to the Research Ethics Board for review and approval. This is done by completing an Amendment Request (available on the website). Please note that no reviews are conducted in August.

4. Submitting annual reports
Ethics approvals are valid for up to 12 months. Prior to the end of the project's approval deadline, the researcher must complete an Annual Report (available on the website) and return it to Research Ethics for review and approval before the approval end date in order to prevent a lapse of ethics approval for the research. Researchers should note that no research involving humans may be conducted in the absence of a valid ethical approval and that allowing REB approval to lapse is a violation of University policy, inconsistent with the TCPS (article 6.14) and may result in suspension of research and research funding, as required by the funding agency.

5. Submitting final reports
When the researcher is confident that no further data collection or participant contact will be required, a Final Report (available on the website) must be submitted to Research Ethics. After review and approval of the Final Report, the Research Ethics file will be closed.

6. Retaining records in a secure manner
Researchers must ensure that both during and after the research project, data is securely retained and/or disposed of in such a manner as to comply with confidentiality provisions specified in the protocol and consent forms. This may involve destruction of the data, or continued arrangements for secure storage. Casual storage of old data is not acceptable.

It is the Principal Investigator's responsibility to keep a copy of the REB approval letters. This can be important to demonstrate that research was undertaken with Board approval, which can be a requirement to publish.

Please note that the University will securely store your REB project file for 5 years after the study closure date at which point the file records may be permanently destroyed.

7. Current contact information and university affiliation
The Principal Investigator must inform the Research Ethics office of any changes to contact information for the PI (and supervisor, if appropriate), especially the electronic mail address, for the duration of the REB approval. The PI must inform Research Ethics if there is a termination or interruption of his or her affiliation with Dalhousie University.

8. Legal Counsel
The Principal Investigator agrees to comply with all legislative and regulatory requirements that apply to the project. The Principal Investigator agrees to notify the University Legal Counsel office in the event that he or she receives a notice of non-compliance, complaint or other proceeding relating to such requirements.

9. Supervision of students
Faculty must ensure that students conducting research under their supervision are aware of their responsibilities as described above, and have adequate support to conduct their research in a safe and ethical manner.

APPENDIX K. Playtest Session with High School Students


PREVENT STD BALL
FROM HITTING
YOUR IMMUNITY
AVOID THESE
CATCH THESE


PREVENT STD BALL
FROM HITTING
YOUR IMMUNITY
AVOID THESE
CATCH THESE