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EFFECTS OF GAME-BASED CHILDHOOD OBESITY PREVENTION FRAMEWORK AMONG PRESCHOOL CHILDREN

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ABSTRACT

This research was carried out to validate a framework of game-based childhood obesity prevention. A mobile game titled *Fight Obesity 2.0* was produced through a five-step gamification approach as an instance of the prevention framework. The game incorporated constructive alignment of intended prevention outcomes and structural game elements. The lean production strategy was deployed to produce a viable serious game with its paratextual materials. The design of the game was validated by 38 game designers through a playtesting session, while the content knowledge was validated by two pediatricians, one from China and another in Malaysia. The game also passed the age rating test under the International Age Rating Coalition. The effects of *Fight Obesity 2.0* in actual prevention context was investigated through a non-equivalent control group pre-test / post-test quasi-experiment. Edumetric tests were conducted with 60 children at the kindergarten in the National Child Development Research Centre. After having a month of exposure to game playing, the experimental group performed significantly better in the post-test as compared to their performance in the pre-test and the performance of the control group in the post-test. In terms of gender difference, female children performed significantly better than the male. Twenty-one null hypotheses were tested to examine the effects of the game upon children's food preferences, conception on the relationship between obesity and physical exercise, and the danger of obesity among children. In conclusion, the game was found to be effective in changing the children's food preference, from liking unhealthy food to disliking unhealthy food. These results were verified by findings revealed through a one-week non-participant observation in the kindergarten and semi-structured interviews conducted with the kindergarten supervisor. The implication of this research suggest that a serious game (designed and developed based on the framework game-based childhood obesity prevention) can make significant positive effects in changing the food preferences among preschool children. However, further studies would be needed to examine how the framework can afford preschool children to comprehend the relationship between physical activities and obesity, and the danger of childhood obesity.

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KESAN KERANGKA KERJA PENCEGAHAN OBESITI KANAK-KANAK BERASASKAN PERMAINAN DALAM KALANGAN KANAK-KANAK PRASEKOLAH

ABSTRAK

Kajian ini dijalankan untuk mengesahkan satu kerangka kerja pencegahan obesity kanak-kanak berasaskan permainan. Sebuah permainan mudah alih berjudul *Fight Obesity 2.0* telah dihasilkan melalui pendekatan gamifikasi lima langkah gamifikasi sebagai satu contoh kerangka pencegahan. Permainan ini menggabungkan penjajaran konstruktif antara hasil pencegahan yang diingini dengan struktur elemen permainan. Strategi produksi sandar telah digunakan untuk menghasilkan permainan serius yang berdaya maju bersama dengan bahan parateksnya. Reka bentuk permainan ini telah disahkan oleh 38 orang pereka permainan menerusi satu sesi uji-main, manakala isi kandungannya telah disahkan oleh dua orang doktor pakar kanak-kanak. Permainan ini juga melepasi ujian pemeringkatan umur di bawah Gabungan Pemeringkatan Umur Antarabangsa. Kesan *Fight Obesity 2.0* dalam konteks pencegahan sebenar telah dikaji melalui satu ujian-pra / ujian-pasca kuasi-eksperimen bagi kumpulan kawalan yang tidak setara. Ujian metrik pendidikan telah dilakukan ke atas 60 orang kanak-kanak di sebuah tadika di Pusat Penyelidikan Pembangunan Kanak-Kanak Negara. Selepas menerima pendedahan bermain permainan selama sebulan, kumpulan eksperimen menunjukkan peningkatan prestasi yang ketara dalam ujian-pasca berbanding dengan prestasi mereka dalam ujian-pra dan prestasi kumpulan kawalan dalam ujian-pasca. Kanak-kanak perempuan menunjukkan prestasi yang lebih baik berbanding kanak-kanak lelaki. Dua puluh satu hipotesis nul telah diuji bagi melihat kesan permainan terhadap kanak-kanak dari segi pemilihan makanan, pembentukan konsep ke atas hubungan antara obesiti dan senaman fizikal, dan bahaya obesiti dalam kalangan kanak-kanak. Kesimpulannya, permainan ini didapati berkesan dalam mengubah pemilihan makanan kanak-kanak, daripada suka makanan yang tidak sihat kepada tidak suka makanan yang tidak sihat. Dapatan kajian ini telah disahkan dari hasil kajian yang diperolehi melalui tinjauan tanpa penyertaan selama seminggu di tadika berkenaan dan temu bual separa berstruktur yang dibuat bersama penyelia tadika. Implikasi kajian ini mencadangkan permainan serius (yang direka bentuk dan dibangunkan berdasarkan kerangka kerja pencegahan obesity kanak-kanak berasaskan permainan) mampu menghasilkan kesan positif yang signifikan dalam mengubah pilihan makanan dalam kalangan kanak-kanak prasekolah. Walau bagaimanapun, kajian lanjutan perlu dilakukan bagi mengkaji bagaimana kerangka kerja berkenaan membolehkan kanak-kanak prasekolah untuk memahami hubungan antara aktiviti fizikal dan obesiti, dan bahayanya obesiti kanak-kanak

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LIST OF ABBREVIATIONS

2D	Two dimensional
ACB	Australian Classification Board
APK	Application Package
BMI	Body Mass Index
CK	Content knowledge
ClassInd	*Classificação Indicativa* or the Brazilian Advisory Rating
DASH	Dietary Approaches to Stop Hypertension
EMV	Ethics, Moral & Values
ESF	European Social Fund
ESRB	Entertainment Software Rating Board
fMRI	Functional magnetic resonance imaging
FYP	Final year projects
GT	Game technology
HRQoL	health-related quality of life
IARC	International Age Rating Coalition
IBS	Irritable Bowel Syndrome
MINDS	Malaysian Invention and Design Society
MTE	Malaysia Technology Expo
MyRA	Malaysia Research Assessment
NCDRC	National Child Development Research Centre

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PC	Personal computer
PECIPTA	International Conference and Exposition on Invention by Institutions of Higher Learning
PEGI	Pan European Game Information
PS	Prevention strategy
QA	Quality assurance
R&D	Research and development
SME	Subject Matter Expert
SNES	Super Nintendo Entertainment System
SOP	Standard operating protocol
SUMI	Software Usability Measurement Inventory
TAM	Technology Acceptance Model
UCG	User generated content
UPSI	Sultan Idris Education University
USK	*Unterhaltungssoftware Selbstkontrolle* or Entertainment Software Self-Regulation
WHO	World Health Organization

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APPENDIX LIST

A Child Development Milestones

B Test Questions Set for the Pre-test and the Post-test

C Application to Conduct Research at Tadika NCDRC

D Approval Granted to Conduct Research at Tadika NCDRC

E Follow-up Observation Checklist

F Screen Shots of *Nutrition Your Life*

G Screen Shots of *Fight Obesity*

H IARC Rating Questionnaire for Digital Games

I Information Sheet for Playtesting

J Consent Form

K Usability Measurement Inventory

L Data Collected in the Quasi-Experiment

M BMI for Boys

N BMI for Girls

O Food Choice Stated by the Children in the Pre-test

P Food Choice Stated by the Children in the Post-test

Q Semi-structured Interview Questions (Kindergarten Supervisor)

R Information Sheet for Interview with Pediatricians

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CHAPTER 1

INTRODUCTION

1.1 Overview

The aim of this research is to create a game-based obesity prevention framework for use in the design, development and validation of serious games for childhood obesity prevention. This framework can be referred by parents, preschool teachers or caretakers, and medical doctors when using games for preventing obesity among preschool children. A game-based childhood obesity prevention framework was developed based on the standard operating procedure of treating childhood obesity in China and then validated by pediatricians in Malaysia and China. A nonequivalent control group pre-test / post-test quasi-experiment was conducted in a kindergarten, followed by a non-participant observation of selected children in the kindergarten. Towards the end of the research, validation from pediatricians was obtained for the prevention framework.

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This thesis consists of six chapters. The first chapter provides an overview of the research, including its background, aims, specific research questions and hypotheses. The second chapter is the literature review of recent studies on childhood obesity treatment and the use of games in medicine and health care. The third chapter presents the methodology and the research design of this study. Chapter four depicts the design, development and validation of a mobile game titled *Fight Obesity 2.0* for this research. Chapter five juxtaposes the findings and discusses how these hypotheses were tested. The last chapter is the conclusion, in which it summarizes all conclusive propositions made throughout this research and explains the overall contribution and limitation of this research.

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1.2 Background of the Research

The origin of this research comes largely from an observed phenomenon of childhood obesity in Malaysia. According to a Malaysian pediatric medical officer in Sabah, Dr. Alya Hamzan, one in every five school-going Malaysian children is overweight or obese (Khoo, 2014). In this sense, an academic research in treating childhood obesity should be cross-disciplinary in nature, hence the genesis of this educational study in Malaysia, conducted through a perspective of a former pediatrician from China. Coincidentally, the issue of childhood obesity in Malaysia is as serious as the problem faced by China, in which 18.8% of people under 20 years old were overweight in 2013 (Wang, 2014). This prompted the urge and the need to carry out an academic study for preventing and treating childhood obesity in both China and Malaysia.

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Being able to conduct this study at the National Child Development Research Centre (NCDRC) in Sultan Idris Education University (UPSI) was indeed an occurrence of serendipity. The idea of pursuing a doctorate degree in child and adolescent development under NCDRC was a result of the voluntary work experience in NCDRC as a preschool Mandarin teacher. The interaction with and observation on the children in NCDRC provided an authentic exposure to the daily living of Malaysian children. This in turn formed the confidence and interest to carry out an academic study on childhood obesity in the Malaysia context, rather than in China.

Meanwhile, prior to the conduct of this study, active involvement in three game production and consultancy projects had provided a positive ground to conduct a game-based obesity prevention study in Malaysia. The involvement began in 2013, when a Mandarin communication learning app was designed and developed in UPSI (see Tan, Lin & Wang, 2013). This was followed by collaboration with game developers in the United States of America (USA) in order to set up the KNeoWORLD game-based learning portal (http://kneoworld.com/home). In particular, the localization of contents for Mainland China market was accumulated through this experience. After that, a game production opportunity was offered by Dr Nurul Fazmidar Mohd Noor from Universiti Malaya to participate in a project titled "Examining how Malaysian School Children Learn Theory of Inventive Problem Solving through a Mobile Game" (project code: CG044) between November 2013 and October 2014. The results of the study demonstrated how constructive alignment could be set to align intended learning outcomes with game elements in order to embed problem-solving skills in game playing (Tan, Nurul Fazmidar & Wang, 2014).

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In fact, the alignment approach could also be made between intended treatment outcomes with game elements in order to counter overweight or obese problems in game playing. In other words, with appropriate alignment, games can be used beyond entertainment.

In the field of serious games, specially designed games are useful in four fields of practice, which are education, business, health and military (Sawyer & Smith, 2009). In the practice of education and health, games have been proven to be naturally engaging to children (Milteer & Ginsburg, 2012). With the shift of multimedia paradigm from personal computer to mobile devices, children are born to be digital natives of mobile gadgets and apps. Nonetheless, the phenomena put parents and teachers in a dilemma, in which they realise the needs of children for games but they worry about the negative effects inherited in games as provoked by mass and social media. In fact, academic researchers could help parents and teachers to walk out of the dilemma by presenting them with findings of empirical studies, as opposed to relying on hearsay to make judgment.

In a nutshell, this study attempts to put a game-based obesity prevention idea into practice, and then examines its effectiveness through a quasi-experimental study on preschool children in Malaysia. The fundamental assumption made in this study is that game playing can make overweight and obesity prevention fun and engaging, which in turn leading to pleasant instead of fearful experience among children who receive treatment. In particular, the assumption has been proven through the playtesting session conducted in this research (see section 3.5.1).

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1.3 Problem Statement

Obesity has become a global epidemic since year 2000 (WHO, 2015), particularly in developing countries. Childhood obesity is associated with a higher chance of obesity, premature death and disability in adulthood (WHO, 2015). As depicted by Sahoo et al. (2015), preschool childhood obesity has been found correlated to obesity in later years of childhood, thus preventing and treating preschool obesity are particularly important. Also, obese children commonly encounter difficulties in breathing (Niehoff, 2009), increased risk of hypertension (Raj, Sundaram, Paul, Deepa, & Kumar, 2007), early markers of cardiovascular disease (Aris, et al., 2017), insulin resistance (Niehoff, 2009), and negative psychological effects (Rawana, Morgan, Nguyen, & Craig, 2010; Goldfield, Moore, Henderson, Buchholz, Obeid, & Flament, 2010; Tanofsky-Kraff, Yanovski, Wilfley, Marmarosh, Morgan, & Yanovski, 2004; Zametkin, Zoon, Klein, & Munson, 2004). Therefore, childhood obesity is causing serious financial and mental pressure to a family and a society.

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According to a systematic review done by Seburg, Olson-Bullis, Bredeson, Hayes, and Sherwood (2015) to compare the effectiveness of primary care-based childhood obesity prevention against treatment intervention, only one effective (out of 31) study was prevention study, as opposed to seven effective treatment intervention studies. In other words, most existing prevention and treatment intervention did not yield the desired positive effects (see section 2.2.3), thus failing to stop the rising numbers of children who face overweight or obesity problem. So, novel approaches, as revealed by Dias, Tibes, Fonseca, and Zem-Mascarenhas (2017) in preventing and

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treating childhood overweight and obesity, are urgently sought after (Deckelbaum & Williams, 2001). These approaches involve the use of behavioral treatment with contemporary computing technologies, and will be discussed further in section 2.4. There are indeed games designed for tackling obesity issues, but those games are generally meant for teenagers or adults. Treating adult obesity is different from treating childhood obesity due to the differences in physiological and psychological characteristics. As a result, designing game contents to prevent and treat obesity would also be different between adults and children (see section 3.4). The game-based childhood obesity prevention framework proposed in this study addresses these differences by including the roles which should be played by kindergarten, parents and overweight or obese child.

The potentials of games, particularly games for health, had been recognized by researchers as efficient and effective means of childhood obesity prevention (Elsevier Health Sciences, 2010; Lison et al., 2015). However, as elaborated by Thompson (2014), the key challenge of using games in preventing childhood obesity was to identify the right balance between "serious-ness" of components that promote behaviour change and "fun-ness" of components that entertain children. In fact, this was a research gap encountered by most of researchers who attempted to design and develop games for childhood obesity prevention, hence the genesis of this PhD study to fill in the research gap.

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1.4 Research Aim and Objectives

This research aims to validate a framework of game-based childhood obesity prevention. A provisional framework was proposed based on the standard operating protocol (SOP) practiced in hospital by pediatricians for treating and preventing obesity among preschool children. Figure 1.1 is a time chart of visits by patients in a SOP for treating childhood obesity in hospital. As depicted by Forslund et al. (2014), this SOP was deduced based on the Upppsala Longitudinal Study of Childhood Obesity (ULSCO), and it is widely practiced in Europe. It consists of five sets of procedure: 1) First visit; 2) Feedback; 3) Treatment; 4) Annual follow-up; and 5) Treatment. The ULSCO protocol covers seven areas of diagnosis, which are goals, nutrition, sleep, well-being / welfare, stress, physical activity and relationships / network (Forslund et al. 2014). The universality of this SOP and its areas of diagnosis lay the foundation for the development of the framework of game-based childhood obesity prevention in this research (see section 2.5).

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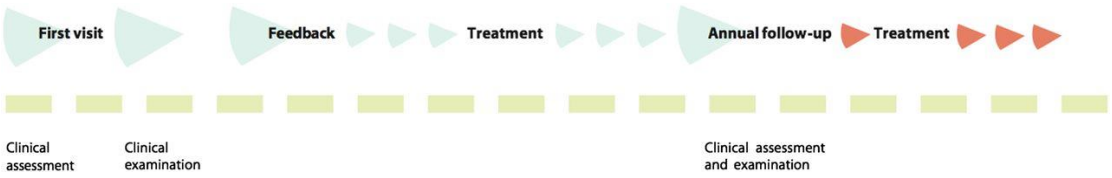


Figure 1.1. Time Chart of Visit by Patients in Hospital. Source: Forslund et al. (2014)

A serious game was designed, developed and validated for use as a research instrument in a quasi-experimental study which was conducted in Tadika NCDRC. A nonequivalent control group pre-test / post-test quasi-experiment was carried out with

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60 preschool children in Tadika NCDRC to the following achieve four research objectives:

1. To design, develop and validate a mobile game for use in childhood obesity prevention among preschool children.

2. To compare the differences of preschool children's food preference before and after playing a childhood obesity prevention game.

3. To compare the differences of preschool children's conception on the relationship between obesity and healthy lifestyle before and after playing a childhood obesity prevention game.

4. To compare the differences of preschool children's conception on the danger of childhood obesity before and after playing a childhood obesity prevention game.

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1.5 Research Questions and Hypothesis

The game-based childhood obesity prevention framework covers three aspects in preschool obesity prevention. The first aspect is about preschool children's food preference; the second aspect is related to preschool children's conception on healthy lifestyle; and the third is about preschool children's conception on the danger of

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childhood obesity. These aspects were operationalised into the following four research questions:

1. How to design, develop and validate a mobile game for use in childhood obesity prevention among preschool children?

2. Is there a significant difference of preschool children's food preference before and after playing an obesity prevention game?

3. Is there a significant difference of preschool children's conception on the relationship between obesity and physical exercise before and after playing an obesity prevention game?

4. Is there a significant difference of preschool children's conception on the danger of obesity before and after playing an obesity prevention game?

The first research question was planned to be answered by identifying suitable gamification approach and game production methods. As for the remaining three questions, three null hypotheses and three alternative hypotheses were formulated for statistical testing in search for answers, as :

1. H_0: Preschool children's food preference shows no significant difference before and after playing an obesity prevention game.

2. H_1: Preschool children's food preference shows significant positive change after playing an obesity prevention game.

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3. H_0: Preschool children's conception on the relationship between obesity and physical exercise show no significant difference before and after playing an obesity prevention game.

4. H_1: Preschool children's conception on the relationship between obesity and physical exercise show significant improvement after playing an obesity prevention game.

5. H_0: Preschool children's conception on the danger of obesity shows no significant difference before and after playing an obesity prevention game.

6. H_1: Preschool children's conception on the danger of obesity shows significant improvement after playing an obesity prevention game.

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1.6 Significance of this Study

The field of child and adolescent development is essentially a multi-disciplinary field where the body of knowledge of health science and social sciences converge to generate new knowledge—a fundamental requirement of awarding a PhD under Malaysian Qualification Framework (Malaysian Qualifications Agency, 2015).

The outcomes of this original research would contribute to the above-mentioned field by broadening the boundary of knowledge through an in-depth thesis,

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which will be presented and defended according to UPSI standards. Alongside to the thesis, internationally refereed publications had been written based on the findings of this empirical study.

1.7 Research Scope and Limitations

This study is conducted under the academic settings, in which it combines health science and social sciences (see Figure 1.2). Therefore, this game-based treatment study should be considered as a healthy early child development study, as classified by WHO (Irwin, Siddiqi & Hertzman, 2007).

Although a prototype mobile game titled '*Fight Obesity 2.0'* was designed and developed to validate the game-based obesity prevention framework, this is essential not a computer science study. Nonetheless, the algorithm, mechanics and programming technicality of the game has been taken care of by professionals in the game industry. The game contents were validated by Google Play through the International Age Rating Coalition (IARC). In terms of limitation, this study was constrained by three matters, namely the participants, the device used to conduct the study, and the mobile game.

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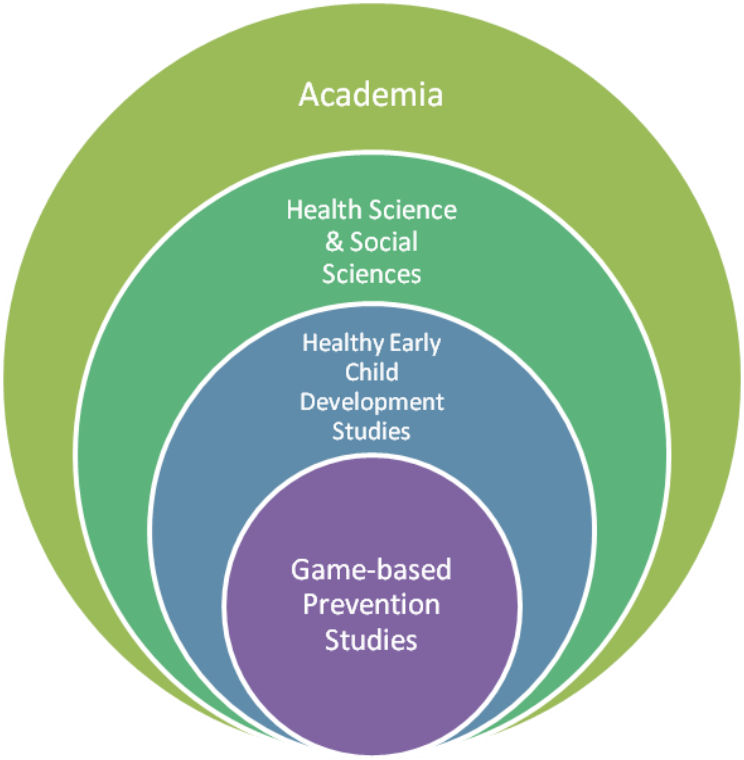


Figure 1.2. Scope and Position of Game-based Prevention Studies in Academia

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1.7.1 The Participants

This study was limited to Malaysian preschool children aged five and six years old, as opposed to all age groups in preschool childhood. This limitation was set to align with the age setting by NCDRC regarding the use of digital multimedia contents. The As depicted by the Centers for Disease Control and Prevention (2015), preschoolers should be able to notice a difference between girls and boys, and also recall part of a story—cognitive skills required to accumulate content knowledge on childhood obesity prevention. Child development milestones are attached in Appendix A for reference. Also, children younger than four years old generally do not have sufficient cognitive capacity to conceptualise the relationship between obesity and food

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preference, physical exercise and consequences of being obese (Centers for Disease Control and Prevention, 2015).

The participants of this study were recruited from the National Child Development Research Centre (NCDRC) because the centre is the only one of its kind in Malaysia, where the environment, facilities and facilitation would be unique for conducting game-based obesity prevention research.

1.7.2 The Device Used

Due to the physical bodily limitations possessed by preschool children, the mobile devices used in the quasi-experimental study would be limited to 7-inch tablet, instead of using smartphones with smaller screen or bigger size tablets with heavier weight. Only identical tablets would be used to collect data with the participants.

1.7.3 The Mobile Game Used

The operating system of the device used will be limited to only Android system because the mobile game was designed and developed specifically for this platform. In terms of game contents, the game levels were limited to three to match the needs for testing all hypotheses.

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1.8 Operational Definitions

1.8.1 Body Mass Index

Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults (WHO, 2015). It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2).

1.8.2 Childhood Overweight

Overweight is defined as abnormal or excessive fat accumulation that may impair health (WHO, 2015). A BMI greater than or equal to 25 is overweight. Childhood overweight occurs when a child is above the normal weight for his or her age and height (WHO, 2015). Body mass index (BMI) is a measure used to determine childhood overweight and obesity. According to BMI-for-age criteria, a BMI greater than 2SD (standard deviations above the WHO growth standard median) is overweight (0-5 years), a BMI greater than 1SD (equivalent to BMI 25 kg/m^2 at 19 years) is overweight (5-19 years).

1.8.3 Childhood Obesity

Obesity is defined as abnormal or excessive fat accumulation that may impair health (WHO, 2015). A BMI greater than or equal to 30 is obesity. Childhood obesity occurs when a child is above the normal weight for his or her age and height. According to

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BMI-for-age criteria, a BMI greater than three standard deviation is obesity (0-5 years), a BMI greater than two standard deviations (equivalent to BMI 30 kg/m^2 at 19 years) is obesity (5-19 years old).

1.8.4 Mobile Game

For this study, a mobile game, namely *Fight Obesity 2.0* was used as a game-based childhood obesity prevention. It is a digital two dimensional (2D) role-playing game, to be played by preschool children aged between five and six years old.

1.8.5 Prevention

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The word “prevent” literally means “keeping something from happening or making someone or something unable to do something” (Anderson, Prohaska & Satariano, 2015). In this research, the term “prevention” is considered as a part of the treatment algorithm, that is to prevent recurrence of overweight or obesity (National Institutes of Health, 2000).

1.8.6 Game-based Prevention

In this research, game-based prevention is a form of player-centred prevention that uses serious games for health purposes.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

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This chapter reviews literature in two areas of knowledge, i.e. childhood obesity and game-based prevention for obesity. Understanding concepts, existing research findings and issues associated to these areas of knowledge is essential to examine the phenomena and potential of using digital games in treating childhood obesity. The nature of games, particularly how games were used seriously in child development is discussed. Empirical studies conducted by researchers were reviewed and synthesized to juxtapose the importance of game playing in child development since Friedrich Froebel established the Play and Activity Institute in 1837. Since the population of childhood obesity has been increased alarmingly in the world, especially in developing countries, traditional treatment of childhood obesity is showing limited results to date, leading to increasing interest of research into game-based obesity

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prevention. Hence, a provisional framework of game-based childhood obesity prevention is proposed in this study.

2.2 Epidemiology of Childhood Obesity

This study is essentially an effort to contribute to the knowledge of childhood obesity research. Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health (WHO, 2015). According to the National Collaborative on Childhood Obesity Research (NCCOR), childhood or pediatric obesity is a serious global public health issue because the rates of overweight and obesity have increased significantly since the 1980s worldwide (Lobstein & Frelut, 2003; Orleans & Quinn, 2014). This statement is supported by the data and statistics of World Health Organization (WHO, 2015), in which childhood overweight and obesity have increased dramatically since 1990, and the worldwide prevalence of childhood overweight and obesity increased from 4.2% in 1990 to 6.7% in 2010. This trend is expected to reach 9.1%, or 60 million in 2020.

2.2.1 Factors of Childhood Obesity

Sun, Schutz, and Maffeis (2004) unfolded that unhealthy eating behaviours is the main reason why children became overweight or obese. In addition, Wareham, Van Sluijs, and Ekeleund (2005) revealed that a low level of physical activity is the key factor that negatively affects the energy balance of human beings. This factor of

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childhood obesity is consistent with findings in other studies across three decades (Dietz & Gortmaker, 1985; Marshall et al., 2004; Hills, King, & Armstrong, 2007). In fact, these findings remained unchanged as Popkin et al. (2014) justified through a longitudinal study and claimed that shifts in physical activity and diet are two key factors of childhood obesity worldwide. In particular, Robert, Jeffrey, Margaret, and Kristy (1997) found that the risk of adult obesity was greater in both obese and non-obese children if at least one parent was overweight. Thus, the prevention of obesity should be acculturated in early years at home.

2.2.2 Comorbidities of Childhood Obesity

Comorbidities associated with overweight and obese adults are similar in children, such as elevated blood pressure, increased risk of dyslipidaemia and fractures, early markers of cardiovascular diseases, negative psychological effects, recurring breathing difficulties and higher prevalence of insulin resistance (WHO, 2015). Although overweight and obesity are associated with many severe medical consequences even at a young age, the most common short-term consequences of pediatric obesity are psychosocial in nature, such as psychological problems, body weight discrimination or weight-related teasing (Wille et al., 2010). In a word, the health-related quality of life (HRQoL) would be reduced considerably among children who face overweight or obesity problem (Wille et al., 2010).

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Meanwhile, Goran (2001, p. 159) concluded that the "persistence of pediatric obesity into adulthood increases according to the age at which obesity is initially present." This finding reinforced a Japanese study conducted by Kotani, Nishida, and Yamashita (1997), in which approximately one-third of obese children grew into obese adults. In recently study, Solveig et al. (2014) showed that the incidence of obesity between the ages of five and 14 years old was more likely to have occurred at younger ages, primarily among children who had entered kindergarten overweight in United States of America. As a result, it is recognized that the prevention of obesity at younger ages would be more effective and efficient at later ages.

2.2.3 Strategies of Treating Childhood Obesity

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In general, there are three main modalities of treating obesity. The first modality of treating obesity is medication. Three types of drugs regularly considered for treating childhood obesity in USA are orlistat, sibutramine and metformin, but none of them are approved by the Food and Drug Administration for preschool children (Uli, Sundararajan, & Cuttler, 2008). In other words, medication modality cannot be considered for treating early year's children with overweight or obesity problem.

The second treatment modality is bariatric surgery, which aims to "reduce caloric intake by restrictive or malabsorptive operations on the gastrointestinal tract" (Uli et al., 2008, p. 40). As described by DeMaria et al. (2007), bariatric surgery can be carried out through two major procedures, which are the laparoscopic adjustable

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gastric banding and the Rouxen-Y bypass. Nonetheless, bariatric surgery "can have serious adverse effects" (Kaplan, 2005), and is controversial in youth, in which it should not be performed with early year's children (Apovian et al., 2005).

The third modality is the lifestyle intervention, which is the only approved treatment modality for early year's children. According to Uli et al. (2008), the lifestyle intervention aims to induce negative energy balance through diet, exercise, counselling, or a combination of these strategies. Through medical studies conducted in Ohio, USA, the lifestyle intervention has been proven to be effective for up to two years (Uli et al., 2008). In particular, children aged five to twelve years old and children with overweight profit from lifestyle interventions.

Recent lifestyle intervention treatments are generally based on the two frameworks, which are family-based and school-based obesity preventions (Sung-Chan, Sung, & Brown, 2012). A systematic review of randomized controlled trials using family-based models for childhood-obesity intervention suggests that family-based obesity preventions rooted in behavioural theory. The family-based model achieved better results than those theoretically connected to family systems theory.

In early lifestyle intervention and obesity prevention, Deckelbaum and Williams (2001) suggested to provide children with early experiences with foods and flavours in order to achieve four objectives, 1) to develop children's healthy food preferences; 2) to encourage appropriate parental feeding practices; 3) to monitor

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weight increment rate; and 4) to provide nutrition education among children and their parents.

Educational interventions have been proven effective by Sbruzzi et al. (2013) in treating childhood obesity. For instance, in a health education programme called 'Planet Health', a two-year intervention involving middle school children, was found effective in increasing fruit and vegetable consumption among girls (Gortmaker, Peterson, & Wiecha, 1999). In another programme, Sallis, McKenzie, and Conway (2003) used environmental, policy and social interventions to increase physical activity and lower fat food choices. The results showed increased physical activity in boys. In terms of educational media, Frenn, Malin, and Brown (2005) deployed an Internet video-tailored intervention to increase physical activity and decrease fat intake. Positive effects were shown among middle school pupils who took part in the programme. These effects were consistent with the findings revealed through sequential interactive computer-tailored interventions (Vandelanotte et al., 2005).

2.2.4 Issues with Lifestyle Intervention Treatment

Due to the ethical and medical constraints set by authorities, the treatment of choice for childhood obesity is actually lifestyle intervention (Reinehr, 2013). Despite positive outcomes shown in various lifestyle intervention treatments, the extent of weight loss through lifestyle intervention is considered moderate and limited to the first two years (Reinehr, 2013). Also, there is a serious lack of empirical studies

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conducted with preschool children, since most of the success interventions for childhood obesity were involving only primary or secondary school participants.

Furthermore, empirical studies conducted with children were generally resource intensive, thus the practicality of replicating the intervention to broader target children is indeed questionable (Uli et al., 2008). Lifestyle intervention could be frustrating for both patients and physicians, because it generally involves high commitment and considerable effort, and the effects might vary or even encounter weight rebound after treatment (Uli et al., 2008). In a word, early intervention and prevention would yield better treatment outcomes among early year's or preschool children. This leads to the need of an implementation model, such as the culture of health action model proposed by Orleans and Quinn (2014) for overcoming issues of childhood obesity, as shown in Figure 2.1. The model laid the foundation for a series of policy and environmental interventions to halt and reverse drivers of the childhood obesity epidemic in four countries, which are USA, United Kingdom, Australia and Canada (Orleans & Quinn, 2014).

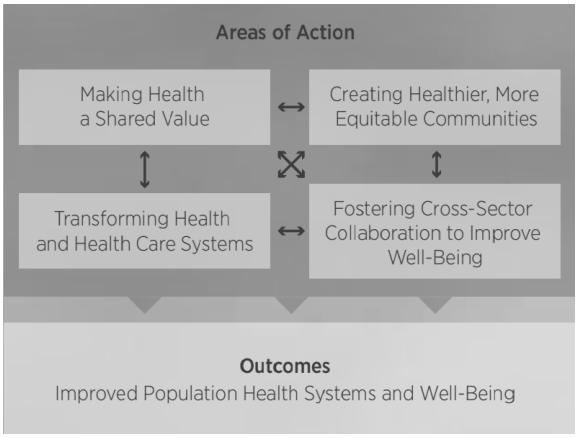


Figure 2.1. The Culture of Health Action Model

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2.3 Using Games as Childhood Obesity Prevention Strategy

According to Tan (2010, p. 14), game is essentially "an activity, either a form or spell of sport, engaged in for amusement, especially an organised, competitive one played according to rules and decided by skill, strength or luck". When a non-game activity is being converted into a game, the conversion process is regarded as gamification (Tan, Nurul Fazmidar, & Wang, 2014). In this sense, when the lifestyle intervention treatment for childhood obesity is carrying out in a form of game, the treatment is actually gamified.

Beyond entertainment, games can be used for serious purposes, hence the concept of serious games. The term "serious game" has been used to describe video games that have been designed specifically for training and education (Annetta, 2010). The first instance of serious gaming can be traced back to Edwin Link who constructed the first flight simulator in the late 1920s. After this early start sporadic examples of serious games followed mostly in the military and medical fields.

The idea of using games for serious purposes was proposed in a structured way by Clark Abt in 1970, who published a book later entitled *serious game* (Abt, 1987). Although, in this book, Abt was mostly concerned with card and board games, the definition which he offered is still relevant:

> Games may be played seriously or casually. We are concerned with serious games in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for

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> amusement. This does not mean that serious games are not, or should not be, entertaining.
>
> (Abt, 1987, p. 9)

In the 1980s, two promising disciplines of virtual reality and edutainment, which used games for non-entertainment purposes, started to expand. Unfortunately, this expansion did not last long and both of these concepts failed to fulfill their early promise. Virtual reality struggled with expensive hardware, the absence of case studies, lack of attention for end user's requirements and failures to provide meaningful and functional intellectual property. As for edutainment, the idea of acquiring education via entertainment resulted boring games, which attracted limited interest in playing (Dillon, 2013). In a word, serious games must avoid these drawbacks in order to succeed.

Apart from the above-mentioned attempts, Ben Sawyer developed the first virtual university system at Harvard University, which led to the research into using games for serious purpose. In fact, any games used in a treatment strategy can be seen as serious games. Then he started the Serious Games Initiative in Washington in 2002, which focuses on the usage of serious games for training, education, health and public policy. This initiative formed connections between the game industry and health, education, training and public policy projects which require game design and development services.

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2.3.1 Serious Games for Health and Medicine

Most people think of video games as entertainment, but the field of medicine has a history of embracing games as a means to engage patients behaviourally to improve their health outcomes. Games are now being evaluated in randomized trials with the scientific rigor applied to pharmaceutical therapies (Kato, Cole, Bradlyn, & Pollock, 2008).

There are some commercially available video games for health, which were built on past research that showed video games were effective as a distraction for pain, nausea, and anxiety and were powerful motivators for people to engage in active behaviours (Lee & Liu, 2016). In early 1990s, Vasterling, Jenkins, Tope, and Burish (1993) compared the effects of video games against standard relaxation training among young cancer patients. Both interventions were found effective as cognitive distraction to reduce nausea prior to chemotherapy and had lower blood pressure following chemotherapy compared with controls. This finding validated the use of games as intervention strategies in medical treatment.

Similar validation studies were carried out ever since. For instance, Kato et al. (2008) had proven that video game intervention can significantly improve treatment adherence and indicators of cancer-related self-efficacy and knowledge in adolescents and young adults who were undergoing cancer therapy.

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In physical therapy, a research team led by O'Connor in Houston Medical Center invented the *GameWheels,* with manual wheelchair interface, for patients with spinal cord injury (O'Connor et al., 2000; O'Connor, Fitzgerald, Cooper, Thorman, & Boninger, 2002). Figure 2.2 shows the actual wheelchair integrated with a video game. They conducted kinetic and physiological analysis with 35 patients and concluded that playing a video game while exercising may help to motivate manual wheelchair users to exercise longer and regularly. However, exercising while playing a video game may not be associated with higher pushrim forces and stroke frequencies. In a word, using game for treatment can be a good and effective motivation to patients, but the actual treatment outcomes may not be achieved through game playing.



Figure 2.2. Using a Wheelchair to Control Interaction in a Video Game. Source: O'Connor et al. (2002)

Like O'Connor et al. (2002), Widman, McDonald, and Abresch (2006) were attempting to achieve similar effects in physical therapy. Figure 2.3 is a commercially

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available video game *Need for Speed* that was used in conjunction with an add-on exercise hand crank device (ergometer) called the GameCycle to control movements in the games (Widman et al., 2006).

The use of tailor-made games to improve the health of patients shows that a great deal of innovation and creativity for patients. There are some famous games worth learning, firstly, Re-Mission 2 is a project of HopeLab, a nonprofit that harnesses the power and appeal of technology to improve human health and well-being, help kids and young adults with cancer take on the fight of their lives (see Figure 2.4). Based on scientific research, the games provide cancer support by giving players a sense of power and control and encouraging treatment adherence. As of November 2017, Re-Mission 2 offers six different games via its website at http://www.re-mission2.org/, which are *Nanobot's Revenge*, *Stem Cell Defender*, *Nano Dropbot*, *Leukemia*, *Feeding Frenzy*, and *Special OPS*.



Figure 2.3. The GameCycle Uses *Need for Speed* to Guide Wheelchair User Operates the Hand Crank Device. Source: Widman et al., (2006)

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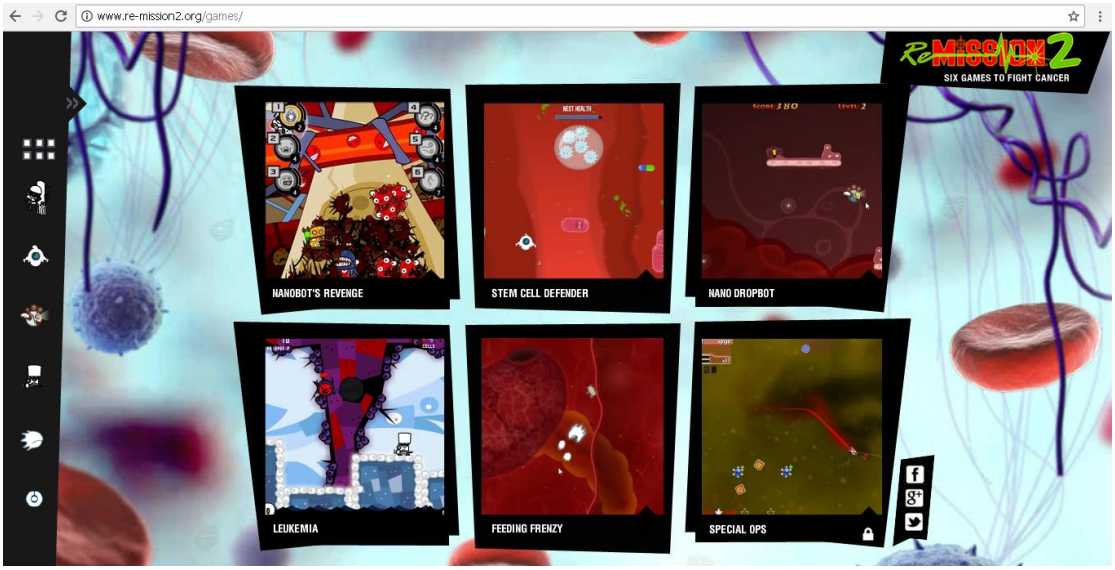


Figure 2.4. Serious Games in the Re-Mission 2 Project (Source: HopeLab, 2017)

A team of researchers and game designers at the University of Washington Harborview Burn Center developed a virtual reality pain reduction game called *SnowWorld* for burn patients to burn pain (Hoffman et al., 2006). By using functional magnetic resonance imaging (fMRI) brain scanning instrument, the research team revealed that significant reductions in pain was achieved when playing *SnowWorld* (see Figure 2.5).



Figure 2.5. SnowWorld was Used as a Virtual Reality Pain Control. Source: Hoffman et al. (2006)

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The practice of using games to treat children grew side-by-side with the rise of Super Nintendo Entertainment System (SNES) since 1990s. One classic video game for health is *Packy and Marlon*, which is aimed at children with diabetes (see Figure 2.6). According to a randomized clinical trial study conducted at Health Games Research (2017c), diabetes patients who had access to the game showed greater perceived self-efficacy for diabetes self-management, leading to a 77% reduction in their urgent care and emergency clinical visits. Another classic video game for health that was released on SNES is *Bronkie the Bronchiasaurus* (see Figure 2.7). It was made for young children with asthma, in which playing the game was found leading to 40% reduction of urgent and emergency clinical visits (Health Games Research, 2017a).



Figure 2.6. Packy and Marlon was Developed by WaveQuest for Children with Juvenile Diabetes. Source: Health Games Research (2017c)

Vilozni, Barker, Jellouschek, Heimann, and Blau (2001) found an interactive computer-animated system called *SpiroGame* effective in facilitating spirometry in preschool children, which in turn supporting the diagnosis of respiratory disease. The

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effects of game-based treatment are also supported by the findings of Herndon, Decambre and McKenna (2001), when they had proven interactive computer games combined with a conservative program improve symptoms in most children patients with voiding dysfunction.

Tailor-made games are also frequently used in medical education. For instance, *Oncology Game* was featured as an interactive, computer-assisted board game for cancer patient management (see Figure 2.8). It was developed for medical students to help them appreciate the multidisciplinary aspects of oncology patient management, increase the knowledge of general principles in cancer care, and promote teamwork skills in solving clinical issues (BrainPOP Educators, n.d.). Both off-the-shelf and tailor-made games show promising evidence and potential of games for health and medicine-based treatment.

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Figure 2.7. Bronkie the Bronchiasaurus was Developed by WaveQuest for Asthmatic Children. Source: Health Games Research (2017a)

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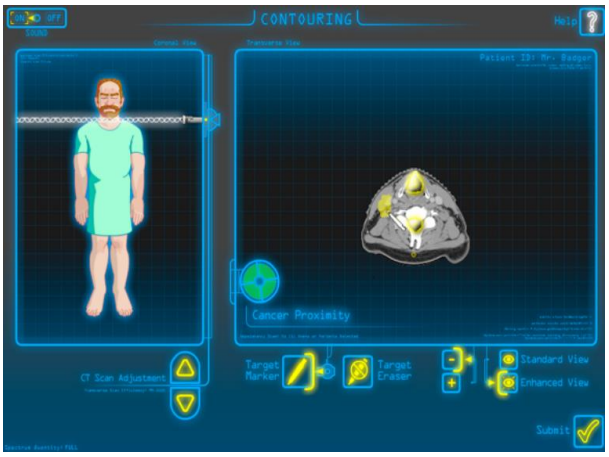


Figure 2.8. A Screenshot Captured from the *Oncology Game*. Source: BrainPOP Educators (n.d.)

2.3.2 Games for Obesity Prevention and Treatment

Game-based prevention is a form of patient-centered prevention that uses serious games for health purpose. In the third edition of the textbook titled Play Therapy: The Art of the Relationship, the author Landreth (2012) defined child-centered play therapy as a dynamic interpersonal relationship between a child (or person of any age) and a therapist trained in play therapy procedures who provides selected play materials and facilitates the development of a safe relationship for the child to fully express and explore self through play. Play is regarded by Landreth (2012) as a medium of child's natural communication, for optimal growth and development.

In obesity prevention and treatment, there are a number of studies that support the idea of exergaming: physically active games seem to be a safe, fun, and valuable means of promoting energy expenditure for children (Graves et al, 2008). According to a review of electronic interventions for prevention and treatment of overweight and

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obesity in young people, most studies demonstrated some forms of significant outcome, such as reported changes in dietary and physical activity behaviours, among participants who received interactive electronic game interventions (Nguyen, 2011). Some games were designed to promote healthy diet, such as *Hungry Red Planet* that was developed by Health Media Lab to cultivate children nutrition skills (Health Games Research, 2017b).

Empirical studies have linked video game play with obesity (Vandewater, Shim, & Caplovitz, 2004). As shown in Figure 2.9, video games that accompany wireless video game console systems like the Nintendo Wii and certain accessories (such as the dance pad with *Dance Dance Revolution*) have been shown to significantly increase energy expenditure among players (Graves et al., 2008). Although the energy expenditure may not be as great as engaging in an authentic version of the sports simulated in the games (such as boxing, tennis, and bowling), these video games provide alternative activities for individuals concerned about video games as a sedentary activity.



Figure 2.9. Screenshot of *Dance Dance Revolution*. Source: Konami (2009)

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The Nintendo *Wii Fit* game, in which players engage in strength, balance, and aerobic activities (see Figure 2.10), has topped the charts as the best-selling console game (Orry, 2009). *Zamzee*, developed by the HopeLab, is a game-based website pediatric treatment program (Health Games Research, 2017d). The use of *Zamzee* increased physical activity of children by 59% on average over a six-month study period, showing positive impact on risk factors associated with heart disease and diabetes (Harvey, 2014).

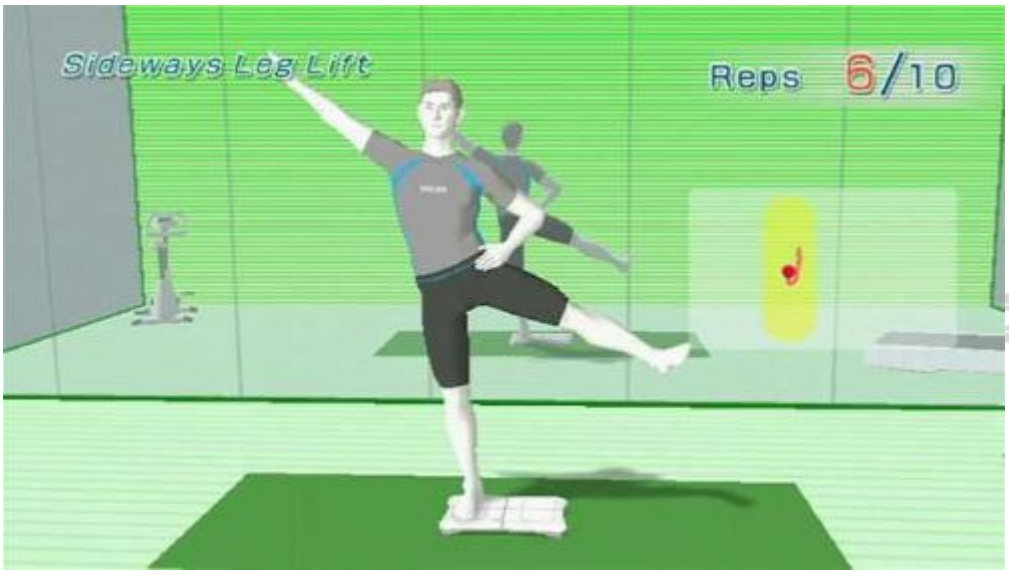


Figure 2.10. Screenshot of *Wii Fit* Balancing Game. Source: Matsunaga (2007)

2.3.3 Issues of Using Games in Childhood Obesity Prevention

In the literature review conducted by Dias, Tibes, Fonseca, and Zem-Mascarenhas (2017), 17 studies of serious games used in childhood obesity prevention or treatment were identified and examined. Two contradictory views were found in the review:

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skeptics who opposed or worried about the use of games and scholars who supported the use of games. Among the supporters of the use of games in childhood obesity prevention and treatment, there scholars who asserted the use of bespoke serious games for health, in contrast to the use of commercial off-the-shelf video games.

2.3.3.1 Skeptics Who Opposed the Use of Games

Daley (2009) recognized children playing computer and video games for a long period of time as a key factor that causes public health problem. When active video gaming or exergaming became a social entertainment trend, Daley (2009) critically analyzed empirical studies which claimed to have produced positive results of using active gaming to improve physical activity levels and health outcomes among children. One criticism Daley (2009, p. 763) held upon exergaming was that "active gaming is no substitute for real sports and activities," because only "a small number of exergaming activities engage children in moderate-intensity activity, but most do not." Based on a critical literature review, Daley (2009, p. 763) highlighted that

> ...only three very small trials have considered the effects of exergaming on physical activity levels and/or other health outcomes in children. Evidence from these trials has been mixed; positive trends for improvements in some health outcomes in the intervention groups were noted in two trials. No adequately powered randomized, controlled trial has been published to date, and no trial has assessed the long-term impact of exergaming on children's health.

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In conclusion, Daley (2009, p. 763) insisted to the need to carry out "high-quality randomized, controlled trials to evaluate the effectiveness and sustainability of exergaming, as well as its clinical relevance". Daley (2009) suggested that researchers and educators should remain cautious on the ability of exergaming to improve children's health until such rigorous studies are conducted.

Meanwhile, Radon et al. (2010) analyzed the feasibility of activity-promoting video games among obese adolescents and young adults in a clinical setting. They aimed to evaluate whether games which require body movements can increase physical activity of players or not. They offered those games to 84 inpatients aged 13 to 28 years between March and May 2007, and then gathered and assessed the reasons for playing and non-playing those games. The results showed that 51 out of 84 participants played at least once in the two-month period. However, the weekly play in the first week (median = 27 minutes) reduced drastically in week four (median = 0 minute). In conclusion, Radon et al. (2010) claimed that activity-promoting video games "could have an impact on the activity of obese adolescents and young adults", but since the players' interest of the games dropped drastically over time, "the suitability of them for weight reduction programmes in young people cannot be ensured."

In addition to what was discovered by Radon et al. (2010), Graves, Ridgers, Atkinson, and Stratton (2010) reported no significant differences between groups on body fat, and concluded that video game use did not positively affect physical activity. In an experimental study that involved 42 children aged eight to ten years in

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the United Kingdom, Graves et al. (2010) studied the effects of active video gaming on children's physical activity, behavior preferences and body composition. Multiple games, as opposed to one game, were used to avoid boredom over time. Children in the intervention group played two games using two provided game devices at home for 12 weeks. Measurements of their body fat changed were carried out after six and twelve weeks from the baseline. Graves et al. (2010) admitted that larger trials are needed to verify the impact of active video gaming on children's physical activity and health, as compared to sedentary video games.

In a cross-sectional, between-subjects experiment that involved both control and experimental groups, Pempek and Calvert (2009) examined the effects of advergames on the consumption of snacks among 30 low-income African American children aged nine to ten years in urban public elementary schools. The participants were assigned randomly to three groups: a group who played a game that relates to healthy food; a group who played a game that relates to less healthy food, and a control group. At the end of this study, Pampek and Calvert (2009) found out that while children generally like to play advergames, those who played the game that prompted to healthy food selected and ate significantly more healthy snacks than those who played the other game. This lead to a worrying conclusion, because advergames that promote healthy and less healthy food are generally effective among children. Thus, there is a need for a framework or a set of guidelines that can regulate the use of games among children to prevent childhood obesity.

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2.3.3.2 Supporters of the Use of Commercial Off-the-shelf Games

When Murphy et al. (2009) examined the effects of using *Dance Dance Revolution* (Konami, 2009) for twelve weeks to improve endothelial dysfunction and other risk factors in thirty-five overweight children, they discovered that the baseline with regard to total cholesterol and low-density lipoprotein of children in the experiment improved significantly. However, Murphy et al. (2009) admitted that "the results document the need to explore relationships between obesity, endothelial function, inflammation, lipids, exercise intensity, and gender in a larger sample of overweight children". Also, the study involved no control group, thus no comparison was made to analyze the causes of improvement after playing the video game.

Graft, Pratt, Hester, and Short (2009) were also interested in the effects of exergaming, specifically the use of active video games like *Dance Dance Revolution* and *Nintendo Wii Sports*. An experiment was conducted with 23 children to compare their energy expenditure rates when playing active video games in relation to watching television and walking on treadmill. Apart from energy expenditure, Graft et al. (2009) also measured their heart rate, step rate, arterial elasticity and perceived exertion. The comparison indicated that the energy expenditure of playing games or walking was two times or three times more than watching television. The heart rate and perceived exertion of participants also showed similar levels of increment, despite variations in step rate across these activities. In conclusion, Graft et al. (2009) claimed that energy expenditure when playing active video game is comparable to moderate-intensity walking among children. Therefore, the use of active video games should be

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encouraged to promote energy expenditure among children. However, the findings of this study need to be triangulated.

In a qualitative research setting, Fogel, Miltenberger, Graves, and Koehler (2010) examined the effects of exergaming on physical activity among four inactive children aged nine years in a physical education classroom of a public elementary school in United States of America. The children were regarded as inactive because they spent at least 30% of the time available to participate in physical activity either standing, sitting, or watching others. Fogel et al. (2010, p. 591) revealed that "exergaming produced substantially more minutes of physical activity and more minutes of opportunity to engage in physical activity than did the standard physical education program." They also claimed that exergaming in the elementary school was socially acceptable to the physical education teacher and the pupils. Fogel et al. (2010, p. 591) concluded that "exergaming appears to hold promise as a method for increasing physical activity among inactive children and might be a possible intervention for childhood obesity." Nonetheless, the effects of exergaming on four children should be triangulated or cross-checked with results of other studies to extend it generalizability.

Quinn (2011) introduced the use of active video gaming, specifically using *Just Dance* and *Dance Dance Revolution* into the middle school curriculum as a school-based childhood obesity intervention in New Jersey, United States of America. He argued that the physical education needs intervention to allow for more active time, in order to increase student participation in the class. In practice, Quinn (2011)

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conducted a pilot study with 86 pupils aged between eleven and twelve years, and discovered that the students became significantly more active in physical education class after the intervention. Therefore, Quinn (2011, p. 3) concluded that the use of active video gaming not only can meet state and national physical education standards, but also can increase adolescent activity, "as a measure to decrease the childhood obesity epidemic." However, Quinn (2011) admitted that there is a need to investigate the long-term efficacy and continued usage of active video gaming within the school, before expanding to other similar schools and to children or adolescent of different age groups.

Gao, Hannan, Stodden, and Valdez (2013) also examined the impact of *Dance Dance Revolution* on the physical fitness and academic achievement of 208 Latino children in an elementary school for two years. Gao et al. (2013) repeated the measures across two years period, establishing the pre-test baseline and post-test outcomes of time to complete a one-mile run, BMI, and reading and math scores. A statistical data analysis showed significant differences between the intervention and comparison groups in the one-mile run and the math scores in Year 1 and Year 2. Gao et al. (2013) concluded that the use of the dancing game as intervention improved the cardiorespiratory endurance and math scores of the pupils over one-year time. Thus, they proposed to consider integrating such game playing activity at schools to promote healthy lifestyle and to enhance literacy and numeracy among Latino children.

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Apart from promoting individual or selected active video games, there were researchers who preferred to organized game-based childhood obesity prevention and treatment programmes. Christison and Khan (2012) evaluated the efficacy and feasibility of a community-based weight management programme for 48 overweight or obese children aged between eight to sixteen years using active video games. Forty of the children completed the programme and their average BMI showed significant reduction. Also, Christison and Khan (2012) reported that the children improved their average Global Self-Worth score, increased their exercise hours per week, while reducing screen time and soda intake at the end of the program. In conclusion, Christison and Khan (2012, p. 382) asserted that the programme "may be an effective weight management intervention that is feasible with high participation rates." Nonetheless, they agreed that these results must be confirmed through a larger randomized controlled trial study.

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Trost, Sundal, Foster, Lent, and Vojta (2014) also organized a pediatric weight management programme in the United States of America to evaluate the effects of active video gaming on physical activity and weight loss in children participating in an evidence-based weight management programme delivered in the community. The programme included a group-randomized clinical trial on 75 overweight or obese children aged around 10 years, which was carried out for sixteen weeks in YMCAs and schools in three different states in the USA. Trost et al. (2014) discovered that participants who played active games exhibited significant increases in moderate-to-vigorous as compared to participants who did not play active games. As a result, Trost et al. (2014, p. 407) concluded that "incorporating active video gaming into an

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evidence-based pediatric weight management programme has positive effects on physical activity and relative weight."

2.3.3.3 Supporters of the Use of Bespoke Serious Games

Baranowski et al. (2010) conducted a two-month randomized clinical trial with two groups of 133 obese children aged between ten to twelve years. The study aimed to evaluate the effects of playing two serious games for health, titled *Escape from Diab* and *Nanoswarm: Invasion from Inner Space* on children's diet, physical activity and adiposity. Participants in the treatment group played two games sequentially, while participants in the control group played diet and physical activity knowledge-based web-based casual games. At the end of the study, Baranowski et al. (2010) concluded that playing either of the games can increase the intake of fruit and vegetable among obese children. Anyhow, they believed that further research is required to study the optimal design of game components in order to maximize the change of behaviors.

By using a bespoke online game called 'ETIOBE Mates', Baños, Cebolla, Oliver, Alcañiz, and Botella (2013) examined the efficacy and acceptability of an internet platform to improve the learning of nutritional knowledge among 228 children. Baños et al. (2013) assumed that nutritional knowledge is required to prevent and treat obesity. Therefore, they created the game to improve children's nutritional knowledge, and compared it to a paper-based pamphlet in an experiment. The results showed that the acquisition of nutritional knowledge in the experimental

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group was significantly better than the control group. In conclusion, Baños et al. (2013, p. 234) claimed that "online games can be an effective method of delivery for preventive and treatment tasks that are otherwise tedious for children".

2.4 Childhood Obesity Prevention and Treatment Frameworks

A thorough literature search for existing frameworks or models associated to childhood obesity prevention returned with three relevant studies. The first study was a proposal of Amarasinghe and D'Souza (2012) to resolve obesity issues through public health activities in a form of conceptual framework and model. The second study was a technical framework of cloud-based pervasive serious game, which attempts to support obesity treatment through technology perspective. The third study was focusing on a theoretical foundation and functions of a bespoke serious game for affecting dietary preference among children. Critical review of these studies justifies the need for a framework that can direct child caretakers, parents and individual children to prevent childhood obesity.

Amarasinghe and D'Souza (2012) created a conceptual framework to explain factors which cause obesity (see Figure 2.11). At the core of this framework, obesity is directly and iteratively related to health and physical activity, while the level of physical activity is determined by socioeconomic factors. In particular, socioeconomic factors are affected by demographic factors and genetic composition of individuals. At the outset of the conceptual framework, neighbourhood economic

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environment is directly and iteratively related to the socioeconomic factors mentioned above. The conditions of the environment are the effects of the natural or man-built environment, and the social environment where individuals reside.

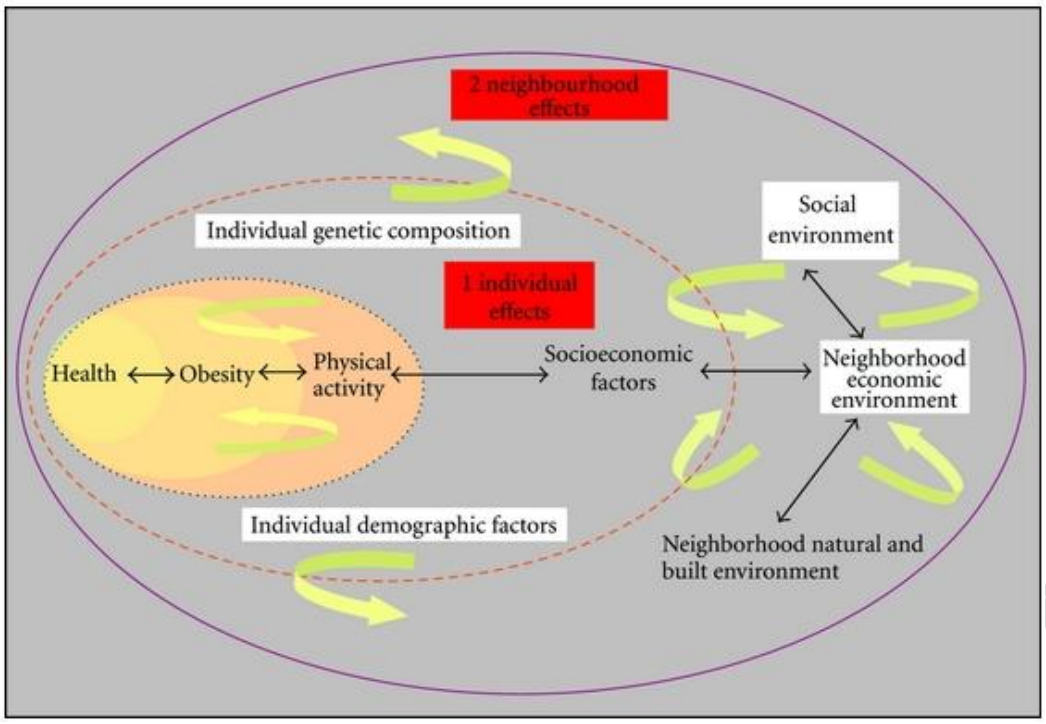


Figure 2.11. A Conceptual Model Proposed by Amarasinghe and D'Souza (2012) to Explain Factors Which Cause Obesity

Based on this conceptual framework shown as Figure 2.10, Amarasinghe and D'Souza (2012) proposed the individual, socioeconomic, and ecological model or ISEEM for obesity prevention and health promotion. The ISEEM was attempted to explain four interconnected components of public health services (see Figure 2.12). The individual component aims to enhance the quality of human capital through physical activity and nutritional education; the social component intends to develop social capital through community empowerment activity and health education; the

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economic component targeted on regulation of food labeling and media advertising, alongside with the provision of economic incentives for selling healthy foods; while the environment component involves setting urban land use policy to optimize combination of public infrastructure for public health activity. No doubt, both the conceptual framework and the ISEEM proposed by Amarasinghe and D'Souza (2012) were useful to comprehend the cause-and-effect and possible solutions to tackle childhood obesity issue at high level, but there is a need for action plan and specific guidelines on what actually child carers, parents and individual children should do tackle this issue. That was why a relatively more specific framework was created in this research, and presented in section 2.5.

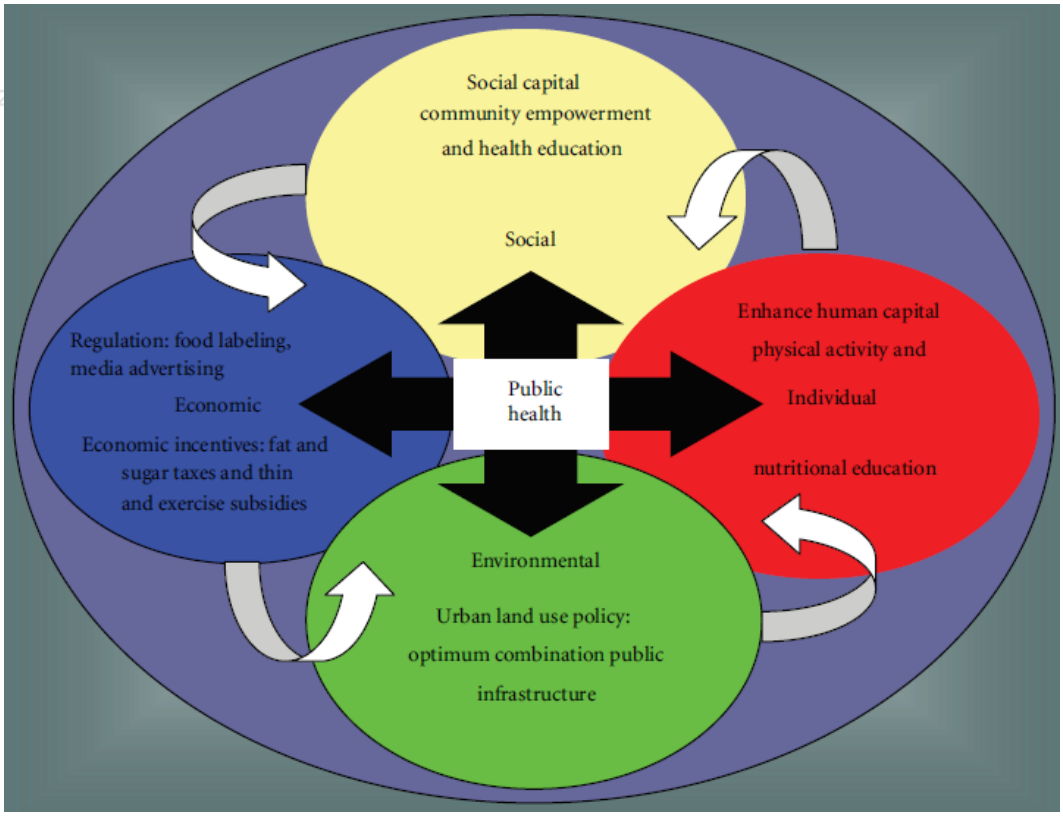


Figure 2.12. The Individual, Socioeconomic, and Ecological Model (ISEEM) for Obesity Prevention and Health Promotion. Source: Amarasinghe and D'Souza (2012)

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Alamri et al. (2013) proposed a cloud-based pervasive serious game framework to support obesity treatment (see Figure 2.13). Similar to other cloud-based technology, this framework aims to enable targeted users to play games "on any device like smart phone, pocket PC, laptop or a personal PC without having to download the game engine" (Almari et al, 2013, p. 1233). Through this framework, biological signals on targeted users can be collected and monitored using sensors over computing networks. Alamri et al. (2013) developed a sample serious game to test the capability of the cloud-based system, which in turn validated the feasibility of the framework. Nonetheless, the usefulness of the framework needs to be extended to actual practices in order to assure its robustness under various circumstances.

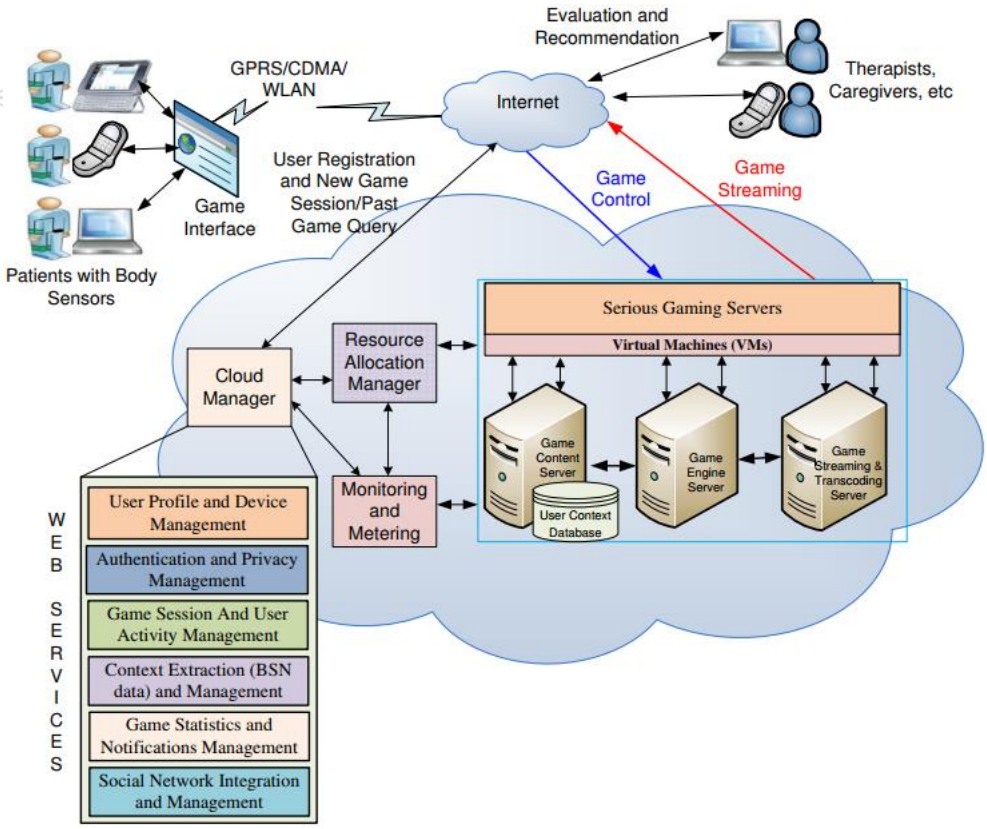


Figure 2.13. A Cloud-based Pervasive Serious Games Framework. Source: Alamri et al. (2013).

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Only one game-based childhood obesity prevention framework was found in the literature. Beasley et al. (2012) examined the effects of using a bespoke serious game titled *The Quest to Lava Mountain* on the dietary preference among children aged between eight to twelve years. A logic model was created to deficit the theoretical foundation and functions of the game (see Figure 2.14). Despite lacking empirical evidence, the model intends to translate simulated game-based behaviors to real-world dietary and physical activity behaviors. The game was expected to capture dietary behavior, health ratings and in-game performance of targeted players. Although this logic model may be too specific for the game, causing the lack of generalizability, it set a good reference for how a framework for game-based obesity prevention could be developed in an academic research.

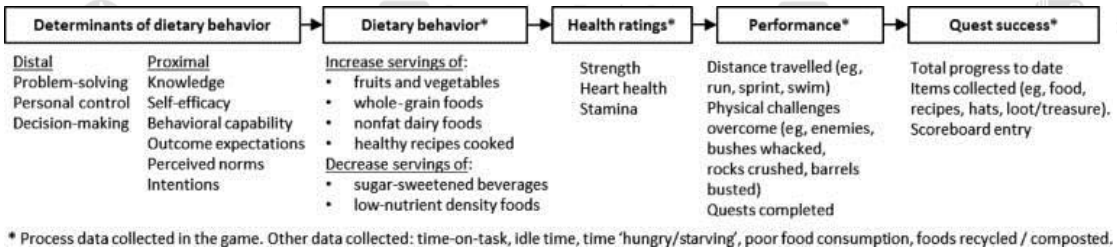


Figure 2.14. A Logic Model of *The Quest to Lava Mountain*. Source: Beasley et al. (2012)

2.5 Serious Games Production and Validation

Since year 2000s, serious games production was perceived by the game industry as new opportunities for several reasons. According to Michael and Chen (2005), serious games can keep production teams in the game industry busy between retail

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entertainment game projects. They also saw the production of serious games as an experiment ground for testing alternative playing styles and distribution (Michael & Chen, 2005). In this sense, serious games were not regarded as a "serious" business opportunity by game designers and developers in the creative industry. Instead, creating serious games was regarded just as filler for in-between jobs period, rather than a core business of a game production studio. Professionals in the creative industry typically used the same method they knew in making entertainment games to produce serious games.

In contrast, the academia was keen to produce games for serious purposes (such as Kankaanranta & Neittaanmaki, 2009; Göbel & Wiemeyer, 2014), and regarded the production of serious games as a core research and development (R&D) matter. Apart from measuring the effectiveness and efficiency of using games in various fields of study, academics explored the methodology of producing serious games (such as Akilli, 2007; Marfisi-Schottman, George & Tarpin-Bernald, 2010), and they might not refer to existing methods of entertainment game production (as in Amri, 2010).

Literature associated to how to design and develop serious games were gathered and juxtaposed in order to identify issues between the passive approaches in the creative industry and the research-oriented approaches in the academia.

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2.5.1 Serious Games Production in the Game Industry

Mäkilä, Hakonen, Smed, and Best (2009) compared two game production models to a software product development model in order to identify similarities and differences between those models (see Figure 2.15). One of the game production models was deployed by Manninen et al. (2006) was meant for a Finnish game studio called LudoCraft. The studio was commissioned by the European Social Fund (ESF) Research Networking Programme to develop a generic game production model for serious purposes. The other game production model was actually drawn from a game development course textbook, titled "The Game Production Handbook", authored by Chandler (2006). This textbook had been used intensively by lecturers in teaching game design and development. In a word, the representativeness of both of these models was justified.

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Nonetheless, if these models were used to design and develop serious games, pitfalls highlighted by Michael and Chen (2005) would be revealed, degrading the quality of their outputs. In particular, professionals in the creative industry should not carry assumptions they had in the experience of building entertainment games to the production of serious games. Michael and Chen (2005) listed the following assumptions to avoid when producing serious games:

- Like entertainment games, serious games should be kept abreast with the latest consumer game playing and computing technologies.
- Like entertainment games, players of serious games want the richest possible experience from their games.

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- Like entertainment games, players would be satisfied with good enough simulation, rather than reflecting accurate calculation or algorithm.
- Like entertainment games, players would enjoy random surprises.

The above-mentioned assumptions should be avoided when developing serious games, because the success of failure of a serious game would be determined by its effectiveness and efficiency in achieving intended outcomes (Tan, 2016).

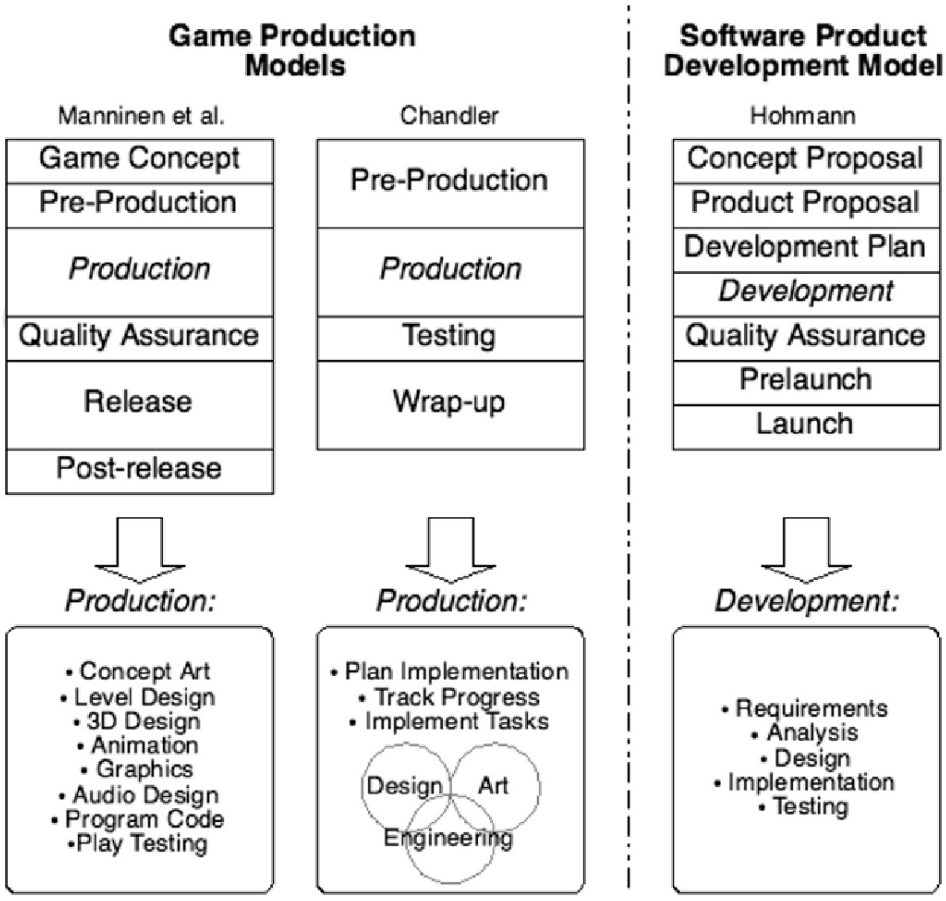


Figure 2.15. Comparison between Game Production Models and Software Product Development Model

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2.5.2 Balancing Serious and Fun Components in Serious Games

In the search for an ideal serious game model, Prenskey (2001) prescribed that the ideal serious games model, especially a model for learning, should have equal proportion of learning and engagement. In other words, learning or other serious intended outcomes should be at least at par with fun or entertaining components in serious games. However, balancing the serious contents with the fun gameplay would be a challenging task. For instance, the architecture framework for scenario-based game development proposed by Westera, Nadolski, Hummel and Wopereisl (2008) was criticized for being too outcome-oriented. The framework was actually used to develop a game titled Emergo, but as it is closed tied to the contents and nature of the subject matter, it was indeed difficult to use the framework for making other serious games. In fact, this was the reason why this research attempted to explore how a balanced serious game could be produced for childhood obesity prevention.

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2.5.3 Quality Assurance in the Game Industry

In the creative industry, a game would go through a four-stage of evaluation process before releasing to the targeted marketplace. These stages are first playable, alpha, beta, gold and release (Bethke, 2003). Each of the stages can be subdivided into the production testing and quality assurance (QA) testing (Levy & Novak, 2010).

When games are produced for serious purposes in health and medicine, academic evaluation and validation methods should be applied on those games, to

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assure the quality of content knowledge on health and medicine, treatment or prevention knowledge, and game technological knowledge. As recommended by UPSI Education Research Laboratory (2016), expert validation on the above-mentioned knowledge should be carried out, followed by laboratory testing and field testing with targeted players.

2.5.4 Models of Serious Games Validation

De Freitas and Oliver (2006) proposed a framework that supports educational games and simulations evaluation, affording tutors to choose suitable games for use in teaching and learning activities. However, this framework was limited to selecting existing games, instead of validating bespoke or custom-made serious games.

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Amri (2010) proposed a conceptual framework for serious games, as shown in Figure 2.16. This framework consists of nine elements, in which the key feature is the game achievement element. According to Amri (2010, p.49), "game achievement is the output from playing the game" which will adjust the level of difficulty within the game activity dynamically based on the level of achievement demonstrated by a player, hence adaptive game balancing. To validate serious games created using the conceptual framework, Amri (2010) further proposed to adapt the Technology Acceptance Model (TAM, proposed by Venkatsh & Davis, 2000) to validate serious games, specifically games for use in formal education. This model examines the usefulness and ease of use perceived by players. Amri (2010) converted the

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conceptual framework into a structural equation modelling format in order to validate the TAM for serious games (see Figure 2.17).

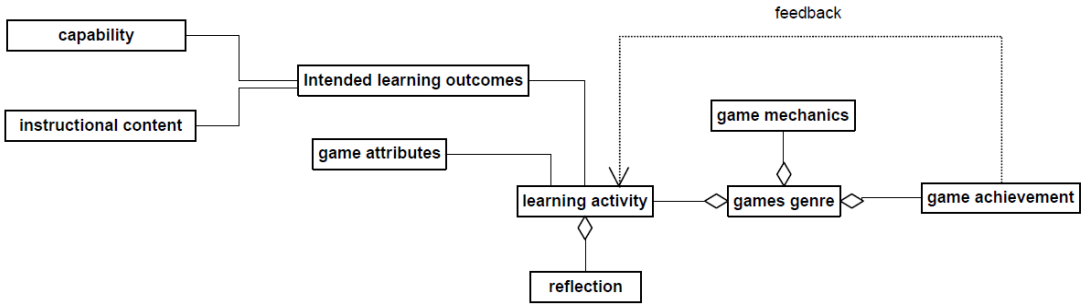
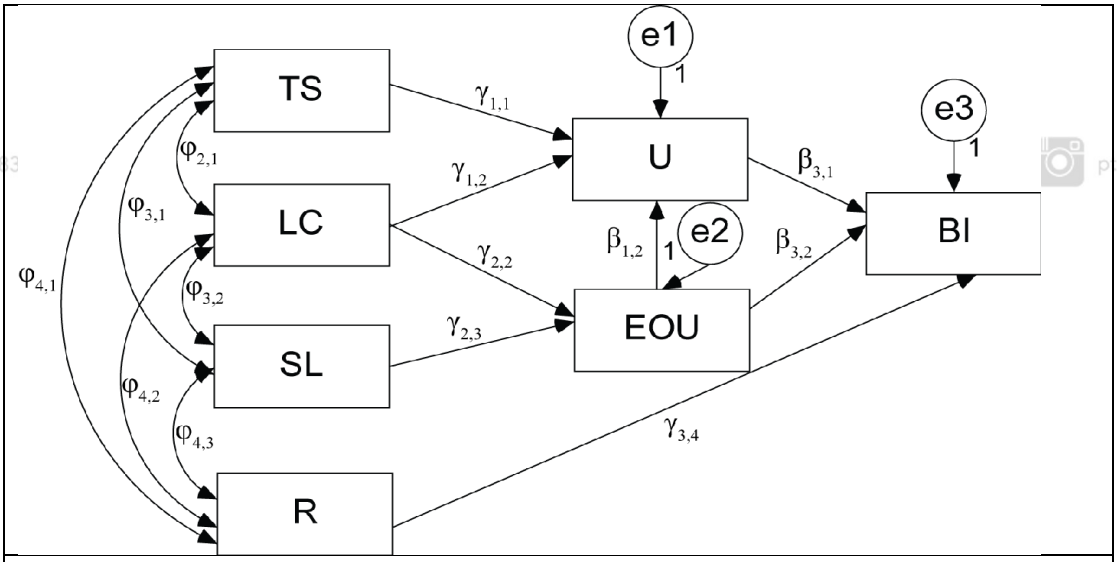


Figure 2.16. A Conceptual Framework of Serious Games



LEGEND:			
Independent variables	TS = Transfer Skills		γ = measurement of causal relationship
	LC = Learner Control		B = paths of a causal relationship between dependent variables
	SL = Situated Learning		
	R = Reward		e1, e2 & e3 = dependent variables' errors
Dependent variables	U = Usefulness		φ = covariance or correlations between pairs of independent variables
	EOU = Ease of Use		
	BI = Behavioural Intention		

Figure 2.17. The Validation of Serious Games through Structural Equation Modelling

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When Tan (2010) attempted to explore how subject matter experts and game experts may collaborate to design and develop serious games for use in formal educational contexts, he developed a comprehensive model, which included methods for serious games evaluation (see Figure 2.18). These methods require the subject matter expert (SME) to develop or adopt game-based learning assessment instruments for:

- the subject matter expert to conduct teach-testing and learn-testing;
- the subject matter expert to collect feedback from players; and
- the game experts to conduct playtesting.

This model was found suitable in this research, because the subject matter expert of the proposed model would conduct teach-testing by asking child caretakers and parents.; while the game expert would conduct playtesting by asking other game experts to rate the usability of a serious game that was designed and developed specifically for this research.

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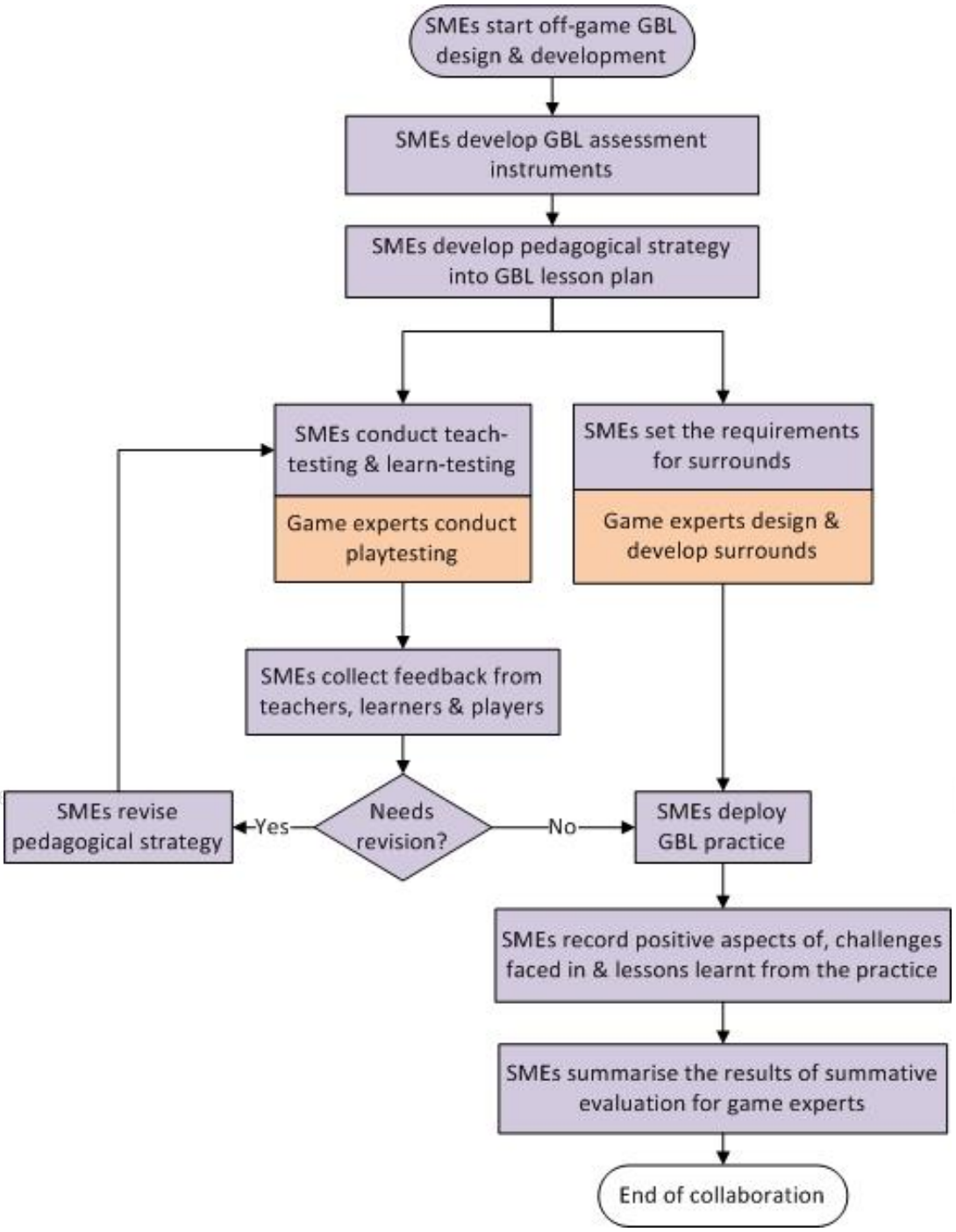


Figure 2.18. The Validation of Serious Games through Usability Rating in Playtesting. Source: Tan (2010)

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2.6 Conclusion

The childhood overweight and obesity is an important public health nowadays. Convention obesity treatment may be inappropriate for preschool children, thus prompting a need for novel therapy method. Games have been used in health and medical treatment for decades, and empirical evidences have proven their effects in motivating patients, increasing treatment adherence, and distracting patients from feeling pain and nausea. These evidences set a promising ground to design and develop serious games for preventing childhood obesity. Existing frameworks or models of game-based childhood obesity prevention were found but less suitable in several aspects. Hence the need to proposed a provisional framework to address those aspects.

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CHAPTER 3

METHODOLOGY

3.1 Introduction

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This chapter depicts the nature of inquiry of this study. It starts from an elaboration of the epistemological paradigm held throughout the conduct of this study. This paradigm determined the choice of methodology, which covered the game design and development approach and the game-based childhood obesity prevention framework validation methods. A five-step gamification approach was chosen when aligning the content knowledge, the intended prevention outcomes and six structural elements of serious game for health. After the game was created, a set of paratextual materials was prepared to afford game-based childhood obesity prevention. These materials consisted of a printed user manual, a promotional video, a website, a Facebook page and a game download page at the Google Play Store. The game was validated using four different methods, involving various types of participants. In particular, the contents of the game were validated by the International Age Rating Coalition (IARC) prior to its publication at the Google Play Store. Next, a playtesting study was

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conducted with 36 game designers to assure the usability of the game. This was done concurrent with a quasi-experimental study, conducted with 60 preschool children at the National Child Development Research Centre (NCDRC) in UPSI.

3.2 Epistemological Paradigm

According to Creswell (2007), the nature of inquiry of a research study would shape the choice of methodology in the study. The nature of inquiry in this study was based on an epistemological paradigm, embraced when it was planned and then conducted between 2012 and 2016 (Guba, 1990). This paradigm had directed all actions and decisions in this research, which was based on a fundamental set of beliefs (Guba, 1990), worldviews (Creswell, 2007) and philosophical assumptions (Crotty, 1998).

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The inquiry of this study involved four research questions, as stated in Section 1.5. The formulation of these questions was set according to two assumptions: 1) a bespoke serious game for health can be designed and developed to prevent childhood obesity; and 2) the effects of a childhood obesity prevention game can be examined through a systematic scientific validation process. These assumptions revealed the belief in positivism (Crotty, 1998), which insisted that objective knowledge can be generated independently of the observer by measuring, quantifying and predicting phenomena which abide universal laws (Cohen, Manion & Morrison, 2007). Therefore, this research fell under the domain of social science that was depicted by Hunt and Colander (2013), rather than social study (as in Seefeldt & Castle, 2013 or

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Mindes, 2014) or sociology (as in Macionis, 2013).

3.3 Research Design

Based on a positivist paradigm, the research design of this study was divided into four phases, involving seven development strategies and eight research methods, as shown in Table 3.1. Research methods employed in the social science, as stated by Frankfort-Nachmias, Nachmias and DeWaard (2014), could integrate the use of the Internet and various social media applications with non-digital instruments, such as observation checklist and questionnaire survey for collecting data from human beings.

In the first phase, a provisional game-based childhood obesity prevention framework was developed. Four strategies were deployed at the same time to structure this framework. The SOP for treating childhood obesity described by Forslund et al. (2014), the treatment algorithm developed by the National Institutes of Health (2002), and the framework proposed by Beasley et al. (2012) were synthesized to form the initial structure of the provisional framework of game-based childhood obesity prevention. Literature related to the use of serious games for health, especially those dedicated to children players was reviewed critically, as shown in Chapter 2. The outputs of the literature review were models or framework on how digital games could be used in obesity prevention among preschool children. Meanwhile, based on a series of reflection on my nine years' experience in clinical medicine studies and practices at five different hospitals (see Table 3.2), a provisional game-based

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childhood prevention framework was proposed at the beginning of this research (see Section 2.4). The provisional framework had been presented to academic researchers in three conferences, namely the National Seminar on ICT in Education 2013, the Fifth International Conference on e-Learning (ICEL) 2015 and the Sixth Irish Conference on Game-Based Learning (iGBL) 2016. In addition, informal discussions were held with medical doctors in hospitals, as a continuous effort to cross-check the authenticity of the framework.

Table 3.1

Methodology of This Four-phase Research

RESEARCH PHASES	**PHASE 1**	**PHASE 2**	**PHASE 3**	**PHASE 4**
	Development of a provisional game-based childhood obesity prevention framework	Design & development of a mobile game for preschool children to prevent childhood obesity	Validation of the effects of a mobile game for preschool children to prevent childhood obesity	Improvement of the game-based childhood obesity prevention framework
METHODO-LOGY	STRATEGIES	GAMIFICATION METHODS	VALIDATION METHODS	IMPROVEMENT STRATEGY
	● Literature review ● Reflection on clinical practice ● Formal discussion in academic conferences ● Informal discussion with medical doctors	● Five-step gamification process ● Player-centric game design ● Lean minimum viable game development	● IARC ratings for mobile game ● Quasi-experiment for testing hypotheses ● Playtesting for usability ● Semi-structured interview	● Revision of prevention ● framework ● Academic publication

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Table 3.2

Reflection of Clinical Medicine Practices in China

Timeframe	Hospitals	Role
2011 - 2012	Ningbo Women and Children's Hospital, Zhejiang Province, China	Pediatrician
2008 - 2011	The Second Affiliated Hospital and Yuying Children's Hospital of Wenzhou Medical College, Zhejiang Province, China	Medical Officer / Postgraduate Trainee
2007 - 2008	Binzhou People's Hospital, Shandong Province, China	Housemanship
2006 - 2007	Jiaozhou People's Hospital, Shandong Province, China	Internship
2003 - 2006	Binzhou Medical University, Shandong Province, China	Medical student

In the second phase, a bespoke serious game, titled *Fight Obesity 2.0* was produced to answer the first research question: how to design and develop a mobile game for use in childhood obesity prevention among preschool children? By referring to the provisional game-based childhood obesity prevention framework in section 3.4, the game was prepared as an obesity prevention instrument for preschool children. The five-step gamification approach proposed by Tan (2015) was adopted to gamify content knowledge on obesity prevention gathered from WHO. Lean production strategy was used to produce a minimum viable game (York, 2012), which featured player-centric game design in order to engage four to six years old children (Shahrel Nizar, Tan & Mohammad Zaffwan, 2014). Chapter 4 of this thesis reports each step of the gamification process, alongside with the design and development of *Fight Obesity 2.0* and all paratextual materials associated to the game.

The effects of *Fight Obesity 2.0* were examined and validated in the third phase. Multiple methods were deployed to validate the content knowledge (CK), the

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game technology (GT), and the childhood obesity prevention strategy (PS). Table 3.3 shows the types of participants involved in the serious game validation.

In the fourth phase, the provisional framework of game-based childhood obesity prevention was revised. The revision was done based on the findings of the quasi-experiment and the answers to four research questions. The revised framework has been submitted as a book chapter for an edited and peer-reviewed book titled Design, Motivation and Framework of Game-based Learning, to be published by IGI Global in 2018.

Table 3.3

Validation Methods of This Four-phase Research

Methods	**Purpose**	**Types of participants**	**N**	**Scope of validation**		
				GT	**CK**	**PS**
IARC Digital Game Content Rating	To achieve global standard rating and age classification.	Rating authorities in various regions	5		/	
Playtesting	To examine the usability of *Fight Obesity 2.0*.	Game designers	38	/		
Non-equivalent control group pre-test / post-test quasi-experiment	To test three hypotheses formulated in this research.	5 to 6 years old preschool children at NCDRC	60		/	/
Follow-up non-participant observation	To examine the transfer of knowledge from game playing to observable behaviours in kindergarten.	14 children who showed significant improvement in the quasi-experiment.				
Semi-structured interview	To examine the perceptions of pediatricians on *Fight Obesity 2.0* and the game-based childhood obesity prevention framework.	Pediatricians	2		/	/
		TOTAL	105			

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3.4 A Provisional Framework of Game-based Childhood Obesity Prevention

As justified in the literature review (see section 2.4), there is a need for developing a framework of game-based childhood obesity prevention for child carers, parents and individual children. After considering the deficiencies in literature, a provisional framework was developed based on SOP for childhood obesity prevention and treatment explained by Forslund et al. (2014), as shown in Figure 1.1 in section 1.4.

In practice, the treatment algorithm developed by the National Institutes of Health (2000) under the Obesity Education Initiative in the United States of America was the basis for constructing a framework for game-based childhood obesity prevention (see Figure 3.1). The algorithm was created for adult patients and it consists of seven examination procedures and nine treatment procedures. In this algorithm, prevention of obesity occurs after patients successfully achieved weight loss, thus the prevention is regarded as a part of the treatment, that is to prevent recurrence of overweight or obesity. As shown in the 11th procedure in the algorithm, the prevention is also seen as maintenance counseling, which consists of dietary therapy, behaviour therapy, and physical activity. These three types of therapies were identified as the major components to be included in the provisional prevention framework.

The provisional framework of game-based childhood obesity prevention was developed by prompting parents or child caretakers to bring an overweight or obese child to see a doctor (see Figure 3.2). When seeing a doctor, standard examination

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will be carried out, as practiced in the treatment algorithm mentioned in Figure 3.1. The key enhancement of the game-based framework, as compared to the treatment algorithm is the identification of components in the SOP that can be gamified to make the prevention activity fun and engaging to children (see section 2.5.2). Also, specific advice or guidance was given to child caretakers in kindergarten, parents and individual children, as part of the prevention procedure.

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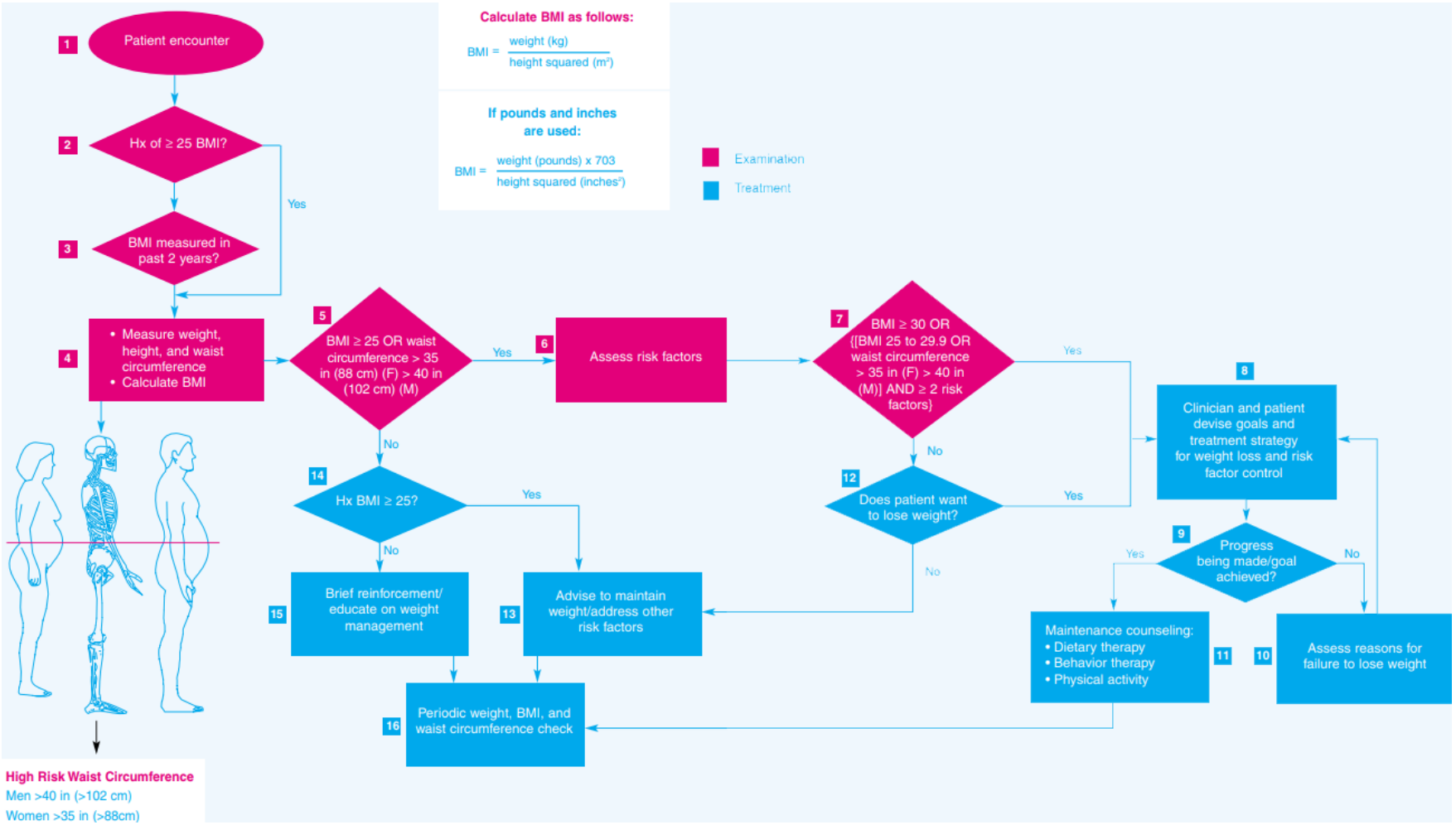


Figure 3.1. Obesity Treatment Algorithm Developed by the National Institutes of Health (2000)

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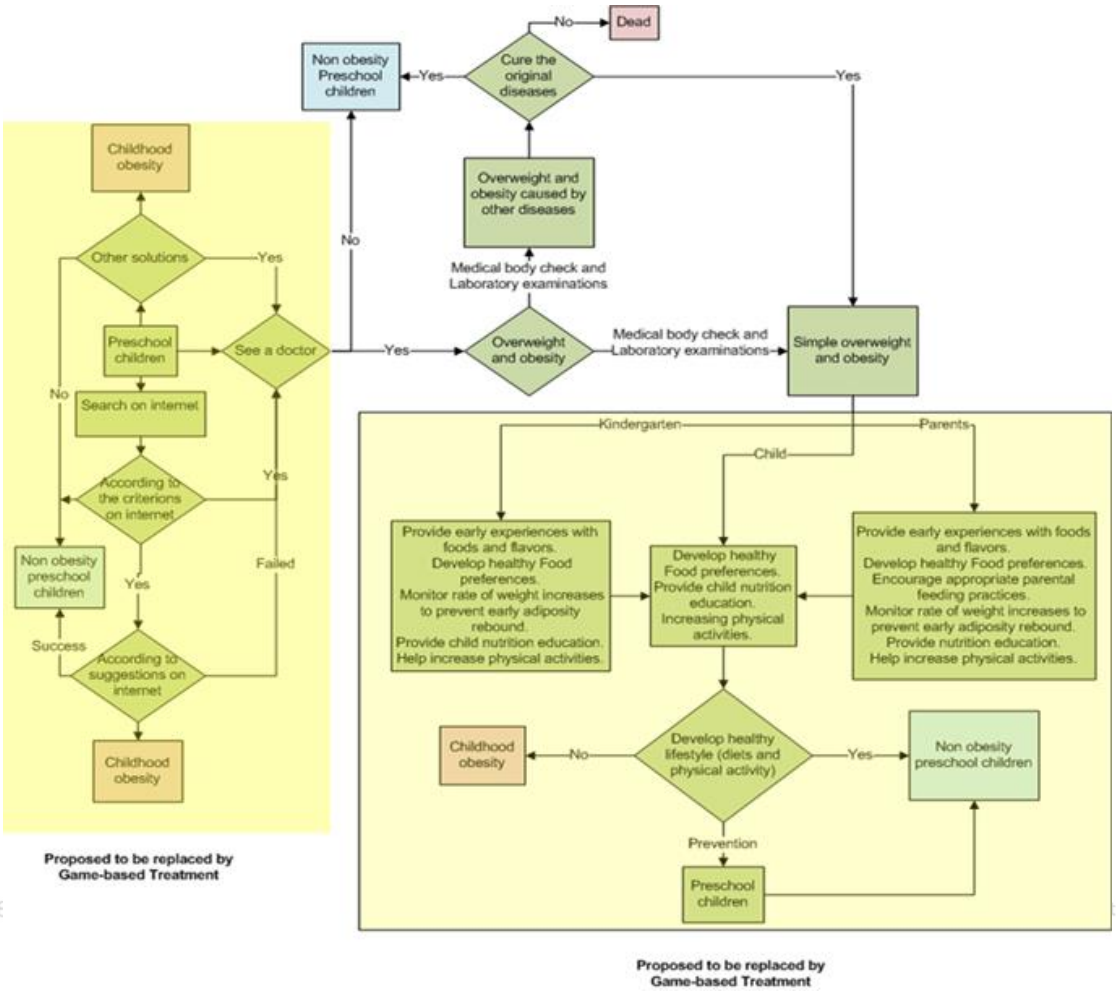


Figure 3.2. The Provisional Framework of Game-based Childhood Obesity Prevention

3.4.1 Non-gamifiable Components in Childhood Obesity Prevention

While this research is trying to advocate the use of games for childhood obesity treatment and prevention, there are no doubt components of procedures in the treatment algorithm which cannot be gamified. As shown in Figure 3.2, only procedures shaded in yellow were found gamifiable, which means the rest of the framework cannot be gamified under the present medical standards, legislation and

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regulation (National Institutes of Health, 2000). In practice, laboratory examinations and obesity caused by diseases and require medication are typically procedures which cannot be gamified.

3.4.2 Gamifiable Components in Childhood Obesity Prevention

The shaded areas in Figure 3.2 illustrate that the procedures can be turned into game-like activities. In this sense, diagnosis, treatment and prevention of childhood obesity can even be done outside of hospital, such as when children are playing games at home or in kindergarten. Child caretaker, parents and children can access the Internet to understand the consequences of being overweight and obese. Also, the provision of guidance to child caretaker, parents and children can be featured into game playing and interactive animation which match the taste and interest of preschool children. Chapter 4 of this thesis explains how gamifiable components of the childhood obesity prevention framework were turned into a serious game.

3.5 Gamification for Childhood Obesity Prevention

In this study, the approach of gamification proposed by Tan (2015) was adopted to design and develop *Fight Obesity 2.0*. Tan (2015) proposed a five-step gamification approach which integrated six structural elements of games depicted by Prensky (2007). According to Prensky (2007), an effective game-based learning should

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encompass six elements of games: goals, rules, interaction, feedback, problems and narrative or fantasy.

The first step of gamifying childhood obesity prevention was setting and defining the purpose of gamification. In this research, the purpose of gamification was to turn non-game playing childhood obesity prevention content knowledge into game playing activities for preschool children. This purpose was aligned to the preference of game technology which could be made available to the targeted player. As mentioned in Section 1.7.2 and Section 1.7.3, seven inches tablet computer which run on Android operating system was chosen as the platform for deploying the childhood obesity prevention contents. After that, a game goal was set for either the male or the female avatar in the *Fight Obesity 2.0* that was to possess healthy food preferences and healthy lifestyle.

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This game goal was broken down into three components, specifically observable behaviours of the game avatar, the conditions of goal attainment, and the degree of goal attainment. The game avatar represents individual game players, including their characteristics, where such representation comprises pedagogical information concerning both the knowledge acquired by players and their behavioural profile (Carron & Marty, 2009). The components of game goal were aligned to the intended outcomes of the childhood obesity prevention, as proposed by Tan, Nurul Fazmidar and Wang (2016). After the alignment, the game goal was used to determine the game challenge. In this gamification practice, preschool children were led to empathize with the challenges encountered by the male or female character they played (Lee, 2007). Meanwhile, game rules, game mechanics and

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physics of the game world were set based on the conditions of goal attainment. The game rules were made explicit, simple and succinct to accelerate the comprehension process and needs among the targeted preschool players, while the game mechanics were made as detailed as possible for game programmers to code and establish the physics of the game world. The degree of game goal attainment was further developed by pedagogy experts and instructional designers, in order to set the model and modes of in-game interaction, and then to prepare formative and summative feedback in *Fight Obesity 2.0*.

The six structural elements of Fight Obesity were not designed and developed in a linear production process. The gamification process was actually a series of iteration, where game designer, pedagogy experts, content experts, programmers and game artists went through several iterative negotiations, discussion and compromise situations, before reaching a mutual optimized design of the game.

3.6 Validity and Reliability of *Fight Obesity 2.0*

In social sciences, validity of measures concerns whether measurements of an instrument are actually what the instrument supposed to measure (Gray, 2009). Therefore, the validity would affect the integrity of a research study, especially the conclusion drawn from the study (Bryman, 2008). On the other hand, reliability of research instruments is important to assure the consistency of measures that are contrived for concepts in social sciences (Bryman, 2008). Concepts associated to

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perception, attitudes and behaviours might not be observable directly. Therefore, these concepts must be operationalized or defined, if not reduced to patterns that can be observable and measurable directly (Krishnan Guru, 2005). In this sense, reliability of measures is regarded as the consistency and stability of a research instrument. When conducting qualitative research, the idea of reliability is coined as trustworthiness (Bryman, 2008).

Three validation strategies were deployed in this research. The first strategy was design validation through playtesting which involved game designers. The playtesting of the game was conducting only with game designers because game designers were assumed to know the mechanics, dynamics and aesthetics of a game more than any other stakeholders of the game (Hunicke, LeBlanc, & Zubek, 2004), including children, parents, pediatricians, and kindergarten teachers and child caretakers. The second strategy of validation was carried out by passing an international standards assessment of game rating. After meeting the technical standards, the design of the game would be suitable for preschool children to play. The third was content knowledge validation done by pediatricians, in which pediatricians from China and Malaysia were engaged to play and validate the childhood obesity contents.

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3.6.1 Design Validation through Playtesting

The purpose of playtesting the serious game was to validate the usability in five aspects, which were Playtesting was likeability, efficiency, helpfulness, control and learnability (Kirakowski & Corbett, 1993). The underlying assumption of conduct of the playtesting session was that game designers know the most about game design, as compared to end users or stakeholders of the serious games. End users of the serious game were regarded as the subjects or participants in the quasi-experiment. They were preschool children who do not have the cognitive knowledge to comprehend the mechanics, dynamics and aesthetics of game design (Hunicke, LeBlanc, & Zubek, 2004), therefore they were not fit to playtest the serious game in this research. Stakeholders of the serious game may be kindergarten teachers and parents. They were regarded as clients who have limited or no professional knowledge on game design, thus they were not fit to playtest the game. In this research, people who were qualified as game designers should have at least two years of formal study in game design and development courses at tertiary education.

The playtesting session was conducted with 38 out of 40 game designers who went through formal game design and development courses at higher education level. Most of the testers possessed a diploma in game technology, and had experience in game design and development. All participants were male, aged between 20 to 23 years old. No female game designer was available on the date when the playtesting session was specially set up in a computer lab in a higher education institution.

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Nevertheless, the game was designed by a female designer and it was important to have the male testers to assure the game as gender neutral game.

The timing of this playtesting session conducted with game designers was to align the game with latest game technology, which normally got refreshed every six months (Polanco, 2016). The instrument used in the playtesting session was a questionnaire adapted from the Software Usability Measurement Inventory (SUMI) developed by Kirakowski and Corbett (1993). The adaptation was made to ensure the context of the questions asked in early 1990s was adjusted to meet the validity requirements set for nowadays mobile apps and computing technology.

Collected data were sorted using Microsoft Excel and then analysed using IBM SPSS, in which descriptive statistics were used to summarize the sample through frequency, mode, and cross tabulation tables. The perception of playtesters was measured on a three-point ordinal scale: agree, undecided, or disagree. The results of the playtesting were organized into five sections: likeability, efficiency, helpfulness, control and learnability.

3.6.2 Technical Validation for Publication at App Store

Upon the completion of the game production, *Fight Obesity 2.0* was validated by going through a rating system governed by the International Age Rating Coalition (IARC). This validation was the first gatekeeper for quality contents in digital games

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designed and developed specifically for serious purposes. The IARC is a "global rating and age classification system for digitally delivered games and apps that reflects the unique cultural differences among nations and regions" (IARC, 2016). Figure 3.3 depicts how IARC works for a new app or game before being published at any participating storefront.

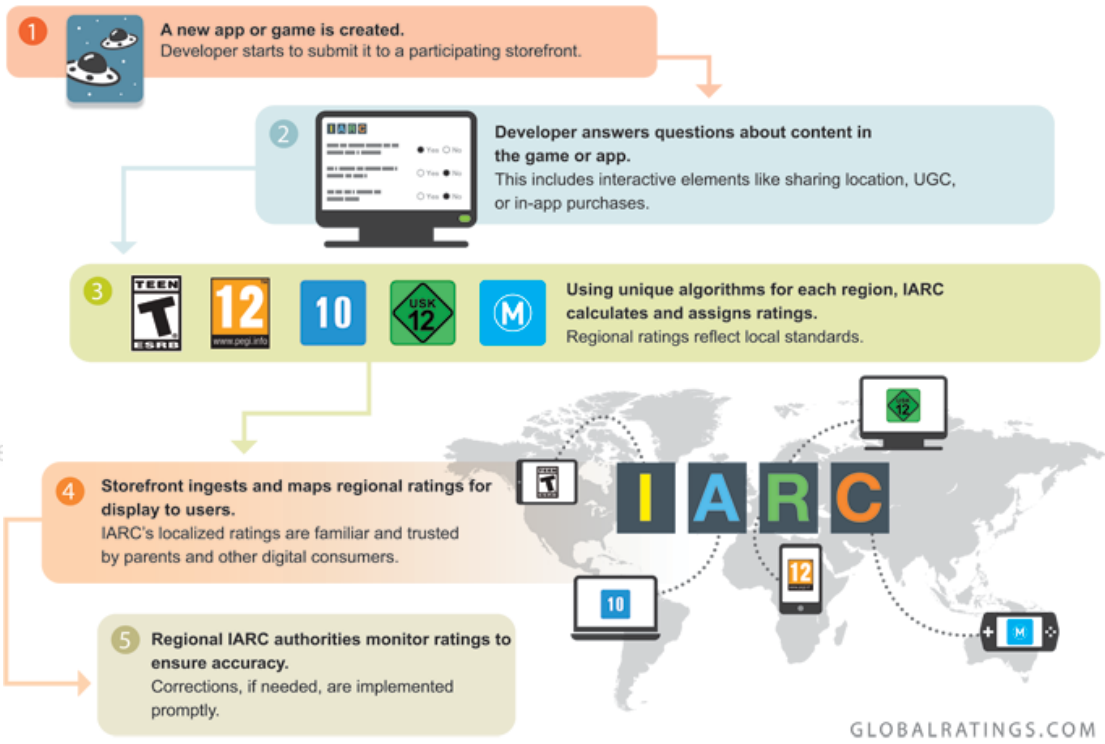


Figure 3.3. The International Age Rating Process, Governed by the IARC

3.6.3 Content Validation by Interviewing Pediatricians

Semi-structured interview was conducted with two volunteering pediatricians who were interested in the game-based childhood obesity prevention framework. The findings of the interview sessions were expected to validate the use of *Fight Obesity*

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2.0 mobile game in healthcare practices, and this in turn would confirm the ecological validity of the prevention framework. The following questions were asked in each of the interview sessions:

a) How do you see the use *Fight Obesity 2.0* as a childhood obesity prevention strategy? Why?

b) Is the content knowledge on childhood obesity prevention in *Fight Obesity 2.0* accurate? Why?

c) Is this childhood obesity prevention strategy effective? Why?

d) Is this childhood obesity prevention strategy practical in Malaysia? Why?

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e) When and where a game like *Fight Obesity 2.0* can be used to prevent childhood obesity?

f) Who may use a game like *Fight Obesity 2.0* to prevent childhood obesity? Like how?

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3.7 Non-equivalent Control Group Pre-test / Post-test Quasi Experiment

A non-equivalent control group pre-test / post-test quasi-experiment was designed and then conducted with sixty preschool children at the NCDRC. This research method was selected to test the following hypotheses formulated for this research:

i) H_0: Preschool children's food preference shows no significant difference before and after playing an obesity prevention game.

ii) H_1: Preschool children's food preference shows significant positive change after playing an obesity prevention game.

iii) H_0: Preschool children's conception on the relationship between obesity and physical exercise show no significant difference before and after playing an obesity prevention game.

iv) H_1: Preschool children's conception on the relationship between obesity and physical exercise show significant improvement after playing an obesity prevention game.

v) H_0: Preschool children's conception on the danger of childhood obesity shows no significant difference before and after playing an obesity prevention game.

vi) H_1: Preschool children's conception on the danger of childhood obesity shows significant improvement after playing an obesity prevention game.

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The purpose of the quasi-experiment was to examine whether or not exposure to an obesity prevention game, specifically *Fight Obesity 2.0* can change preschool children's food preference and conception on obesity. A representation of the quasi-experiment design is shown in Figure 3.4, which was an adaptation of what Cohen, Manion and Morrison (2007) proposed for quasi-experimental studies.

Experimental	O_1	X	O_2
Control	O_3		O_4

Figure 3.4. The Design of a Non-equivalent Control Group Pre-test / Post-test Quasi-experiment

In this research design, X represented the exposure of a group to an experimental variable. In this research, the exposure was playing *Fight Obesity 2.0*, in which the effects were measured. In the quasi-experiment, O referred to the process of measurement, specifically the performance of preschool children when responding to the questions asked by data collectors. In this research, Xs and Os in a given row were applied to the same persons. The left to right order indicated the temporal sequence: from the pre-test conducted in June 2016 to the post-test carried out in July 2016. Xs and Os vertical to one another were simultaneous, which meant O1 and O3 took the pre-test concurrently, and then took the post-test together at the end of the quasi-experiment. Parallel rows separated by dashes represent comparison groups equated by randomization, while those separated by a dashed line represent groups not equated by random assignment (Cohen et al, 2007).

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3.7.1 Instrumentation

Fight Obesity 2.0 was used as the obesity prevention instrument in the quasi-experiment. A four weeks exposure to this game was planned initially, but the actual conduct spanned across five weeks because there was one-week holiday of Hari Raya Aidilfitri, where NCDRC was closed. Nonetheless, the exposure to *Fight Obesity 2.0* was remained as four sessions, one session per week. The exposure to *Fight Obesity 2.0* was the independent variable in this quasi-experiment; while the children's test scores in pre-test and post-test were the dependent variable, as the score could change depending on the exposure to the game.

A set of test questions was developed for use in the pre-test and the post-test (see Appendix B). This instrument consists of 13 test items, six for examining the food preferences of research participants, and seven for testing their conception on childhood obesity, as shown in Table 3.4. This instrument worked under edumetric principles rather than psychometric principles. According to Heun, Heun and Schnucker (n.d., p. 4), "edumetric test is designed to measure the gain or growth of an individual's knowledge, learning skills or ability". This test should be "valid in the sense that scores on them change as the person grows in experience, wisdom, ability to perform effectively on various tasks that life presents to him." McClelland (1973) stressed that the edumetric approach was not deployed to "show relationship of an individual to a norm group or population nor is it necessarily designed to show an individual's standing in relation to some hypothetical variable or standard". Instead, it was deployed to "support generalizations about an individual's performance relative

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to a domain of tasks" such as the cognitive capability to prevent childhood obesity and it was "suited for instructional systems that attempt to be adaptive to individuals" (McClelland, 1973), such as mobile games.

In the case of this research, the reliability of the edumetric test is not dependent upon variable (as in psychometric test), but upon the consistency of gain or growth in scores within an individual on two occasions, specifically the pre-test and the post-test. The validity of an edumetric test can be realized only through the administration of the test at two points in time (Heun et al, n.d.). Thus, the validity of an edumetric test is determined when an individual's gains in a test are compared to his gains or expected gains in skill development (Carver, 1974). It involves the degree of sensitivity of a test to measure the change or gain of an individual.

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Table 3.4

Test Items Included in the Data Collection Instrument

Category	**Test items**	**Alignment to features in *Fight Obesity 2.0***
Food preferences	1. What do you want for breakfast, lunch and dinner?	Question 2, 10 in Level 3
	2. Do you like to eat fried food? Such as fried chicken and fried bananas.	Level 1
	3. Do you like soft drinks?	Level 1; Question 8 in Level 3
	4. Do you like to eat fruits?	Level 1; Question 4 in Level 3
	5. Do you like to eat vegetables?	Level 1; Question 6 in Level 3
	6. Do you like to eat fast food? Such as KFC and McDonald's.	Level 1; Question 3 in Level 3
Conception on childhood obesity	7. Do you think your mother is fat or thin?	Character setup and Level 2
	8. Do you think you are fat or thin?	
	9. Do you like to watch TV?	Question 1 & 9 in Level 3
	10. Do you like to do exercise? Such as running, climbing, swimming, playing badminton.	
	11. Can obesity cause heart problems?	Consultation animation
	12. Can obesity cause diabetes?	
	13. What would you do if you become very fat in the future?	

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In terms of food preferences, Questions 1 to 6 were similar to questions asked in Level 3 of the *Fight Obesity 2.0* mobile game. When playing the game, positive feedback such as a round of applause was given to individual players for every correct answer. But if a player answered incorrectly, negative feedback and explanation of consequences of unhealthy food would be presented to them. No feedback was given when respondents from both the control group and the experimental group answered questions in the pre-test and post-test. This was meant to assure that changes of behaviours and conception among participants were due to the exposure to *Fight Obesity 2.0*. Question 7 and 8 were asked to check whether the participants can differentiate normal, overweight and obese body size or not, either by judging people their mother—a person they had grown up with, or themselves. Question 9 and 10 were related to their daily physical activities. Question 11 and 12 were testing their knowledge on obesity. Answers for these questions can be seen in the virtual consultation animation of *Fight Obesity 2.0*. The test item was an open question, in which participants were tested to see whether they knew how to overcome overweight or obesity problem or not.

To make concurrent data collection using multiple tablet computers, four research assistants were recruited and trained to assist data collection with 60 preschool children at the NCDRC. All of these assistants had experience in game design and development, and they conducted playtesting sessions prior to this quasi-experiment.

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3.7.2 Choosing Tadika NCDRC as the Case for Quasi-experiment

Upon the completion of research instruments in May 2016, a letter of application to conduct research at Tadika NCDRC was sent by the Dean of Institute of Graduate Studies, UPSI to the Director of NCDRC, Prof. Dr. Sopia bt Md Yassin (see Appendix C). The approval for conducting research in Tadika NCDRC was granted for conducting research at Tadika NCDRC (see Appendix D). In actual practice, the study lasted for one month, from June 2016 to July 2016.

Tadika NCDRC was chosen as the case for this research because of its unique roles and functions in Malaysia (Pusat Penyelidikan dan Perkembangan Kanak-kanak Negara, 2016). Up to year 2016, it was the first and only kindergarten in Malaysia that played the role as a child development research centre. The kindergarten not only prepared quality and systematic early childhood education programme, but also stressed several important aspects on early childhood development, including nursing, learning, healthcare, safety and security, living skills and creativity (NCDRC, 2016).

All programmes and activities conducted in the nursery of NCDRC followed the Kurikulum PERMATA Negara or National PERMATA Curriculum (Aminah, Rohani, Nani & Jameyah, 2013); while programmes and activities carried out in Tadika NCDRC was aligned to the National Preschool Standard Curriculum (Bahagian Pembangunan Kurikulum, 2016). The standard curriculum was designed to develop the overall and integrated potential of four to six years old children, which encompassed physical, emotion, spiritual, intellectual and social in a safe and

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enriching learning environment with fun, creative and meaningful activities (Bahagian Pembangunan Kurikulum, 2016). This in turn would enhance skills, establish confidence and develop positive self-concept among children, gearing towards their success in existing environment to handle challenges and responsibilities in primary school later. The development of children aged five to six years old is based on the six cores model proposed by Tadika NCDRC, as shown in Figure 3.5. This model involves not only the educator in the early childhood education system, but also the community and the parents. The model incorporates the following six cores:

- Development of personality, social emotions and spirituality
- Development of language, communication and early literacy
- Development of early mathematical and logical thinking
- Development of senses and the understanding of world environment
- Development of physical and self-management skills
- Development of creativity and aesthetics

The teaching and learning activities in Taska NCDRC were enhanced by innovative technology, in which Microsoft Kinect, Smartboard, Now!Board and computer were used occasionally to expose children to technology world through education (NCDRC, 2016). This was the rationale for choosing Taska NCDRC, in which game-based childhood obesity prevention framework suited the existing innovative learning activities, while reducing the any possible novelty effect caused by the use of game rather than its content knowledge (Poppenk, Kohler & Moscovitch, 2010).

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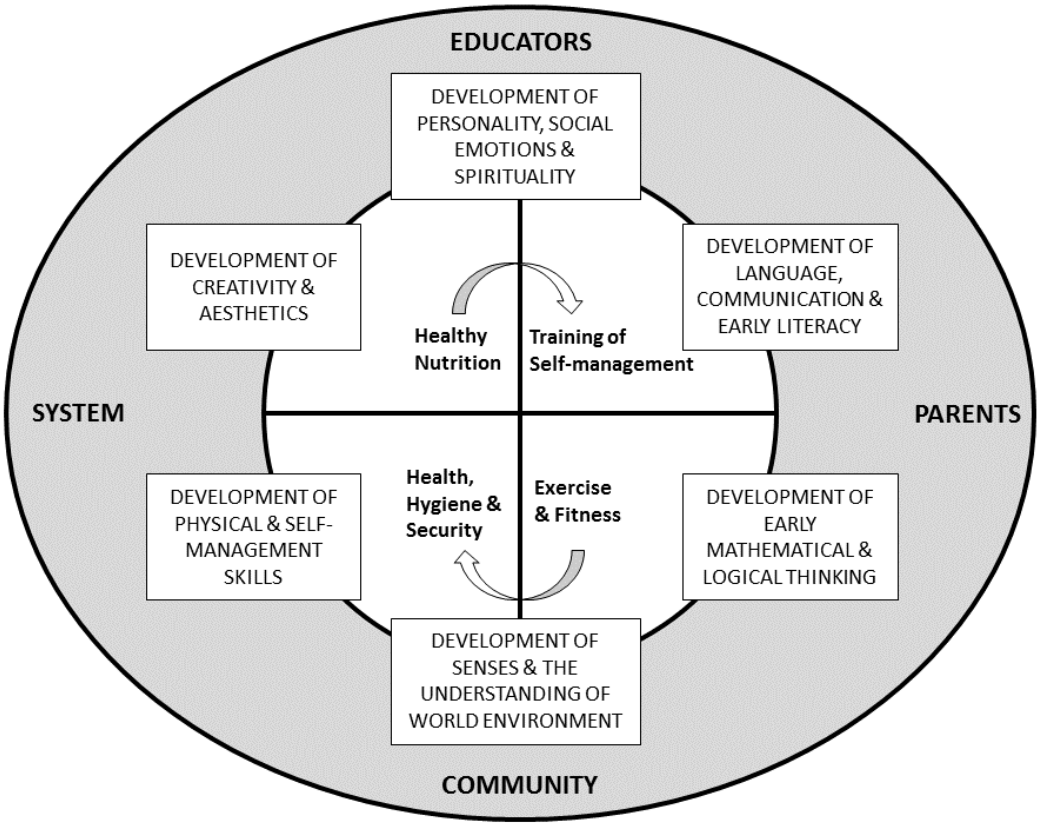


Figure 3.5. Six Major Cores of the Development of Children in Tadika NCDRC

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In 2016, there were two five-year-old classes (5 Jasmine & 5 Orchid) and two six-year-old classes (6 Lavender & 6 Carnation). All classes shared the same curriculum, as shown in Table 3.5. All children went through the same daily routine, where there were health screening and then circle time upon arrival at the NCDRC and they were guided to reflect before leaving NCDRC for lunch. Table 3.6 shows a sample timetable of Tadika NCDRC; while Table 3.7 is the timetable for Bitara Transit Class after leaving Tadika NCDRC.

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Table 3.5

Learning through Play and Development Aspects in Tadika NCDRC

Daily routine	**Learning through play**	**Developmental aspects**	**Time**	**TOTAL**
Health Screening	Bahasa Kita	Communication	3 x 30 minutes	90 minutes
Circle Time	Fun with English	Communication	3 x 30 minutes	90 minutes
Reflection	Ethics, Moral & Value (EMV)	Spiritual, Attitude & Values	4 x 30 minutes	120 minutes
	Let's Explore	Early Science & Early Mathematics	2 x 30 minutes	60 minutes
	Creative Movement	Physical & Aesthetic – Creativity	2 x 30 minutes	60 minutes
	World Around Me	Humanities	1 x 20 minutes	20 minutes
	Star of the Day	Social Emotional	1 x 20 minutes	20 minutes
	Learning through Project	All aspects	5 x 60 minutes	300 minutes

Table 3.6

Timetable of Class 6 Carnation in Tadika NCDRC

	Monday	Tuesday	Wednesday	Thursday	Friday
7:30 am – 8:00 am (30 minutes)	Arrival, Health screening & Breakfast				
8:00 am – 8:30 am (30 minutes)	Circle Time (Outdoor)				
8:30 am – 9:00 am (30 minutes)	Bahasa Kita	Creative Movement	Creative Art	Creative Movement	Ethics, Moral & Value (EMV)
9:00 am – 9:30 am (30 minutes)	EMV	Bahasa Kita	EMV	Bahasa Kita	Fun with English
9:30 am – 10:00 am (30 minutes)	Fun with English	Let's Explore	Fun with English	EMV	Let's Explore
10:00 am – 10:30 am (30 minutes)	Snack				
10:30 am – 11:30 am (60 minutes)	Learning through project				
11:30 am – 11:50 am (20 minutes)	Individual Reading	Star of the Day	Individual Reading	World Around Me	Individual Reading
11:50 am – 12:00 pm (10 minutes)	Reflection				

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Table 3.7

Weekday Timetable of Bitara Transit Class at the Tadika NCDRC

Time (pm)	12:00 - 12:45	12:45 - 1:15	1:15 - 2:30	2:30 - 3:00	3:00 - 3:30	3:30 - 4:30	4:30 - 5:00
Duration (minutes)	45	30	45	30	30	60	30
Activity	Lunch	Shower	Nap	Wake up	Tea Time	Club / Iqra	Free

The administration and organisation of NCDRC kindergarten (Tadika) and nursery (Taska) were separated from the management of NCDRC, in which both Taska and Tadika were managed by a Grade N41 manager. The manager was assisted by two Grade DG44 supervisors, one for Taska and another for Tadika. There were 12 certified Pendidik or education officers, in which eight of them were Grade DG41 (Bachelor degree holders) and four of them were Grade DG29 (Diploma holders). The education officers were supported by 12 Pembantu Pengurusan Murid or pupil management assistants (two Grade N22 and 10 Grade N19) and 13 Taska/Tadika assistants (Grade N19). Table 3.8 shows the management and staff who worked in Taska / Tadika NCDRC.

Table 3.8

The Management and Staff of Taska / Tadika NCDRC

Position / Job title	**Grade**	**Gender**		**Total**
		Male	**Female**	
Manager	N41	0	1	1
Tadika Supervisor	DG44	0	1	1
Taska Supervisor	DG41	0	1	1
Education Officer	DG41	0	8	12
	DG29	1	3	
Pupil Management Assistant	N22	0	2	12
	N19	0	10	
Taska / Tadika Assistant	N19	0	13	13
Food Preparation Assistant	N19	2	3	5
		GRAND TOTAL		45

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Another reason for choosing the context in Taska NCDRC was due to the systematic and scientific daily nutrition plan. Table 3.9 shows the menu prepared for children aged three to six years old children in NCDRC. Three sets of menu: Week 1, Week 2 and Emergency were prepared in Taska NCDRC in order to establish balance and healthy diet with variety. The food and beverage were prepared by five Grade N19 Food Preparation Assistants. Figure 3.6 shows how food was prepared by an assistant in the Bitara Transit Class, located in the old NCDRC building in Sultan Abdul Jalil Shah Campus, UPSI. One week of non-participation observation was conducted in Tadika NCDRC and Bitara Transit Class, from 8:00 am to 1:00 pm. This was made possible as NCDRC was designed and built with specific observation rooms, as shown in Figure 3.7.

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Table 3.9

Three Sets of Menu for Children in Tadika NCDRC

Day	Menu	Breakfast	Snack	Lunch	Afternoon tea
Mon	Week 1	Cereals (Koko Krunch)	Kaya bread & warm water	White rice, papaya & warm water; Kurma telur + carrot + potatoes	Chocolate pudding Warm water
	Week 2	Cereals (Corn flakes)	Marble cake & warm water	White rice, water melon, pear & warm water; Telur masak sweet sour lobak + potatoes	Lychee pudding Warm water
	Substitute		Jam bread & warm water	White rice, orange & warm water; *Telur masak kari* & fried vegetable	Corn pudding Warm water
Tue	Week 1	Biscuits	Fried macaroni & warm water	White rice, apple & warm water Chicken potato curry + red carrot	Vegetable fritter Warm water
	Week 2	Cereals (Corn flakes)	Macaroni soup & warm water	White rice, papaya & warm water; Sweet sour dory fish & fried vegetable	Corn porridge Warm water
	Substitute	Cereals (Koko Krunch)	Biscuits & fruit juice	White rice, water melon & warm water; Chicken carrot soup + potatoes	Banana porridge Warm water
Wed	Week 1	Cereals (Corn flakes)	Kuewteow soup & warm water	White rice, papaya & warm water; Fried dory fish & salad	Apam polkodot Warm water
	Week 2	Cereals (Koko Krunch)	Fried kuewteow & warm water	White rice, apple & warm water Chicken potatoes soup + red carrot	Bread pudding Warm water
	Substitute	Cereals (Honey stars)	Kaya bread & warm water	White rice, apple & warm water Dory fish carrot soup + celery + potatoes	Chocolate pudding Warm water
Thu	Week 1	Biscuits	Nasi goreng Cina & warm water	White rice, pear & warm water *Ikan tongkol masak kicap* & fried vegetable	Corn porridge Warm water
	Week 2	Cereals (Corn flakes)	Tuna sandwich & warm water	White rice, water melon & warm water; *Ikan tongkol masak singang* & fried vegetable	Apam polkodot Warm water
	Substitute	Cereals (Corn flakes) & raisins	Biscuits & fruit juice	White rice, papaya & warm water Chicken carrot soup + potatoes	Chocolate cake Warm water
Fri	Week 1	Cereals (Honey stars)	Mee hoon soup & warn water	Tomato rice, orange & warm water; *Ayam masak merah* & salad	Roti ban + mushroom Soup & Warm water
	Week 2		Fried noodle & warm water	White rice, orange & warm water; Stew chicken	Cucur manis Warm water
	Substitute	Cereals (Honey stars) & raisins	Marble cake & warm water	White rice, pear & warm water Vegetable soup + dory fish fillet	Butter bread Warm water

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Figure 3.6. A Food Preparation Assistant was Preparing Lunch at Bitara Transit Class



Figure 3.7. A Photo Taken When Observing Children Having Their Breakfast in Class 5 Jasmine

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3.7.3 Population and Sampling for Quasi-Experiment

The population of children in Tadika NCDRC in year 2016 was 117. However, according to the Creative Media Content Guidelines for Children Below Six-Year-Old (NCDRC, 2014), the use of creative media, including games was classified according to age: Zero to four years old and four to six years old. Since four years old children falls in-between two categories, they were excluded from this study in order to avoid over-generalization of findings drawn from this research for children below four years old. Therefore, only Year-Five and Year-Six children were recruited in the quasi-experimental study. For ethical reasons, names or identifiable images of children were not revealed in this thesis.

There were 38 Year-Five and 31 Year-Six children enrolled to Tadika NCDRC. Thus the population of targeted participants in the quasi-experiment was 69 people, in which 39 were male and 30 were female. In terms of ethnicity, there was only one female Chinese child who enrolled into Year-Five Orchid class, and the rest of the children were Malay.

The initial plan was to include all Year-Five and Year-Six children in this study. However, on 14 June 2016 when the pre-test was conducted, nine children were absent. For practical and logistic reason, 60 samples instead of the whole population were included in this study. From the children who were present on 14 June, 30 of them were randomly assigned to the control group, while another 30 were randomly assigned to the experimental group. In other words, simple random

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sampling approach was used to determine who should be in what group. In practice, individual names of all children (33 Year-Five children and 27 Year-Six children) present on the pre-test session were put into a mug. After shuffling in the mug, thirty names were taken out from the mug to form the control group, as shown in Figure 3.8. The results of the sampling indicated that there were 16 Year-Five and 14 Year-Six children in the control group; while the experimental group consisted of 17 Year-Five and 13 Year-Six children (see Table 3.9). In terms of gender, the control group was equally formed by each gender, while the experimental group consisted of 18 male and 12 female children.



Figure 3.8. Simple Random Sampling Approach Used in the Quasi-experiment

Table 3.10

The Results of the Simple Random Sampling

Class		Sample		Non-sample	Sub-total		TOTAL
		Control	Experimental				
5 Jasmine	Male	3	5	4	12	20	38
	Female	4	3	1	8		
5 Orchid	Male	5	5	0	10	18	
	Female	4	4	0	8		
6 Lavender	Male	2	5	1	8	17	31
	Female	4	4	1	9		
6 Carnation	Male	5	3	1	9	14	
	Female	3	1	1	5		
	Total	30	30	9		69	

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3.7.4 Ethical Considerations

Before the conduct the study, approval from the NCDRC was granted to allow all Year-Five and Year-Six children at the Tadika NCDRC to participate in this research. There were two levels of participation: pre-test / post-test and non-participant observation. A set of ethical issues related documents were distributed to relevant parents through NCDRC. During the conduct of the study, the anonymity of the participants was protected and guaranteed upon the information provided or data collected throughout their participation. Besides, non-discriminatory language was used in all the reports associated this research.

3.8 Non-participant Observation in NCDRC

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A week of non-participant observation was conducted in NCDRC to track the behaviour of 14 selected children who participated in the quasi-experimental study. An observation checklist was prepared to record actual food choice and involvement in scheduled physical activities in Tadika NCDRC (see Appendix E). At the end of the observation, a semi-structured interview was conducted with the Supervisor of the Tadika NCDRC in order to verify inputs gathered through the observation, while confirming that teachers in Tadika NCDRC actually possess content knowledge associated to childhood obesity. Outcomes of the observation and the interview were meant to triangulate the results gathered from the quasi-experiment.

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3.9 Summary

This chapter articulates the positivist research design of this research. It begins with a brief description on the gamification approach used to design and develop a serious game by aligning the intended childhood obesity prevention outcomes to six structural elements of games. Next, it presents three serious games validation strategies deployed to assure the validity and reliability of *Fight Obesity 2.0*, which was the key research instrument in this research. Then, the chapter juxtaposes sequentially all research methods used to collect data and to analyse data, and explains why those methods were chosen.

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CHAPTER 4

SERIOUS GAME DESIGN, DEVELOPMENT AND VALIDATION

4.1 Introduction

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This chapter aims to achieve the first objective of this research: to design, develop and validate a mobile game for use in childhood obesity prevention among preschool children. The chapter depicts the inception of *Fight Obesity 2.0*, which was designed for preschool children to acquire knowledge about healthy lifestyle and diet. To achieve this design goal, three types of content knowledge were gamified, i.e. converting the learning of content knowledge into a series of fun and engaging game playing activity. To parents, preschool teachers, caretakers and medical doctors, *Fight Obesity 2.0* can support their effort on preventing obesity among preschool children, particularly to children aged 5 and 6 years old. The chapter elaborates the inception of the original Fight Obesity game, the game idea incubation, the design and development of *Fight Obesity 2.0* mobile game in this research. The elaboration is divided into game design and development model, gameplay design, game story and narrative design, game space design and feedback system design. Since the game

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production was iterative in nature, thus each of the design aspects would cover all iterations, depicting the evolution of the design from the original Fight Obesity to *Fight Obesity 2.0*.

4.2 In Search of Suitable Game Designer

Prior to the creation of *Fight Obesity 2.0*, several designs of games for obesity prevention were examined by curating final year projects (FYPs) submitted by students who pursued Diploma in Game Design and Development at the Faculty of Art, Computing and Creative Industry (FSKIK), Universiti Pendidikan Sultan Idris (UPSI) since 2014. In particular, two FYPs were found matching the theme of childhood obesity.

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The first game titled *Nutrition Your Life* was designed and developed by Yeong Mei Wan (2014) using selected content knowledge prepared for this study (see Figure 4.1). This 2D personal computer (PC) game was created using a game authoring software called Game Maker. The game was targeted at primary school pupils, specifically children aged nine years old and above. In Level 1, players were directed to answer questions related to diet choice and healthy lifestyle (refer to Appendix F). The results of curation indicated that Nutrition Your Life was not suitable to be further developed for use in this research. In particular, text-based questions asked in the game should be turned into voice over audio, and answer options presented to preschool children should be represented by graphics.

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The second curated game was *Fight Obesity*, designed and developed by Lee Ying Xuan (2015), as shown in Figure 4.2. This 2D platformer mobile game was developed using a game authoring software called Unity3D. The game featured three stages, where players were instructed to move leftward and eat healthy food along the movement. It was targeted at preschool level, using selected content knowledge prepared for this study. No question was asked to players (see Appendix G) throughout the game. After examining the features and game elements, Fight Obesity was chosen to further develop the gameplay for use in this study. Lee Ying Xuan was commissioned to create a new version of Fight Obesity.

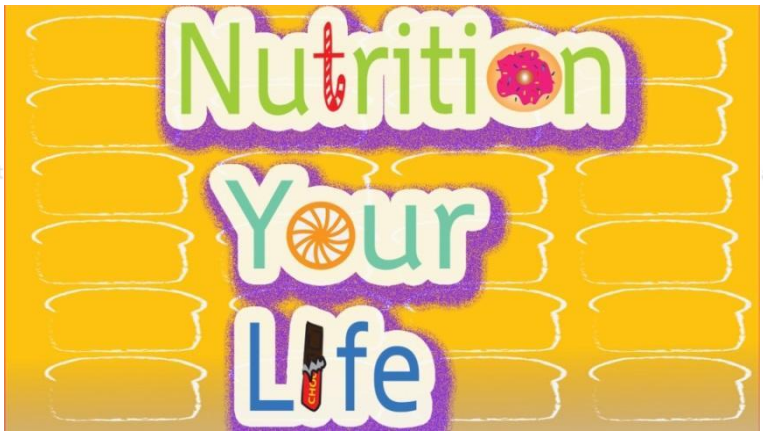


Figure 4.1. Nutrition Your Life, the Title of Final Year Project Proposed by Yeong Mei Wan

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Figure 4.2. Fight Obesity, the Title of Final Year Project Proposed by Lee Ying Xuan

4.3 Game Design and Development Model

The game design and development model proposed by Tan (2010) was adapted as the game creation and research methodology (see Figure 4.3). This model supported the provisional framework of game-based childhood obesity prevention by turning gamifiable components into game features. The framework supposed that there should be game features that support the development of healthy lifestyle in childhood. In particularly, the game should highlight the importance of healthy diet and physical activities. The game should also contain the consequences of childhood obesity.

Apart from the game designer mentioned in section 4.2, the production team of *Fight Obesity 2.0* consisted of two game-based learning specialists in UPSI, and two game programmers. The two game-based learning specialists were selected based on their experience in completing at least two R&D projects in gamification and game-based learning, while the programmers were chosen based on their credential

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and experience in developing serious games. In particular, the programmers took part in the production of two educational games before joining the production team of *Fight Obesity 2.0*.

The subject matter expert of the game presented the requirements of the game to the game production team at the pre-production stage through face-to-face meetings and discussion. The game designer developed game ideas based on the content knowledge (see section 4.4) supplied by the subject matter expert. It is important to stress that in the creation of serious games, the needs and requirements of the subject matter experts would be prioritized as opposed to the targeted players, as revealed by Tan, Johnston-Wilder, and Sean (2010) when they examined the differences between serious games and games for entertainment. Also, preschool children may know what features of a game they want to play, but they generally do not know the features of a serious games they need to play in order to acquire knowledge on childhood obesity. Thus, this serious game for health presumed that only subject matter experts should supply knowledge contents, as opposed to preschool children, parents or kindergarten teachers. This in turn omitted the need to involve preschool children, parents or kindergarten teachers in the game content and design validation process.

The production stage of the game started once the subject matter expert agreed with the game idea. The game idea would be turned into a paper-based prototype (see section 4.5). After the paper-based prototype was evaluated, revised and approved by the subject matter expert, the subject matter expert who was a pediatrician by

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profession started to write the user manual for the serious game. The manual included off-game treatment and prevention strategies that guided the usage of the game; while the game production team prepared paratextual materials for using the game (see section 4.7). The design of the serious game was validated by 38 game designers (see section 4.9), while the content knowledge of the game was validated by two pediatricians were invited, one from China and another from Malaysia (see section 4.10). No revision was suggested for the game by the pediatricians and all game designers who validated the game independently.

After having a validated game, the game was deployed through the quasi-experiment (see section 5.2). The results of the quasi-experiment served as the summative evaluation of the game, which in turn, informed the revision of the provisional framework (see section 6.3). At the end of the process, good features of the serious games and lessons learnt were recorded to structure guiding principles for medical professionals, game designers, parents and kindergarten teachers who are interested to use serious games for preventing childhood obesity.

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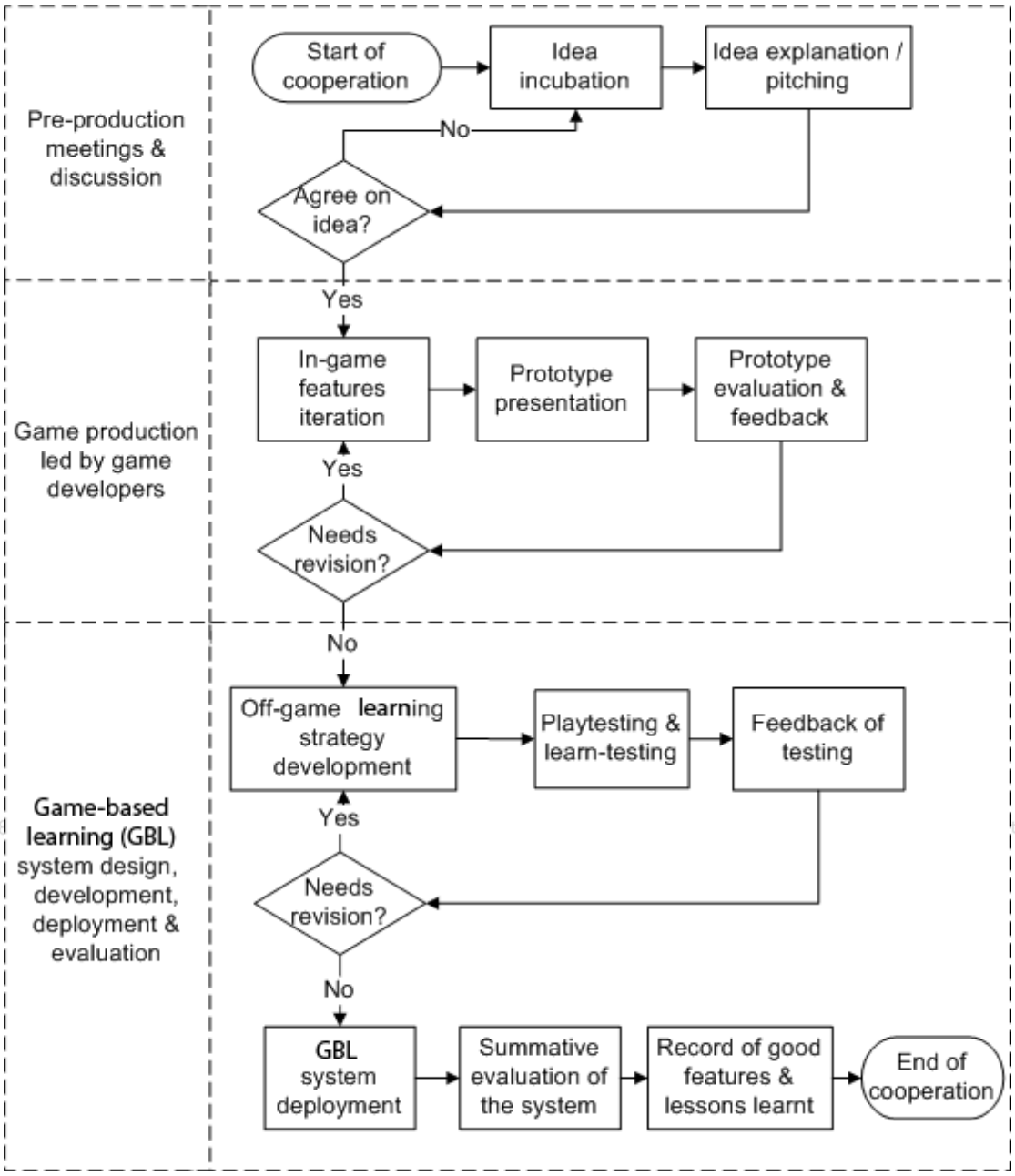


Figure 4.3. The Game Creation and Research Model. Source: Tan (2010)

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4.4 Preparing Content Knowledge for *Fight Obesity 2.0*

In terms of content knowledge, seven prompting questions and answers were prepared based on recommendation of World Health Organization (WHO, 2015), as shown in Table 4.1, 4.2 and 4.3. The questions were grouped under three types of knowledge for the game:

- Knowledge of children obesity
- Knowledge of ways and means of treating children obesity
- Knowledge of the universals and abstractions in treating children obesity

Table 4.1

Content Knowledge of Children Obesity Prepared for Fight Obesity 2.0 (WHO, 2015)

Prompting Questions	**Answers adapted from World Health Organization**
Q1. What is childhood overweight and obesity?	Overweight and obesity are defined as "abnormal or excessive fat accumulation that presents a risk to health".
Q2. What the cause of childhood overweight and obesity?	The fundamental cause of childhood overweight and obesity is an energy imbalance between calories consumed and calories expended.
	Global increases in childhood overweight and obesity are attributable to a number of factors including: ● A global shift in diet towards increased intake of energy-dense foods that are high in fat and sugars but low in vitamins, minerals and other healthy micronutrients; ● A trend towards decreased physical activity levels due to the increasingly sedentary nature of many forms of recreation time, changing modes of transportation, and increasing urbanization.
Q3. What are the consequences of obesity?	Childhood obesity is associated with a higher chance of premature death and disability in adulthood. Children who face overweight or obesity problem are more likely to stay obese into adulthood and to develop non-communicable diseases (NCDs) like diabetes and cardiovascular diseases at a younger age. For most NCDs resulting from obesity, the risks depend partly on the age of onset and on the duration of obesity. Obese children and adolescents suffer from both short-term and long-term health consequences. The most significant health consequences of childhood overweight and obesity, that often do not become apparent until adulthood, include: ● cardiovascular diseases (mainly heart disease and stroke); ● diabetes; ● musculoskeletal disorders, especially osteoarthritis; and ● certain types of cancer (endometrial, breast and colon).

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Table 4.2

Content Knowledge of Ways and Means of Treating Childhood Obesity (WHO, 2015)

Prompting Questions	Answers adapted from World Health Organization
Q4. What can be done to fight the childhood obesity epidemic?	The goal in fighting the childhood obesity epidemic is to achieve an energy balance which can be maintained throughout the individual's life-span. General recommendations: 1. Increase consumption of fruit and vegetables, as well as legumes, whole grains and nuts; 2. Limit energy intake from total fats and shift fat consumption away from saturated fats to unsaturated fats; 3. Limit the intake of sugars; and 4. Be physically active - accumulate at least 60 minutes of regular, moderate- to vigorous-intensity activity each day that is developmentally appropriate.
Q5. How to develop healthy diet?	For diet, recommendations for populations and individuals should include the following: 1. Achieve energy balance and a healthy weight 2. Limit energy intake from total fats and shift fat consumption away from saturated fats to unsaturated fats and towards the elimination of trans-fatty acids 3. Increase consumption of fruits and vegetables, and legumes, whole grains and nuts 4. Limit the intake of free sugars 5. Limit salt consumption from all sources and ensure that salt is iodized.
Q6. What is the recommended level of physical activity for children aged 5 - 17 years?	For children and young people, physical activity includes play, games, sports, transportation, chores, recreation, physical education, or planned exercise, in the context of family, school, and community activities. In order to improve cardiorespiratory and muscular fitness, bone health, and cardiovascular and metabolic health biomarkers: 1. Children and youth aged 5–17 should accumulate at least 60 minutes of moderate- to vigorous-intensity physical activity daily. 2. Amounts of physical activity greater than 60 minutes provide additional health benefits. 3. Most of the daily physical activity should be aerobic. Vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone*, at least 3 times per week. *For this age group, bone-loading activities can be performed as part of playing games, running, turning or jumping.

Table 4.3

Content Knowledge of the Universals and Abstractions in Treating Childhood Obesity (WHO, 2015)

Prompting Questions	Answers adapted from World Health Organization
Q7. What are the principles for treating children overweight and obesity?	Overweight and obesity are largely preventable. It is recognized that prevention is the most feasible option for curbing the childhood obesity epidemic since current treatment practices are largely aimed at bringing the problem under control rather than effecting a cure. The goal in fighting the childhood obesity epidemic is to achieve an energy balance which can be maintained throughout the individual's life-span.

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In order to ensure the achievement of game objectives would yield the attainment of intended learning outcomes in *Fight Obesity 2.0*, a constructive alignment proposed by Tan, Nurul Fazmidar and Wang (2014) was adopted, as shown in Figure 4.4.

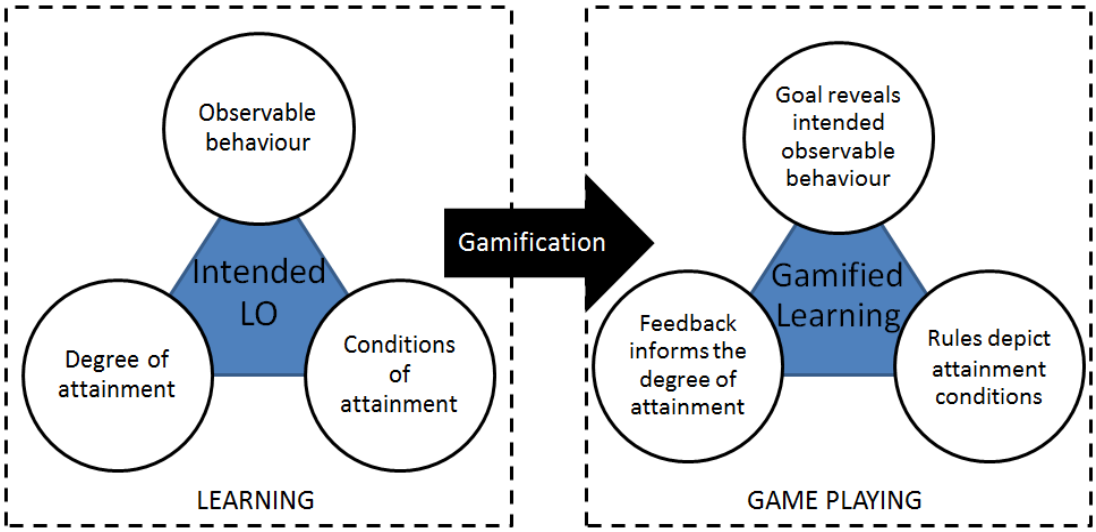


Figure 4.4. Constructive Alignment Model Used in the Game Design Process

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4.5 Developing Game Ideas through Paper-based Prototype

The initial game idea was sketched and proposed as a board game that involved playing cards, as shown in Figure 4.5. In the first iteration, a paper-based prototype tabletop game was created to test the playability of *Fight Obesity 2.0*. This tabletop game required a triangular game board (Figure 4.6), a circle dice (Figure 4.7), and a deck of playing cards which contain questions for players to answer (Figure 4.8). In this multiplayer game, three players were directed to choose healthy food for

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breakfast, lunch and dinner, by answering questions related to healthy lifestyle (Figure 4.9).

The paper-based prototype was created to assure that all game contents required in the obesity prevention framework were feasible to be included in game-like activities. Despite being a feasible multiplayer game, the tabletop version of Fight Obesity game needed to be improved to cover all three types of content knowledge for childhood obesity.

In the case of this research, some of the features were discarded after evaluating the paper-based prototype. In particular, all calculation of calories were omitted in the mobile game because the concept of calories was not required for preschool children to build conception of childhood obesity. All question cards were transformed into drawings of recognisable scenarios of children' daily living. Also, a digital mobile game would capture more children's attention than a physical tabletop game.

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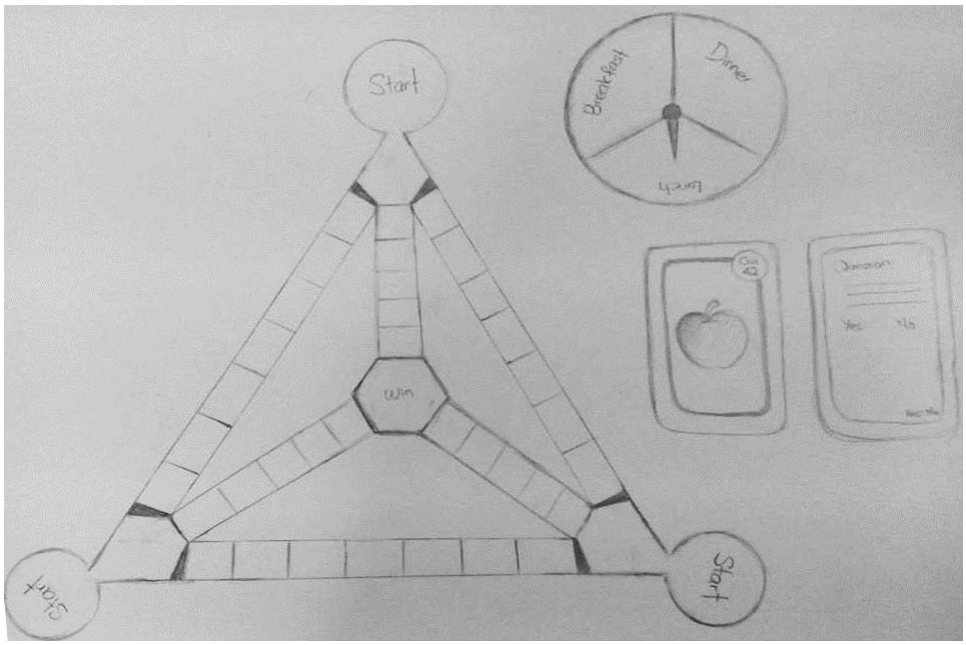


Figure 4.5. Sketches of Initial Game Idea of *Fight Obesity 2.0*



Figure 4.6. The Game Board for the Paper-based Prototype of *Fight Obesity 2.0*

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Figure 4.7. The Circle Dice for the Paper-based Prototype of *Fight Obesity 2.0*



Figure 4.8. A Deck of Food Cards, Designed for the Paper-based Prototype of *Fight Obesity 2.0*



Figure 4.9. Food-related Questions Cards for the Paper-based Prototype of *Fight Obesity 2.0*

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4.6 Fight Obesity 2.0 Mobile Game

Fight Obesity 2.0 has been predetermined as a single-player game on mobile devices. The game was produced by a team of people, as credited in the game credits (see Figure 4.10).

The design of the game was started by setting its gameplay. Gameplay depicts how a game is played, thus it consists of "the challenge that a player must face to arrive at the object of the game, and the actions that the player is permitted to take to address those challenges" (Adams, 2010, p. 9). *Fight Obesity 2.0* combined three types of challenges—knowledge, time pressure, and physical coordination to engage players, as depicted in Table 4.4. As a serious game intended to intervene lifestyle of preschool children, knowledge challenge was the key challenge of this game.

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As for game interaction model and mode, *Fight Obesity 2.0* is a single-player avatar-based game, in which player can only role-play and control one avatar—either a boy or a girl game character in the game world, acting upon stimulus perceived by the avatar when overcoming challenges featured in three game levels.

The game goal of *Fight Obesity 2.0*, i.e. the goal set for the main character in the game world was to keep a healthy lifestyle by choosing healthy diet and doing exercise. In terms of game rules, players must complete three game levels, especially by answering all ten questions asked in Level 3 correctly.

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Figure 4.10. Game Production Credits of *Fight Obesity 2.0*

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Table 4.4

Combination of Game Challenges in Fight Obesity 2.0

Game level			Challenge type	Descriptor
1	2	3		
✓	✓	✓	knowledge	To test players' knowledge on factual information.
	✓		Time pressure	To test players' capability to achieve game goal before running out of time.
✓	✓		Physical coordination	To test players' hand-eye coordination when responding to stimulus shown to them.

In terms of development, the tabletop version of Fight Obesity game was revised to build the *Fight Obesity 2.0* mobile game (see Figure 4.11). Unity3D was chosen as the authoring tool for this game. A game flow diagram was developed to finalize the sequence of all events in *Fight Obesity 2.0*. These events were player events (rhombuses), in-game events (rectangles), and narrative events (circles and ovals), as shown in Figure 4.12.

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Figure 4.11. The Splash Screen of *Fight Obesity 2.0*

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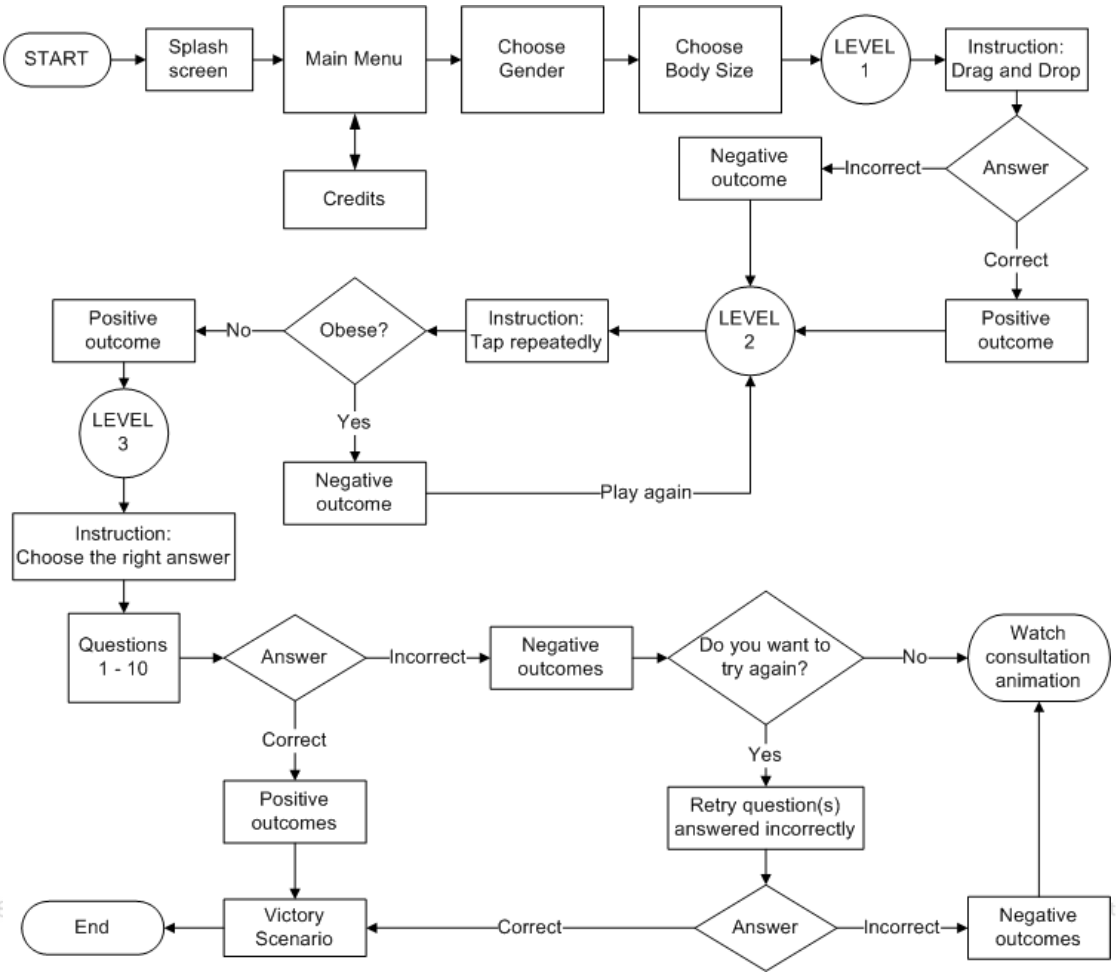


Figure 4.12. The Overall Game Flow of *Fight Obesity 2.0* Mobile Game

Fight Obesity 2.0 consists of four characters: the Boy, the Girl, the Mommy and the Doctor. The Boy and the Girl are two main characters while the Mommy and the Doctor are supporting characters. As the hero or the heroin in the game world, the design of the Boy and the Girl were the utmost important matter for *Fight Obesity 2.0*. Figure 4.13 and Figure 4.14 show a series of facial expressions designed in the form of animation sprites for the Boy and the Girl characters.

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Figure 4.13. The Facial Expressions of the Boy Game Character



Figure 4.14. The Facial Expressions for the Girl Game Character

The initial idea of *Fight Obesity 2.0* required players to choose an avatar according to their gender and age (see Figure 4.15). However, the requirements was changed to setting the gender and body size instead of gender and age, because the age of targeted players were limited to 5 and 6 years old preschool children, as

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recommended by the media guideline published by the National Child Development Research Centre (2014).

After clicking the "Play" button on the Main Menu (see Figure 4.16), players were guided to choose the gender (see Figure 4.17) and the body size (see Figure 4.18 and Figure 4.19) of their avatar to represent their virtual self. After that, they could start playing three game levels sequentially.

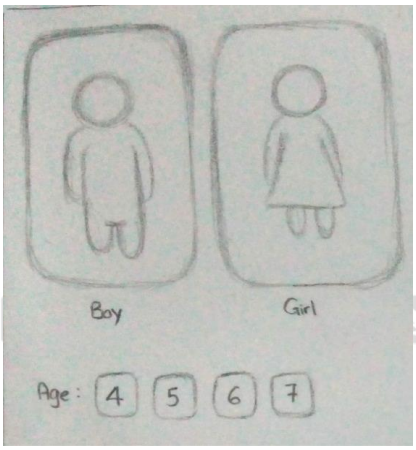


Figure 4.15. The Initial Idea of Avatar Figure Settings

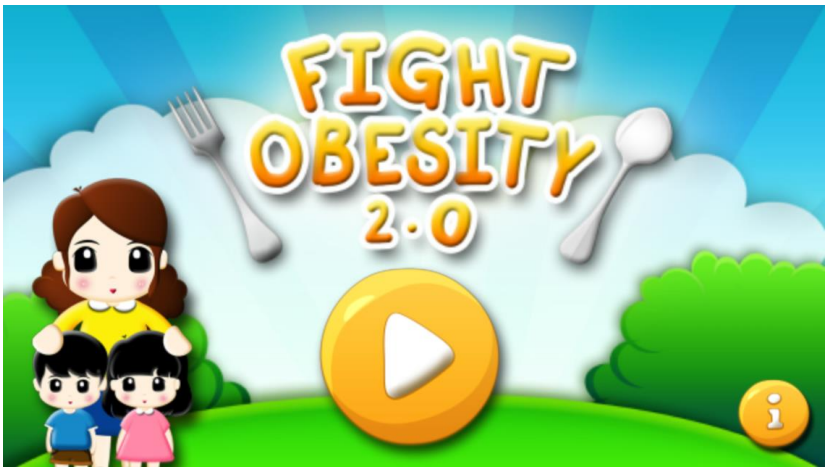


Figure 4.16. The Main Menu of *Fight Obesity 2.0* Mobile Game

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Figure 4.17. Selection of Gender for Game Avatar

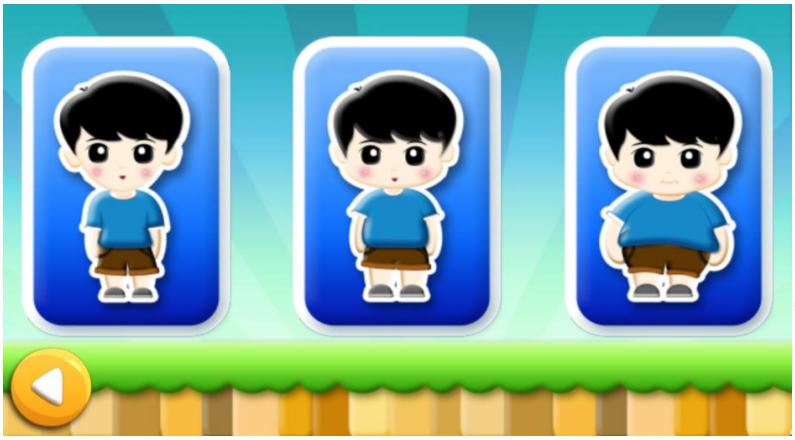


Figure 4.18. Selection of Body Size for the Boy Game Character

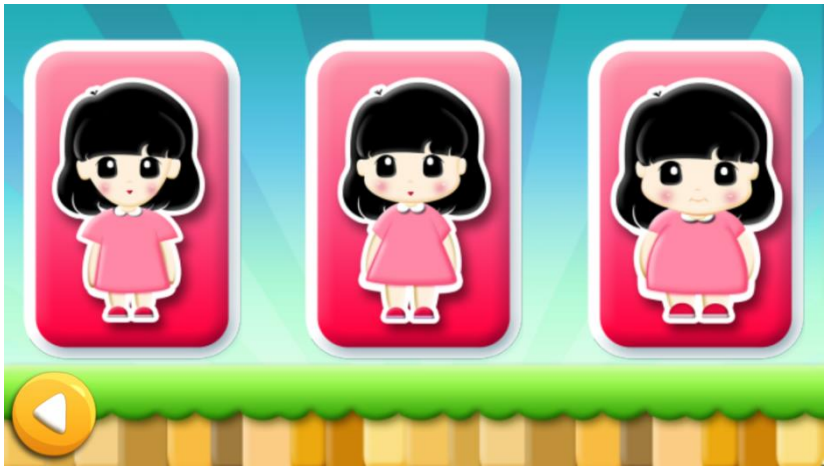


Figure 4.19. Selection of Body Size for the Girl Game Character

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4.6.1 Level 1: Drag and Drop

The design goal of Level 1 was to help tackling the problem of obesity in Malaysia by educating children the virtue of healthy eating habits. In the ideation process, a constructive alignment was made between observable behaviour, condition and degree of attaining the intended outcome and game goal, rules and feedback, as shown in Table 4.5.

Figure 4.20 shows the initial gameplay idea developed for this game level, in which players need to choose healthy food to feed the avatar, by dragging a choice of food and dropping it into the avatar's mouth. In game development process, the initial idea was improved by having various food circling the avatar, optimizing the number of food can be presented to players in one time, as shown in Figure 4.21. If players chose healthy food, the health bar would increase and a big tick sign would pop up to reinforce players' positive action. However, if players chose unhealthy food, the health bar would decrease and a big cross sign would pop up to warn players' negative action (see Figure 4.22).

Table 4.5

Alignment between Intended Outcomes and Game Elements of Level 1

Observable behaviour Differentiate …	**Condition** …healthy food and non-healthy food…	**Degree** …by making less than 3 mistakes in less than 10 attempts.
Goal Choose the right food for the avatar.	**Rule** 1. Drag and drop healthy food to raise the health bar. 2. Choosing unhealthy food will lower the health bar. 3. Avatar can only eat maximum two units of unhealthy food.	**Win Feedback** Well done!! You eat healthy!! **Lose Feedback** You are obese / overweight!! You eat unhealthy!!

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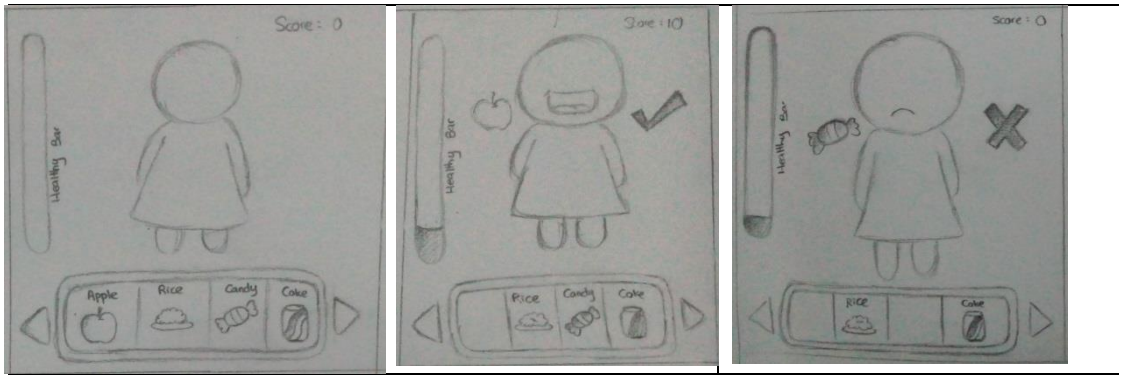


Figure 4.20. Initial Gameplay Idea of Level 1

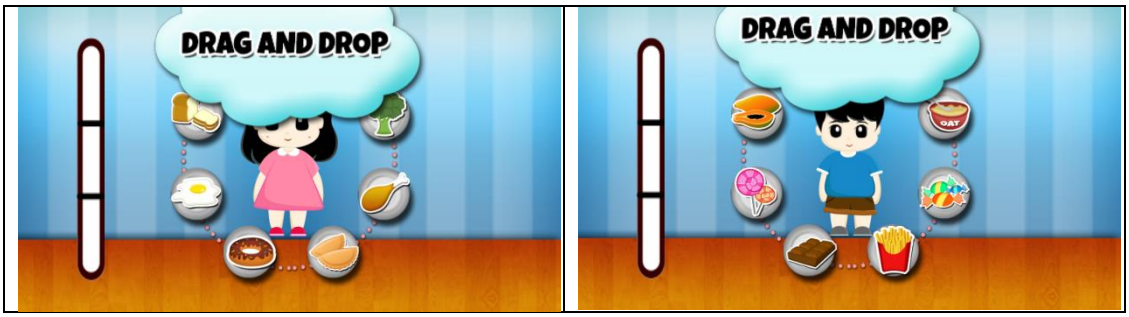


Figure 4.21. Drag and Drop Healthy Food to Feed the Boy or the Girl Game Character

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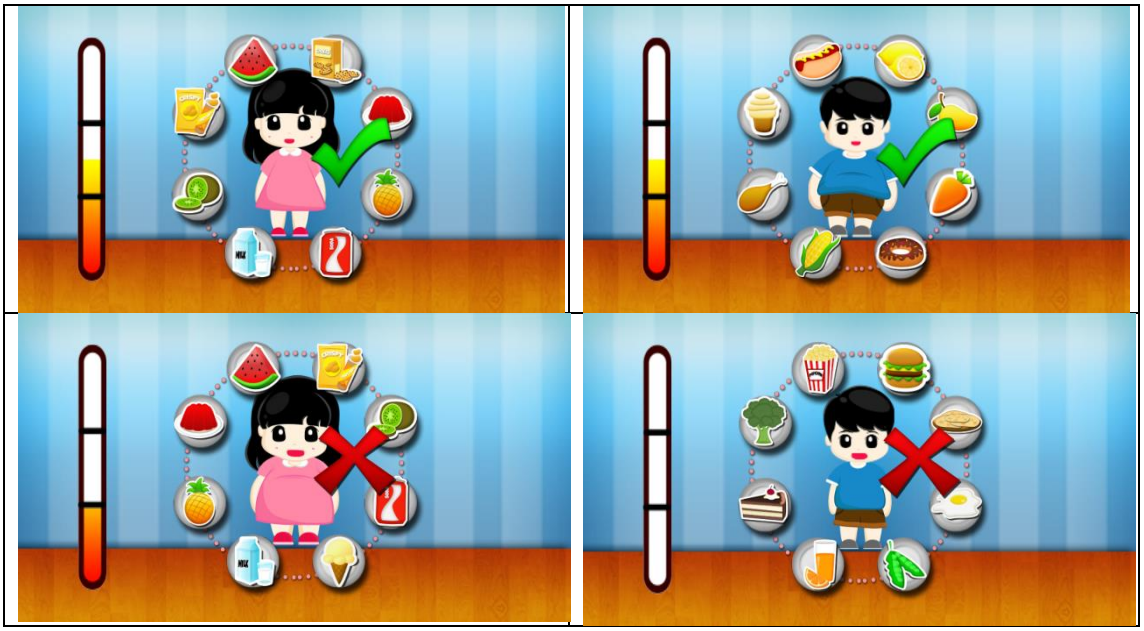


Figure 4.22. Positive and Negative Visual Feedbacks Reinforce Players' Behaviours.

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There were 42 options of food and drink created for Level 1, in which 23 of them were healthy while 19 were unhealthy, as shown in Figure 4.23. Players won Level 1 after the health bar turned full, and they would be directed to watch the winning animation. They would be praised for their achievement. However, when they made three mistakes, i.e. feeding the avatar with three units of any unhealthy food, they would be warned for losing Level 1 because their avatar was obese due to unhealthy diet (see Figure 4.24).



Figure 4.23. Graphics of Food and Drinks Created for *Fight Obesity 2.0*

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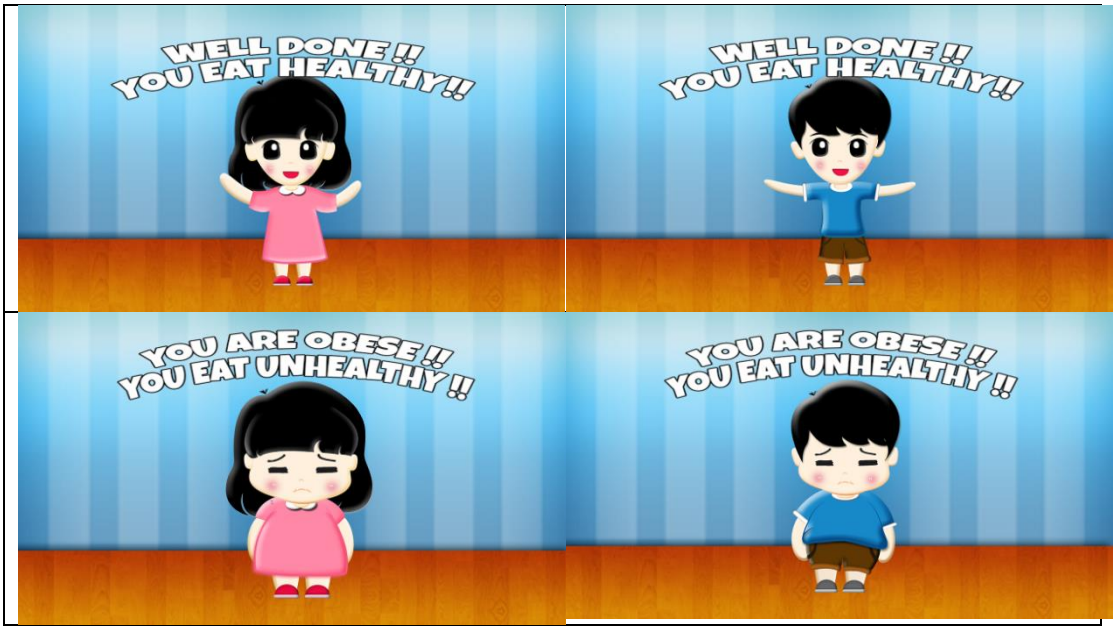


Figure 4.24. Reward of Glory for Winning; Punishment for Losing

In terms of game mechanics, players must feed the avatar with six (without eating unhealthy food) to ten units (eating one or two unhealthy food) of food in order to win Level 1. In total, there are 33 possible winning conditions, as listed in Table 4.6.

4.6.2 Level 2: Tap Button Rapidly

Level 2 was designed for children to learn the importance of exercise. The body size of players' avatar in Level would be carried forward to Level 2, signifying that exercise help shaping unhealthy body size caused by unhealthy diet. In the ideation process using constructive alignment, two exercise apparatus—hula hoop and skipping rope were chosen for Level 2 (see Table 4.7).

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The initial gameplay of Level 2 required players to choose an apparatus and tap the avatar for 60 seconds (see Figure 4.25). However, in the implementation, instead of tapping avatar, players were instructed to tap the icon of hula hoop or skipping rope, and the duration was reduced to avoid players from getting bored (see Figure 4.26).

Table 4.6

All Possible Winning Conditions in Level 1

33 possible winning conditions		**Attempts in choosing correct food**									
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
No mistake (1 condition)		✓	✓	✓	✓	✓	✓				
Made 1 mistake (6 variations of conditions)		✗	✓	✓	✓	✓	✓	✓			
		✓	✗	✓	✓	✓	✓	✓	✓		
		✓	✓	✗	✓	✓	✓	✓	✓		
		✓	✓	✓	✗	✓	✓	✓	✓		
		✓	✓	✓	✓	✗	✓	✓	✓		
		✓	✓	✓	✓	✓	✗	✓	✓		
Made 2 mistakes (26 variations of conditions)	Made mistake at the 1st attempt (6 variations of conditions)	✗	✗	✓	✓	✓	✓	✓	✓		
		✗	✓	✗	✓	✓	✓	✓	✓	✓	
		✗	✓	✓	✗	✓	✓	✓	✓	✓	
		✗	✓	✓	✓	✗	✓	✓	✓	✓	
		✗	✓	✓	✓	✓	✗	✓	✓	✓	
		✗	✓	✓	✓	✓	✓	✗	✓	✓	
	Made mistake at the 2nd attempt (6 variations of conditions)	✓	✗	✗	✓	✓	✓	✓	✓	✓	
		✓	✗	✓	✗	✓	✓	✓	✓	✓	✓
		✓	✗	✓	✓	✗	✓	✓	✓	✓	✓
		✓	✗	✓	✓	✓	✗	✓	✓	✓	✓
		✓	✗	✓	✓	✓	✓	✗	✓	✓	✓
		✓	✗	✓	✓	✓	✓	✓	✗	✓	✓
	Made mistake at the 3rd attempt (5 variations of conditions)	✓	✓	✗	✗	✓	✓	✓	✓	✓	✓
		✓	✓	✗	✓	✗	✓	✓	✓	✓	✓
		✓	✓	✗	✓	✓	✗	✓	✓	✓	✓
		✓	✓	✗	✓	✓	✓	✗	✓	✓	✓
		✓	✓	✗	✓	✓	✓	✓	✗	✓	✓
	Made mistake at the 4th attempt (4 variations of conditions)	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓
		✓	✓	✓	✗	✓	✗	✓	✓	✓	✓
		✓	✓	✓	✗	✓	✓	✗	✓	✓	✓
		✓	✓	✓	✗	✓	✓	✓	✗	✓	✓
	Made mistake at the 5th attempt (3 variations of conditions)	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓
		✓	✓	✓	✓	✗	✓	✗	✓	✓	✓
		✓	✓	✓	✓	✗	✓	✓	✗	✓	✓
	Made mistake at the 6th attempt (2 variations of conditions)	✓	✓	✓	✓	✓	✗	✗	✓	✓	✓
		✓	✓	✓	✓	✓	✗	✓	✗	✓	✓

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Table 4.7

Alignment between Intended Outcomes and Game Elements of Level 2

Observable behaviour Understand the consequences of…	**Condition** …doing exercise and stopping exercise upon the size of body…	**Degree** …by relating exercise to healthy lifestyle and connecting obesity to stopping exercise.
Goal Tap ether skipping rope or hula hoop buttons to simulate exercise.	**Rule** 1. Tap skipping rope or hula hoop button rapidly for 30 seconds to keep avatar fit. 2. The body size of avatar may turn into obese when he or she stops doing exercise.	**Win Feedback** Well done!! You are healthy!! **Lose Feedback** You are obese / overweight!! You need more exercise!!

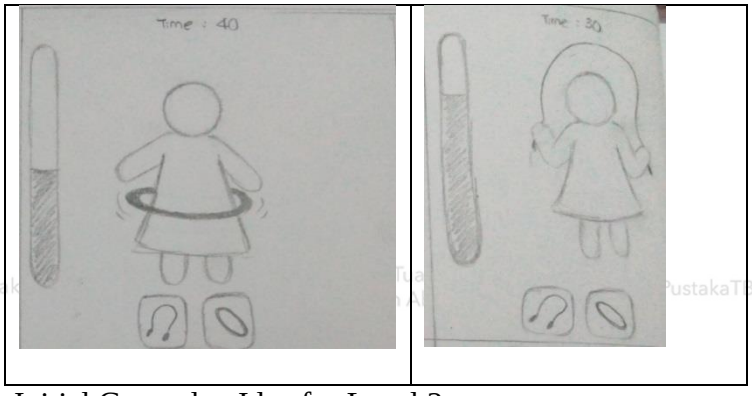


Figure 4.25. Initial Gameplay Idea for Level 2

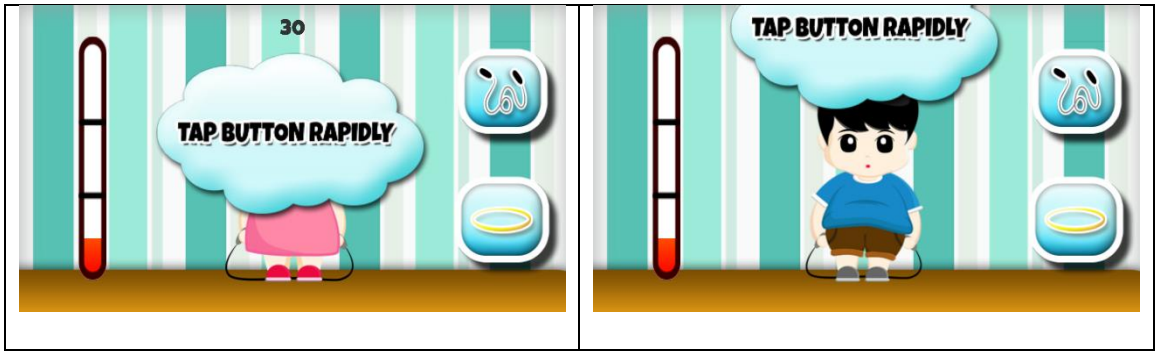


Figure 4.26. Finalized Gameplay for Level 2

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Players must keep the health bar green to fight against obesity. When the avatar did exercise, the health bar would turn into green colour; but when the avatar stopped doing exercise, the health bar would turn back to red colour (see Figure 4.27). Once the health bar turned full at the end of 30 seconds, players won Level 2, and they would be directed to watch the winning animation. They would be praised for their achievement and advised for their failure (see Figure 4.28).



Figure 4.27. The Health Bar Must be Kept at Green Colour to Fight Against Obesity

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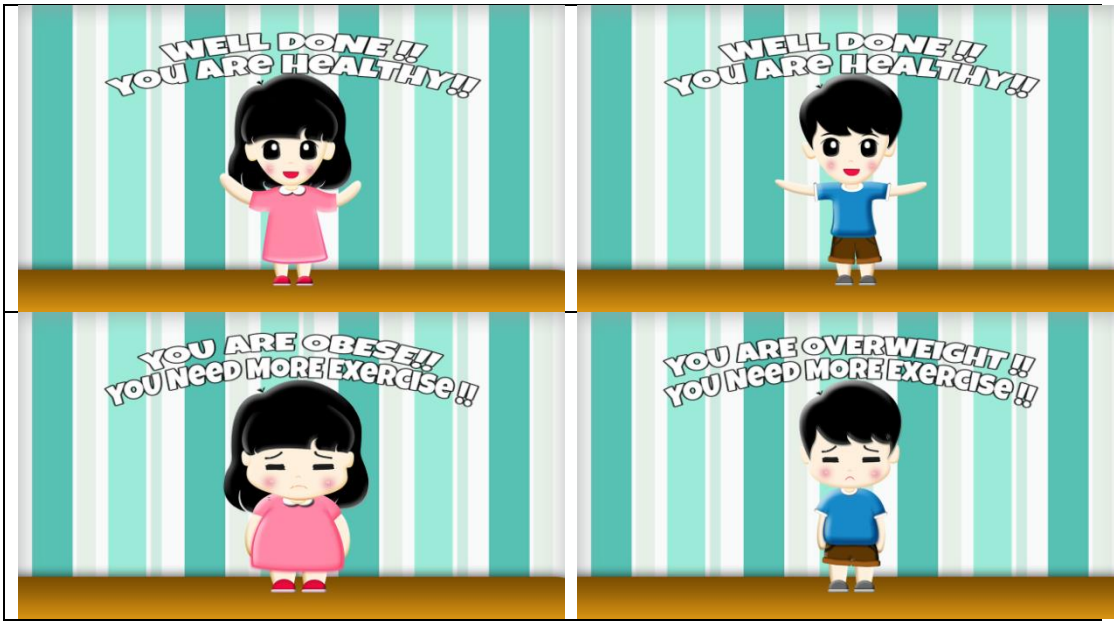


Figure 4.28. Reward of Glory for Winning; Punishment for Losing

4.6.3 Level 3: Choose the Right Answer

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In Level 3, the players are guided to learn characteristics of healthy lifestyle and good habits. As shown in Table 4.8, the constructive alignment requires players to answer ten questions correctly in order to win this game level. These questions were divided into three categories: the importance of doing exercise; the importance of right food choices; and the importance of right drink and drinking water.

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Table 4.8

Alignment between Intended Outcomes and Game Elements of Level 3

Observable behaviour Choose…	**Condition** …the right options which reflect healthy lifestyle…	**Degree** …in all ten questions, without making the same mistake twice.
Goal Tap on a correct option for healthy lifestyle.	**Rule** Answer all ten questions correctly. Players are given a second chance for every mistake made.	**Win Feedback** Very good! You will become healthy and strong! **Lose Feedback** You will become obese! You will become fat and lazy. You are not healthy! You should drink more water.

The initial gameplay of Level 3 was asking players to choose one out of two foods in a context (see Figure 4.29). The decision made by players would trigger an explanatory animation which indicated the position of the food in the food pyramid. At the end of the level, a total score would be shown to the player. After several iterations of design and development, all explanatory animations were compiled to form the virtual consultation (see Section 4.7).

Question 1 and Question 9 stressed the importance of doing exercise and the consequences of not doing exercise (see Table 4.9). To reinforce the memory of players, these questions and the feedback of answering individual questions were presented through graphics and audio, as shown in Figure 4.30 and Figure 4.31.

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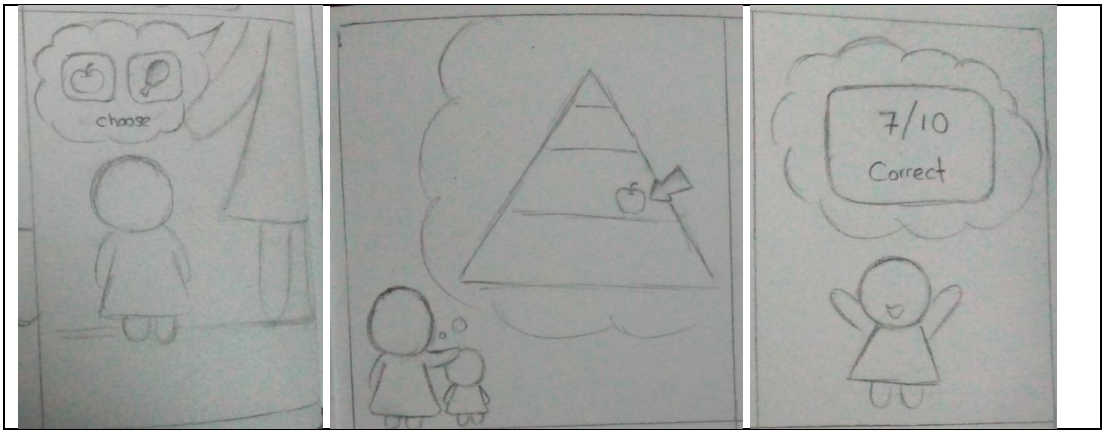


Figure 4.29. Initial Gameplay Idea for Level 3

Table 4.9

Questions Associated to the Importance of Doing Exercise and the Consequences of Not Doing Exercise.

No.	Questions	Answers	Feedback
1	I am going out for a walk. Do you want to come with me?	Yes, Mommy. I want to come.	You will become healthy and strong!
		No, Mommy. I want to stay home.	You will become fat and lazy.
9	You should exercise a little bit.	Okay, Mommy.	Very good!
		No, I don't want to.	You will become fat and lazy.

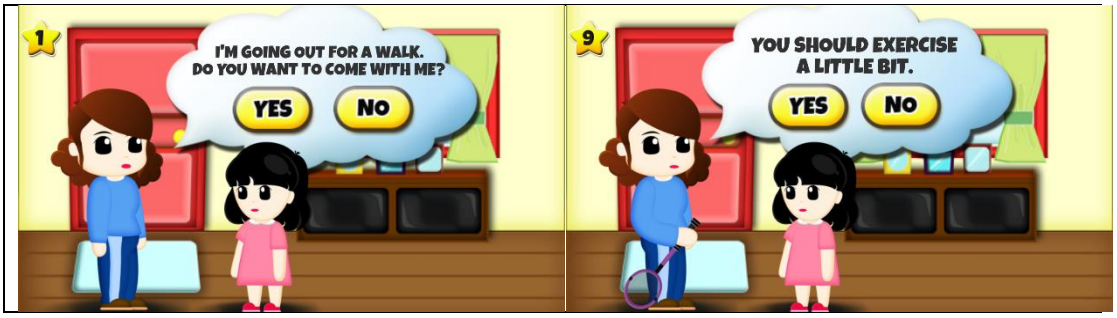


Figure 4.30. Graphical Representations of Question 1 and Question 9

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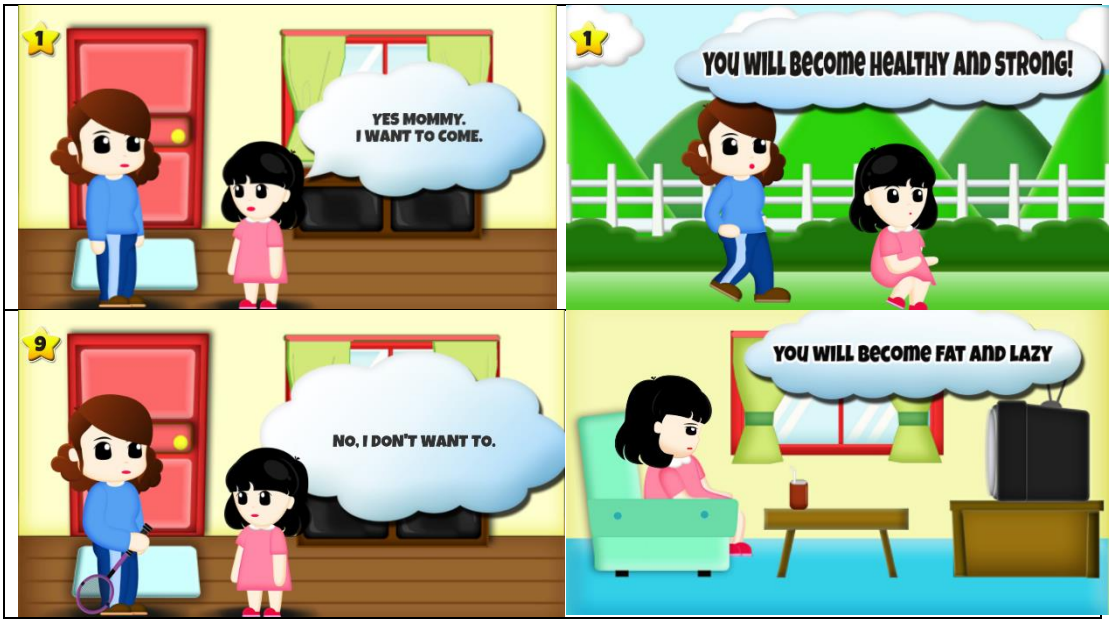


Figure 4.31. Positive and Negative Feedback for Doing and Not Doing Exercise

Five questions were set to depict the importance of right food choices (see Table 4.10). These questions were asked by Mommy, in which players were prompted to choose healthy food in Question 2, 4, 6 and 10, and they were asked whether they like to eat fast food or not in Question 3 (see Figure 4.32). The feedback of answering individual questions was presented through graphics and audio in order to reinforce the memory of players, as shown in and Figure 4.33.

Table 4.10

Five Questions were Associated to the Correct Choice of Food

No.	Questions	Answers	Feedback
2	What would you like for breakfast?	Bread and egg	Very good!
		Nasi Lemak	You will become obese!
3	Do you want to eat burger?	No, thanks, Mommy.	Very good!
		Yes, Mommy, please!	You will become obese!
4	What do you like for snacks?	Fresh fruits	Very good!
		Candy	You will become obese!
6	What would you like to eat?	Vegetable	Very good!
		Cream cake and chocolate donut.	You will become obese!!
10	It is dinner time. What do you want to eat?	Sandwich	Very good!
		Burger	You will become obese!

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Figure 4.32. Graphical Representations of Question 2, 3, 4, 6 and 10



Figure 4.33. Positive and Negative Feedback Healthy Food Choice

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Three questions were set to depict the importance of choosing right drink and drinking plain water (see Table 4.10). The Mommy asked these questions and players had to choose plain water in Question 5 and 7, and they were asked whether they like to fruit juice or soda drink in Question 8 (see Figure 4.34). Correct answers given by players would prompt a same positive feedback in all three questions (see Figure 4.35); while incorrect answers would trigger negative feedback (Figure 4.36).

Table 4.11

Questions Associated to the Correct Choice of Drink

No.	Questions	Answers	Feedback
5	It is hot today. Do you want to get some ice cream?	No, thanks. I want to drink water.	Very good!
		Yes, Mommy. I want ice cream!	You will become obese!
7	Do you want to drink some water?	Yes, mommy. Thank you!	Very good!
		No, thanks, Mommy.	You are not healthy! You should drink more water.
8	What do you want to drink?	Orange juice	Very good!
		Soda drink	You will become obese!

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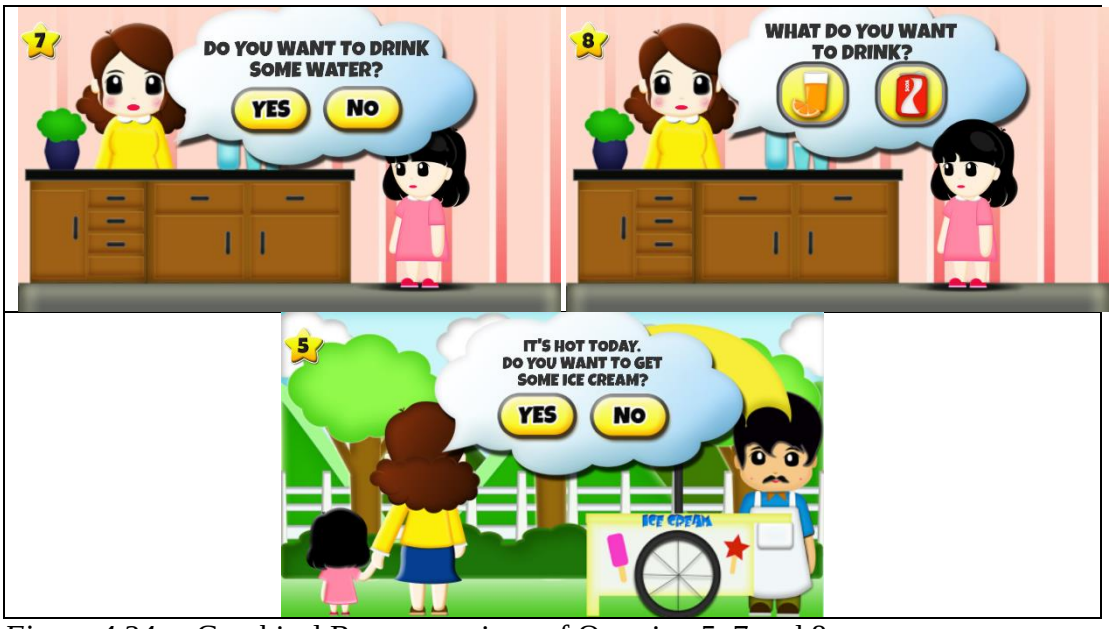


Figure 4.34. Graphical Representations of Question 5, 7 and 8

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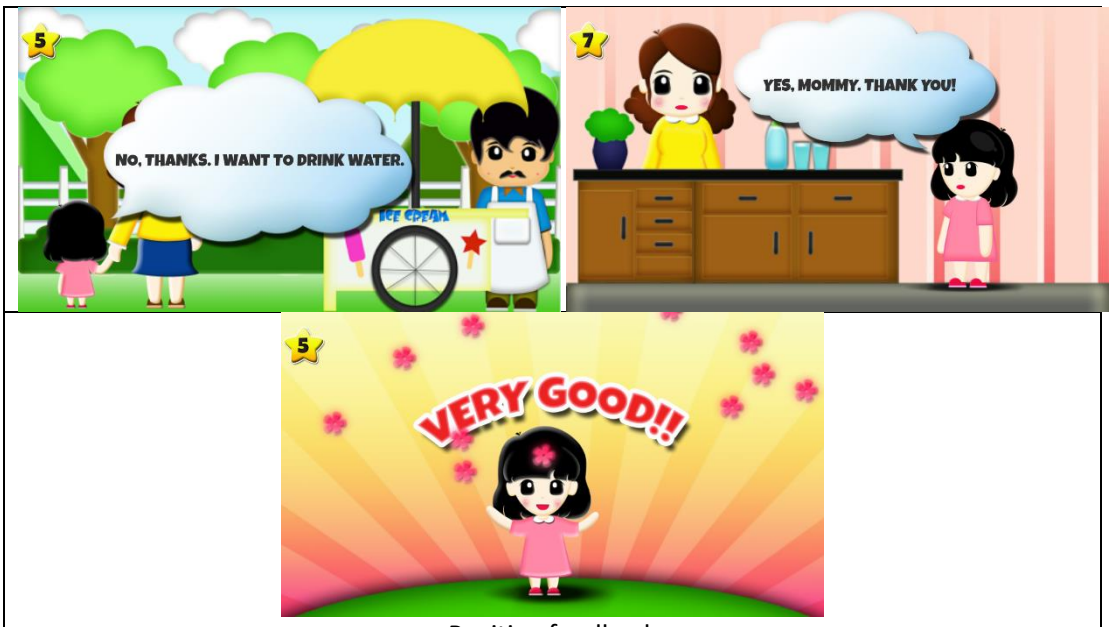


Figure 4.35. Correct Answers Prompt Positive Feedback in Question 5, 7 and 8



Figure 4.36. Incorrect Answers Prompt Negative Feedback in Question 5, 7 and 8

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4.6.4 Virtual Consultation Animation

At the end of Level 3, players who made mistake when answering any question would be given chances to retry questions they answered incorrectly. If they chose not to retry those questions, they would be directed to watch a consultation animation on childhood obesity. A virtual doctor was featured in this animation, where he advises players about the consequences of obesity. Figure 4.37 shows the storyboard of the virtual consultation.

Players could learn the consequences of obesity by understanding what would happen if they became obese. Once the animation is over, the players are prompted on whether they want to try Level 3 again. With the knowledge on how dangerous obesity can be, children would be convinced to choose healthy options for the scenarios featured in Level 3.

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If you eat a lot of unhealthy food and do little exercise, you will become fat…



…and this situation doesn't change, you will get a disease called obesity.



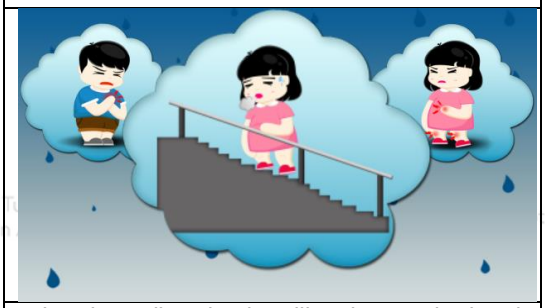
When you grow up, you will become fatter and fatter. And your friends laugh at your fat body.



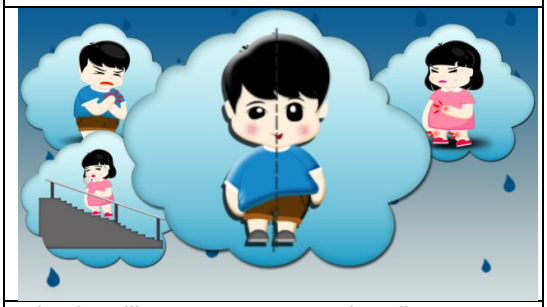
Obesity will harm your heart.



Obesity will cause pain to your keen joins and



…hands easily. Obesity will make you tired and lazy.



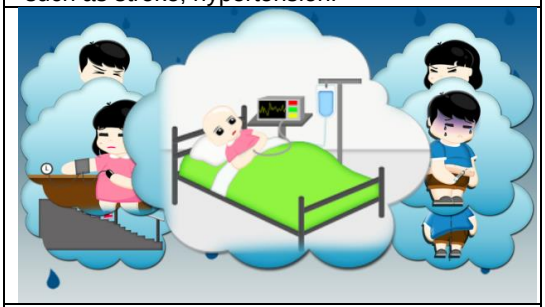
Obesity will cause you to get other diseases,



such as stroke, hypertension.



Diabetes.



Cancer.

Figure 4.37. The storyboard of virtual consultation in *Fight Obesity 2.0*

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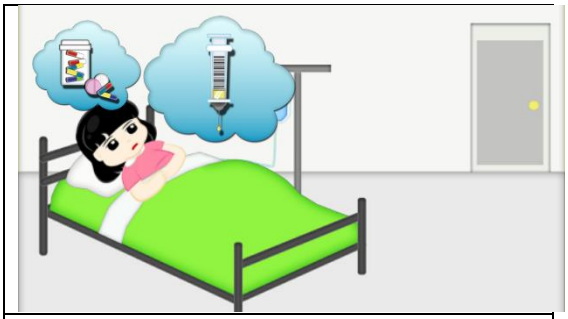
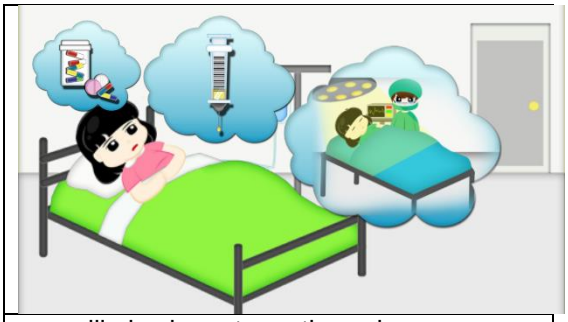
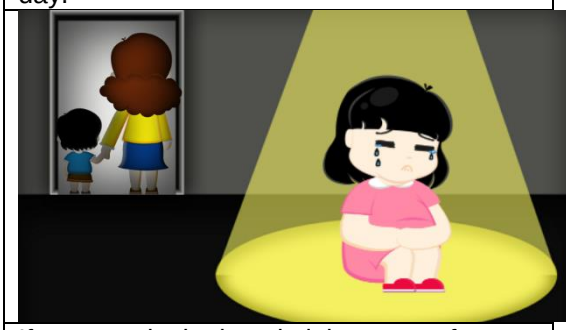
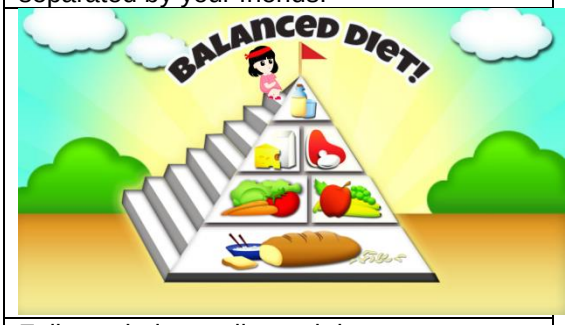
	
Because of that, you will stay in hospital alone to get medicine and injections every day.	you will also have to go through surgery.
	
If you stay in the hospital, because of diabetes and other diseases, you will not be able to stay with your Mommy and Dad.	you will not be able to play with other children.
	
Do you want to be like this in the future?	If you don't want to become sick or be separated by your friends.
	
You need to eat more fruits and vegetables.	Follow a balance diet and do more exercises in order to prevent yourself to get obese.

Figure 4.37 (Continued)

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4.7 Paratextual Materials for *Fight Obesity 2.0*

A series of paratexts were designed and developed for enriching the experience of playing *Fight Obesity 2.0*. These paratexts included a dedicated website, a Facebook page, a game trailer and a training module.

4.7.1 Website and Social Media

A dedicated website was created using WIX HTML 5. This website introduces *Fight Obesity 2.0* at http://fightobesityv2.wixsite.com/fightobesity2 (Figure 4.38). The website introduced the game, showing screenshots of the game (Figure 4.39). Through the website, visitors were directed visitors to download the game Google Play Store to (Figure 4.40) or to view interaction of fans at Facebook page (Figure 4.41). Alternatively, visitors can get in touch with game developers through the website contact page (Figure 4.42).

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Figure 4.38. Homepage of *Fight Obesity 2.0* Website



Figure 4.39. Screenshots of *Fight Obesity 2.0* Presented to Website Visitors

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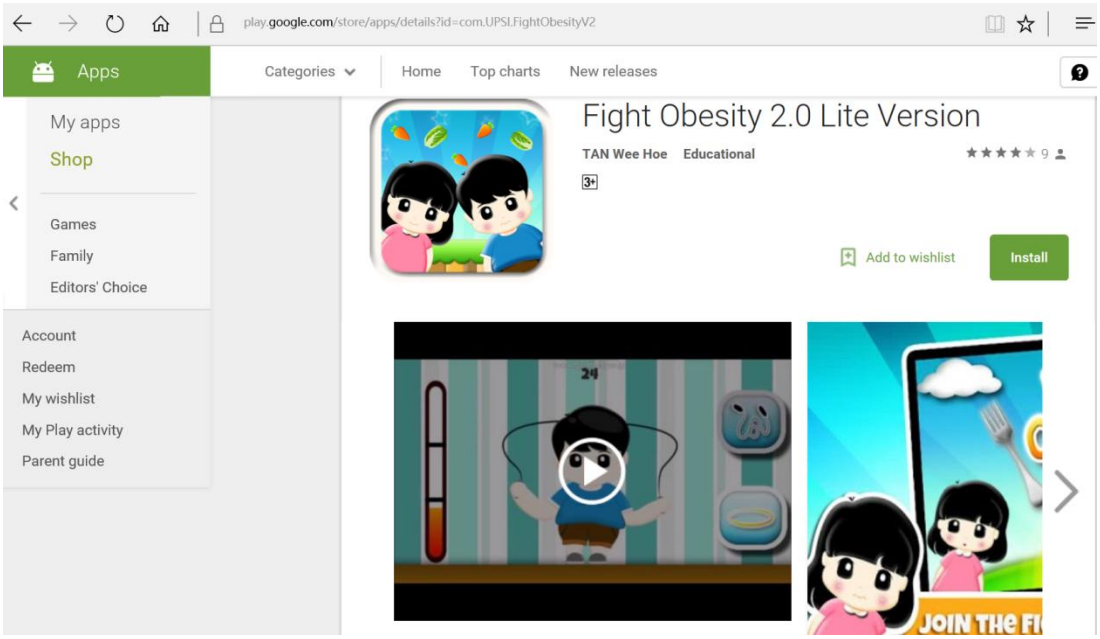


Figure 4.40. *Fight Obesity 2.0* at Google Play Store



Figure 4.41. Facebook Page of *Fight Obesity 2.0*

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Figure 4.42. Online Contact Form

4.7.2 Game Trailer

A 30-second game trailer was produced to promote *Fight Obesity 2.0*. This trailer consists of all game features, including gender option, body size option, Level 1, Level 2, Level 3, Virtual Consultation and a call to download the game. Figure 4.43 is the storyboard of the game trailer.

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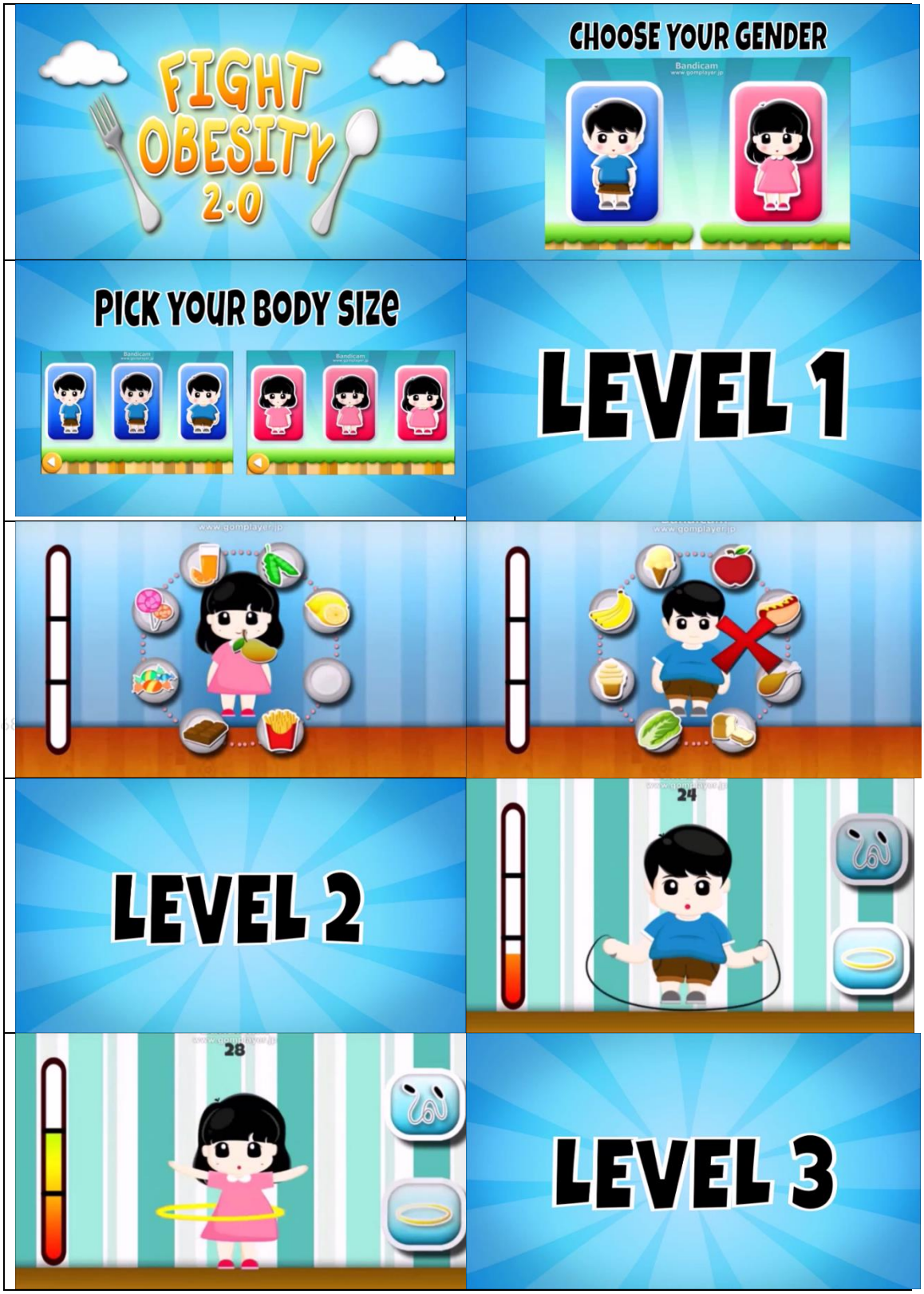


Figure 4.43. Storyboard of *Fight Obesity 2.0* Game Trailer

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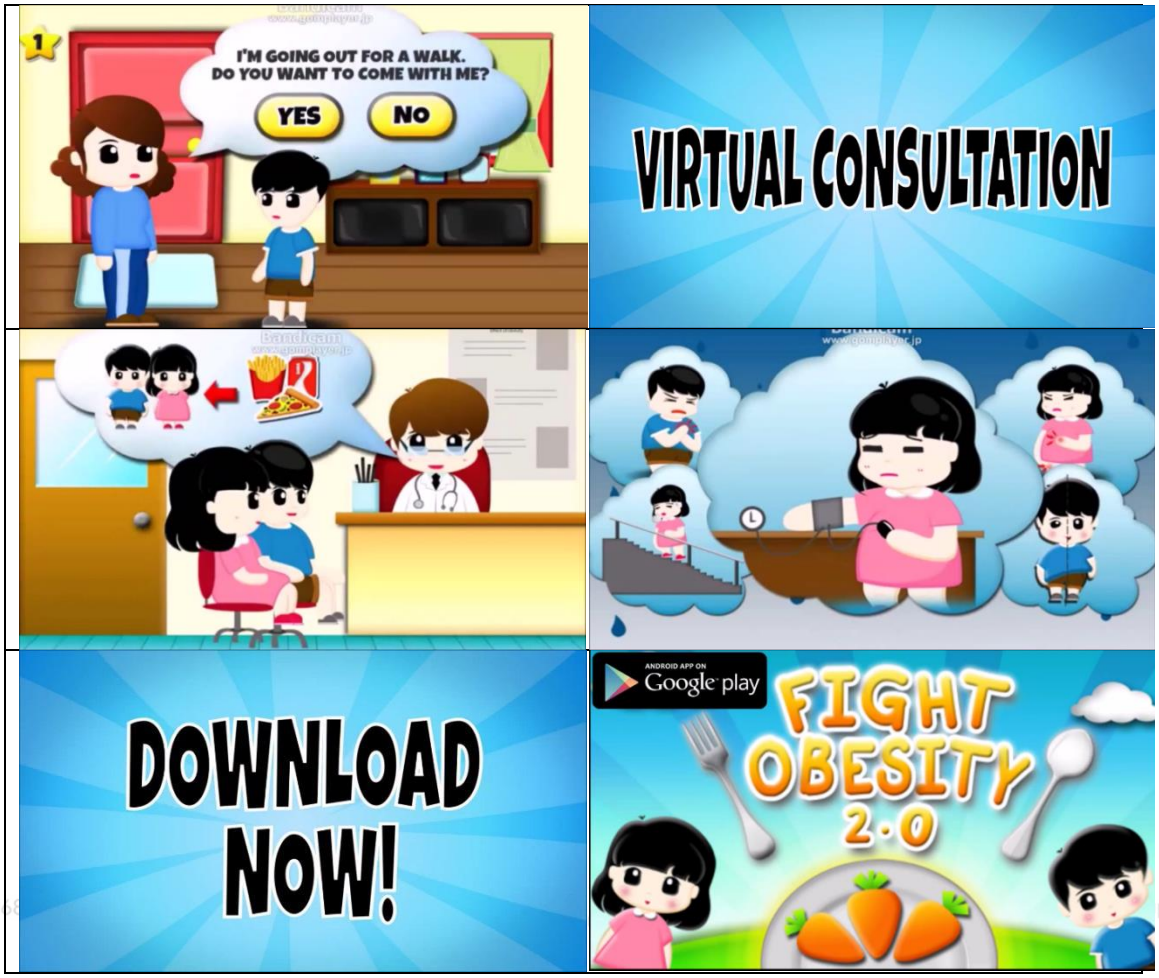


Figure 4.43 (Continued)

4.8 Age Rating of *Fight Obesity 2.0*

Prior to the publication of *Fight Obesity 2.0* in Google Play Store, the game went through an automated classification process under the governance of the International Age Rating Coalition (IARC). The coalition was established to streamline the acquisition of content ratings from authorities in different countries (IARC, 2016).

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As stated in the Developer Distribution Agreement between game developers and Google Inc., the IARC rating has been set as a requirement to participate in the Google Play Store. The rating is intended for three purposes (Google Play Developer Console, 2016):

i) To inform consumers about the age appropriateness of an app

ii) To block or filter content in an app in certain territories or to specific users where legally required.

iii) To evaluate the eligibility of an app for special developer programmes.

In the case of *Fight Obesity 2.0*, the age rating process was walked through by completing the app rating questionnaire in the Google Play Developer Console. In other words, a Google Play Developer account must be registered upfront. The process involved the following six steps:

i) Log in to Google Play Developer Console account

ii) Enter an email address that will be displayed in Google Play Store

iii) Choose a category for the app or game

iv) Complete the app rating questionnaire.

v) Calculate rating.

vi) Apply rating.

As of December 2016, there were six different categories of app in Google Play Store, as summarized in Table 4.12. Each category of app serves different purpose, in which one app can only be rated and published under one specific category. To meet the objectives of this research, the app designed and developed for

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this study was rated and published under the "Game" category. The rating questionnaire for games consists of eight types of questions related to the contents of *Fight Obesity 2.0*, which were 1) violent; 2) fear; 3) sexuality; 4) gambling; 5) language; 6) controlled substance; 7) crude humour; and 8) miscellaneous. The number of questions required to answer ranged from minimum 14 questions to maximum 59 questions, depending whether the game contained any above-mentioned material or not. The actual questions asked in the questions were compiled and included in this thesis for reference (see Appendix H). An IARC Rating Certificate was issued to *Fight Obesity 2.0* on 15 May 2015, indicating the success of the game in passing a content validation, affording the game to be used with children aged three years old and above (see Figure 4.44).

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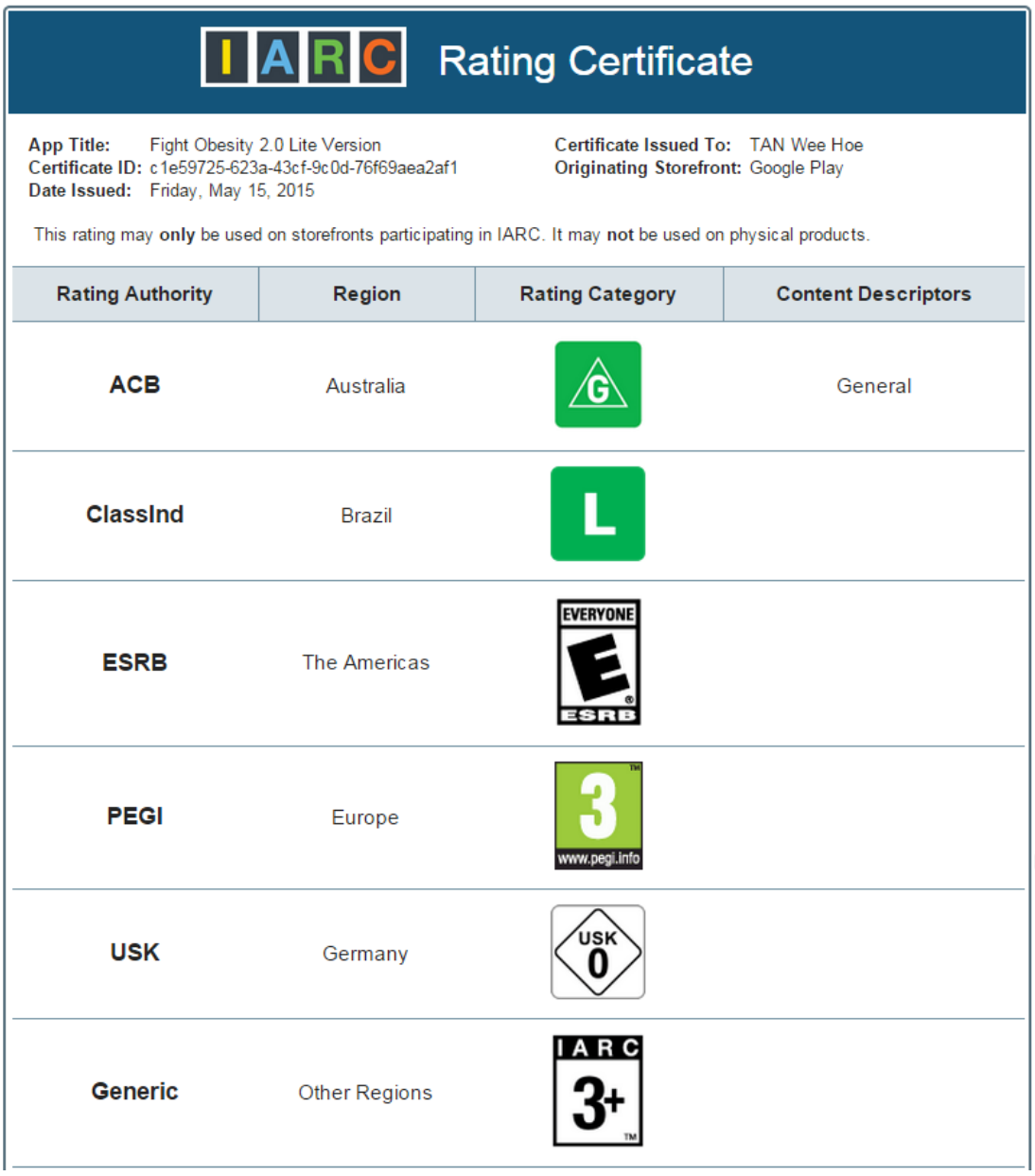
Table 4.12

Six Different App Categories in Google App Store

App category	Characteristics	Examples
Reference, News, or Educational	The primary purpose of the app is to present factual information in a neutral way, alert users to current events, or educate users.	Wikipedia, BBC News, Dictionary.com, and Medscape.
Social Networking, Forums, and user generated content (UGC) sharing	The primary purpose of the app is to enable users to share content or communicate with large groups of people.	Facebook, 9Gag, Google Plus, YouTube, Twitter.
Consumer Store or Commercial Streaming service	The primary purpose of the app is to sell physical goods or curate a collection of physical goods, services, or digital content such as professionally produced movies or music, as opposed to user-created music and movies.	Netflix, Pandora, iTunes, Amazon, Hulu+, eBay.
Game	The app is a game.	Candy Crush Saga, Temple Run, World of Warcraft, Mario Kart, Angry Birds.
Entertainment	The app is meant to entertain users, and does not fit into any of the above categories.	Talking Angela, Face Changer, People Magazine, iKamasutra
Utility, Productivity, Communication or other	The app is a utility, tool, communication, or productivity app or any other type of app that does not meet criteria for any other categories.	Calculator Plus, Evernote, Gmail, Google Docs, Chrome, Snapchat, and WhatsApp.

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IARC Rating Certificate

App Title: Fight Obesity 2.0 Lite Version
Certificate ID: c1e59725-623a-43cf-9c0d-76f69aea2af1
Date Issued: Friday, May 15, 2015

Certificate Issued To: TAN Wee Hoe
Originating Storefront: Google Play

This rating may **only** be used on storefronts participating in IARC. It may **not** be used on physical products.

Rating Authority	Region	Rating Category	Content Descriptors
ACB	Australia	G	General
ClassInd	Brazil	L	
ESRB	The Americas	EVERYONE E ESRB	
PEGI	Europe	3 www.pegi.info	
USK	Germany	USK 0	
Generic	Other Regions	IARC 3+	

Figure 4.44. The IARC Certificate of *Fight Obesity 2.0*

4.9 Results of Playtesting on *Fight Obesity 2.0*

A playtesting session was conducted in a computer laboratory in a Malaysian private university college on 12 November with 38 undergraduate students who were in the

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second year of pursuing their Bachelor of Computer Science (Interactive Software Technologies) degree. The aim of a playtesting session was to rate the technical quality and usability of *Fight Obesity 2.0*.

The playtesting session involved using 27 desktop computers, in which Bluestack 2.0 was installed as the Android emulator in every computer. Testers were split into two batches, in which the first batch playtest *Fight Obesity 2.0* in the morning, while the second batch playtest the game using the same protocol in the afternoon.

The session consisted of three parts: generating game ideas, playing *Fight Obesity 2.0* and rating the usability. In the first part, testers were shown a game design document and a demonstration of a mobile game titled Fight Obesity (Lee, 2015). After that, testers were facilitated in to propose game ideas that may improve the quality of the Fight Obesity (refer to Appendix I). In the second part, the testers played through *Fight Obesity 2.0* and recorded individual play session using Screencast-O-Matic. In the last part of the playtesting, testers were directed to fill in an online usability testing feedback.

4.9.1 Comparison between *Fight Obesity 2.0* and Testers' Game Ideas

Testers were facilitated to generate ideas which may improve the gameplay, aesthetics and feasibility of the original Fight Obesity (see Appendix G). Four criteria of

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measuring creativity proposed by Tony Bony were employed in the classification of ideas (Tan, 2013). The purpose of this comparison was to assure that the quality of *Fight Obesity 2.0* was matching, if not better than the quality of game ideas generated by the testers. Three testers worked in a group (denoted as Trio), 24 testers worked in pairs (Pair01 – Pair12) and 17 testers worked individually (Indiv01 – Indiv17) when they generated ideas. As shown in Table 4.13, there were 42 game ideas generated in this session, where most of the ideas were created for Level 1, as compared to Level 2 (9 ideas), Level 3 (9 ideas) and the Setup and Tutorial Level (8 ideas).

Table 4.13

Classification of Game Ideas Generated by Testers

Game level	**Testers**	**Count of ideas**
Setup and Tutorial Level	Pair12, Indiv03, Indiv05, Indiv08, Indiv09	8
Level 1	Trio, Pair01, Pair02, Pair04, Pair05, Pair08, Indiv01, Indiv04, Indiv11, Indiv15, Indiv17	16
Level 2	Pair06, Pair09, Pair12, Indiv03, Indiv04, Indiv05, Indiv10, Indiv14	9
Level 3	Pair03, Pair07, Pair10, Pair11, Indiv02, Indiv12, Indiv13, Indiv16	9
	TOTAL	42

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4.9.1.1 Quality of Ideas for Setup and Tutorial Level

The testers generated eight ideas for designing the Setup and Tutorial Level, as shown in Table 4.14. In general, the gameplay ideas proposed by the testers were common and lack of novel feature. As for the aesthetic quality, Indiv05 raised up a generic consideration of children' aesthetic preferences, which had been implemented in

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Fight Obesity 2.0. Nonetheless, aesthetic considerations upon the targeted preschool players were limited to general understanding, instead of having thought from psychological and child developmental requirements.

In actual practice, the *Fight Obesity 2.0* mobile game was actually tested throughout its production using the tissue tester approach (Gibson, 2014), to the extent that no tutorial would be needed to start playing Level 1, Level 2 and Level 3. Players intuitively knew how to play to game with the preset graphic user interface (GUI) and instructional voice over narration. In a word, the game character setup in *Fight Obesity 2.0* was either better or aligned to game ideas proposed by the testers prior to the playtesting session.

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Table 4.14

Assessment of Game Ideas for Game Setup Level Generated by Testers

ID	Game idea (Direct quotes)	Novelty of gameplay	Aesthetics of game art	Feasibility of game function	Quantity of ideas
Pair12	Brainstorming, discuss	Game-based brainstorming and discussion is rather common in multiplayer games.	Too little information to determine the aesthetic quality.	Need a facilitator to make game-based brainstorming feasible among targeted preschool players.	2 ideas
Indiv03	Tutorial/hints of the importance of exercise should be shown on the beginning of the level 2.	Common approaches used in existing games.	Hints should be made explicit and timed probably to avoid over dependency.	While tutorial for every game level would be unnecessary, hint could be provided to support completion of learning.	1 idea
Indiv05	Symbol feedback (such as cute icon) with colourful background Some tutorial and demo to guide player how to play Simple input and control	Common approaches used in existing games.	Sensible aesthetic consideration	Feasible, already applied in *Fight Obesity 2.0*	3 ideas
Indiv08	Level 2, put more instruction and tutorial, player still may not know how to play the game	Common approaches used in existing games.	Text-based instruction would not meet the aesthetic preferences of targeted preschool players	Not feasible for targeted preschool players	1 idea
Indiv09	Level 1: Design with tutorials and how to play the game.	Common approaches used in existing games.	Too little information to determine the aesthetic quality.	Feasible but not necessary.	1 idea

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4.9.1.2 Quality of Ideas for Level 1

The purpose of Level 1 was to establish healthy food preference among targeted preschool players. The testers generated 16 ideas for improving the original single-player 2D side-scrolling avatar-based Level 1.

In terms of novelty, four novel gameplay ideas (out of 16 ideas) were found, as shown in Table 4.15. Some testers attempted to replicate the gameplay of popular casual games, such as Fruit Ninja (Pair01 & Pair02), Candy Crush (Pair01) and Baymax in Big Hero 6 (Pair04), which would not be feasible in the case for this study as this may infringe copyright of the original game titles.

Four testers (Pair01, Pair02, Pair05 & Indiv11) suggested to improve Level 1 using dynamic visual and sound effects through a fast-paced tactical gameplay. Although this may engage the targeted preschool players, the overall gameplay of the *Fight Obesity 2.0* mobile game should involve strategic immersion that makes players think before making decision, rather than tactical immersion which emphasizes on the speed, accuracy and persistence of psychomotor reflexes (Adams, 2013).

Some testers (Trio, Pair05, Indiv01 & Indiv11) proposed to include scores or marks to when providing formative feedback or summative feedback to players. However, giving scores or marks to targeted preschool players might require them to associate marks given to or taken away from them and the consequences of eating good or bad food. The use of scores or marks may add an unnecessarily layer of

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conception among the players, hindering them from directly connecting their in-game choices of food to the change of body size.

Meanwhile, Indiv04 and Indiv15 intended to improve Level 1 by separating the food preferences into breakfast, lunch and dinner. The idea of splitting food choices into three meals of a day may be impractical in the multi-racial and multi-cultural contexts in Malaysia.

In a word, none of the ideas generated by the testers for Level actually demonstrated better gameplay, aesthetics or feasibility than the Fight Obesity mobile game.

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Table 4.15

Assessment of Level 1 Game Ideas Generated by Testers

ID	Game idea (Direct quotes)	Novelty of gameplay	Aesthetics of game art	Feasibility of game function	Quantity
Trio	User control the character by left right to walk around the world and there will be random generated food spawn at certain area that if player want to eat the food, press certain button or else just walk pass by it.	The control scheme was a typical single-player avatar-oriented side-scrolling navigation in a linear game space.	The aesthetic value of random generation of food, spawning on the screen matched the actual game design of *Fight Obesity 2.0*.	This idea might not suitable for preschool children since controlling avatar using virtual joystick on Android tablet was not intuitive.	3 ideas
	When the character is fed by healthy food, it will get mark and stay fit / healthy. If the character is fed by unhealthy food, it will deduct mark and grow fat!!! After the food is being feed to the character, some interesting feedback will be shown like Smile: if the food is healthy he will smile while is not healthy = sad and not to say the sound effect.	The idea of using smile with audio as formative feedback was typical in children games.	Combining both visual and auditory modalities would enhance the aesthetic experience of targeted preschool players.	Giving mark to targeted preschool players might require them to associate marks given to or taken away from them and the consequences of eating good or bad food.	
	After the game end, it will show a list of good food and bad food eat by the character to remind them again which food is healthy and which food aren't.	The idea of showing a list of good and bad food eaten by them as summative feedback was novel.	Contrasting good food and bad food at the end of the game might encourage players to choose bad food deliberately in order to see the contrast, thus defeating the purpose of the game level.	Contrasting good food and bad food will only work if targeted preschool players actually chose bad food, which was not the intention of this game level.	
Pair01	Idea 1: toss up healthy food and let the children to cut like Fruit Ninja	This was not a novel idea since it replicates the gameplay of Fruit Ninja.	Fast-paced tactical gameplay would require dynamic visual and sound effects.	This game level should involve strategic immersion rather than tactical immersion, thus it would not be feasible.	2 ideas
	Idea 2: make it like Candy Crush but replace the candies with vegetables. This can influence them and they might get attracted to vegetables	This was not a novel idea since it replicates the gameplay of Candy Crush.	The aesthetics level should match the quality of Candy Crush to attract targeted preschool players.	This gameplay did not align content knowledge of healthy food preferences to solving vegetable puzzles. Also, healthy food preference is not vegetarian food preference.	

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Table 4.15 *(Continued)*

ID	Game idea (Direct quotes)	Novelty of gameplay	Aesthetics of game art	Feasibility of game function	Quantity
Pair02	Like Fruit Ninja, cut the food that will harm you , then earn point or touch the food that appear that benefit you will earn the point, ignore the food that will harm you.	This was not a novel idea since it replicates the gameplay of Fruit Ninja.	Fast-paced tactical gameplay would require dynamic visual and sound effects.	This game level should involve strategic immersion rather than tactical immersion, thus it would not be feasible.	1 idea
Pair04	Choose Healthy food: Eat unhealthy food Baymax will increase size become fat. Eat healthy food Baymax will become fit then until certain point then evolve into super Baymax. End of level will show if Baymax is fat then he will fight lose if fit then will evolve and fight win	This was not a novel idea since it replicates the gameplay of Fight Obesity (Lee, 2015). Transforming into super Baymax replicates the storyline of Big Hero 6 animated film.	The use of popular fictional character like Baymax would definitely attract the interest of targeted preschool players.	This idea infringed the copyright of Big Hero 6, thus it would not be feasible.	1 idea
Pair05	Some foods are drop from top of screen (fruit, burger, candy, vegetable and etc), the game character has to collide with the food in order to eat the food. If the game character eats the healthy foods, the score will increase, else the score will drop. If the time ends, score will be recorded.	The gameplay idea is novel.	Fast-paced tactical gameplay would require dynamic visual and sound effects.	This game level should involve strategic immersion rather than tactical immersion, thus it would not be feasible.	1 idea
Pair08	Eat Colorful - Design a dish with different color of fruit or vegetable follow the picture given, such as rainbow. Each fruit will show the information of the fruit and vegetable and why child should be eating it. This could attract a child asking their parent to let them try the fruit.	The gameplay idea is novel.	Making food colourful would definitely match the aesthetic expectation of targeted preschool children.	Showing food information to preschool children might not be feasible since they do not have the cognitive capacity to comprehend the information.	1 idea
Indiv01	Let them see which foods are healthy when they select the foods and show them the healthy score. The higher the healthy score, the healthier the food. Then let them feed the character by the food that they select. If they select not healthy food to feed him will make the character become fat. If they select healthy food will make him become normal.	The gameplay is typical in educational games.	Heavy text-based information would not match the aesthetic expectation of targeted preschool players.	Providing information to targeted preschool players would make them passive receivers of information. Giving score to them might require them to associate the scores and the consequences of eating healthy or unhealthy food.	1 idea

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Table 4.15 *(Continued)*

ID	Game idea (Direct quotes)	Novelty of gameplay	Aesthetics of game art	Feasibility of game function	Quantity
Indiv04	Series of foods that can be selected to feed the character from breakfast lunch and dinner. The character gets gradually fatter as more unhealthy food is fed. If healthy food is fed, character stays fit	The gameplay of separating food choices into breakfast, lunch and dinners is similar to Nutrition Your Life.	Too little information to determine the aesthetic quality.	Splitting food choices according to breakfast, lunch and dinner was found impractical in the multi-cultural contexts of Malaysia.	1 idea
Indiv11	In level 1, player is given 3 lives and 60 seconds to get as much score as possible.	A typical gameplay of time pressure challenge with limited lives.	Too little information to determine the aesthetic quality.	Giving score to them might require them to associate the scores and the consequences of food preferences.	3 ideas
	There will be randomly three new different foods given every time after player has fed the character food. Only one food will be the healthy food. For example, there is an apple, a candy and potato chips. Player has to choose the healthy food and drag to the game character to feed the character.	This gameplay matched the initial idea of *Fight Obesity 2.0*. However, adding features like time pressure challenge with limited lives would lead players to tactical immersion.	Fast-paced tactical gameplay would require dynamic visual and sound effects.	This game level should involve strategic immersion rather than tactical immersion, thus it would not be feasible.	
	If the healthy is fed to character, score is awarded, and if unhealthy food is fed, 1 life is deducted. The game ends when 60 seconds is up or player used up the 3 lives given. The high score is recorded and players can challenge his or her friends.			Giving score to them might require them to associate the scores and the consequences of food preferences.	
Indiv15	Make a time period where the player must eat the correct meal at the each time period, for example, at if every 5 minutes in game is Breakfast, the player must pick the breakfast and eat it.	The gameplay is novel but it might lead to controversial argument on food preferences for breakfast, lunch & dinners.	Not enough information to determine the aesthetic quality.	Splitting foods choices according to breakfast, lunch and dinner was found impractical in the multi-cultural contexts of Malaysia.	1 idea
Indiv17	In designing level one, I will more emphasize in graphical representation. Kids are dumb, most of them were unable to read the text. Hence some visual graphics is the best choice as more easy for the kids to play. Other than that, some sound effect will also recommend as sounds make the game more emergent. By combining graphic and sound, the game will be more interactive as kids prefer a more easy and interactive game.	Not enough information to determine the quality of gameplay.	Although kids are not dumb actually, the consideration of using graphics and sound effects as opposed to texts makes sense.	Not enough information to determine the practicality of the game idea.	1 idea

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4.9.1.3 Quality of Ideas for Level 2

The purpose of Level 2 was to demonstrate the relationship between physical exercise and obesity. Nine ideas were generated by the testers to improve Level 2, as shown in Table 4.16.

In terms of novelty, most of the ideas matched the actual gameplay of *Fight Obesity 2.0* (6 out of 9). Three gameplay ideas were considered novel, but they were not suitable for actual implementation. In particular, the type of physical exercise proposed by Indiv05 was anaerobic, which was not feasible for targeted preschool children who require aerobic exercises.

As for the aesthetic taste, four testers proposed the use of animated health bar and animated game characters (Pair06, Indiv03, Indiv10 & Indiv14) to represent the status of doing physical exercise.

In conclusion, the current state of Level 2 in *Fight Obesity 2.0* can be considered as an optimum design for use in game-based childhood obesity prevention.

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Table 4.16

Assessment of Level 2 Game Ideas Generated by Testers

Group	Game idea	Novelty of gameplay	Aesthetics of game art	Feasibility of game function	Quantity
Pair06	Design the level with stamina bar, one is fat and one is normal size for the fatty child, when the child did something, then the stamina will decrease rapidly for the normal child, when the child did something, then the stamina will drop slowly then show a story says that the child who always exercise have stronger stamina like that gua~~	This gameplay matched the design of *Fight Obesity 2.0*. However, instead of using stamina bar, health bar was used in *Fight Obesity 2.0* instead.	Changing body sizes of game avatars would attract the interests of targeted preschool players.	This idea meets the game level objective.	1 idea
Pair09	I will let the AI become a very thin person, the player play as the fat person. So when they play sports together, the fat person will be very tired and slow.	This two-player gameplay idea is novel, and it can show the consequences of obesity.	The use of artificial intelligent (AI) non-player character would make players empathize with their unhealthy avatars.	This game idea would be suitable for game level 3.	1 idea
Pair12	Show the bad effect to the player if not do exercise, and show the good if doing exercise	This gameplay matched the design of *Fight Obesity 2.0*.	Not enough information to determine the aesthetic quality.	This idea meets the game level objective, but details on how it can be implemented are not provided.	1 idea
Indiv03	In level 2, you can display a healthy bar state just to inform children obesity, and it also can show whatever food you chosen make changes on the state, but exercise is the only one can reduce the obesity state, which help you to avoid game over.	The gameplay matched the design of *Fight Obesity 2.0*.	Changing the states of healthy bar and characters would attract the interests of targeted preschool players.	This idea meets the game level objective, and was implemented in *Fight Obesity 2.0*.	1 idea
Indiv10	There is a bar indicates children to tap on the screen and the animation/character inside the game will do the exercise, if the child tap the screen successfully until the bar is full, the animation will show a "like" symbol indicates win the game. If the child didn't tap on the game in a certain period, the bar will fall and if empty for some time, the character / animation will fainted and show the lose scene.	The gameplay matched the design of *Fight Obesity 2.0*. The summative feedback of "like" symbol is common in existing games.	Animation of game avatar doing exercise would attract the interest of targeted preschool players.	This idea meets the game level objective, and was implemented in *Fight Obesity 2.0*. Instead of using "like" symbol, a conclusive visual was presented to players upon the success completion of the game level.	1 idea

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Table 4.16 *(Continued)*

Group	Game idea	Novelty of gameplay	Aesthetics of game art	Feasibility of game function	Quantity
Indiv04	Level 2, the player character is a baby, and the baby's parents will say "hey dear, you're too heavy now, I can't even lift you", a weight bar will showed on the screen different exercise will be showed the baby can choose one of the exercise and each exercise labeled with different effort level. Higher effort level will reduce more weight. When the weight bar hit a balanced target, and the player clicked on the "parents" character, player will be lifted up. If the player clicks the parents without hit the weight target, the parents will show a not happy face.	The gameplay is novel but might lead to ethical issue as abandoning baby after being obese is not ethical and legal.	Imposing a baby-related storyline would attract the interests of targeted preschool players.	The idea is not feasible as it might incur ethical issue.	1 idea
Indiv05	Explain in detail of what part of the body is strengthen when one perform certain exercise.	This body building anaerobic gameplay idea is novel.	Animation on changing body parts after doing anaerobic exercise would be needed.	The idea of body building is not feasible for targeted preschool children who require aerobic exercise rather than anaerobic.	1 idea
Indiv14	Player will have to control an avatar to exercise. Player will need to control the avatar to make different actions for different kind of exercise, jogging, sit up or swimming.	The gameplay matched the design of *Fight Obesity 2.0*.	Combining jogging, sit-up and swimming in one scene would be visually appealing to the targeted preschool players.	It would not be feasible to show several types of exercise which require different venues.	2 ideas
	If the avatar didn't exercise enough, it will become unhealthy. There is a healthy bar to determine the healthiness of the avatar. If the bar is low, the avatar will get sick, and in bad mood. If the avatar have enough exercise, it will be energetic and in good mood.	The gameplay matched the design of *Fight Obesity 2.0*.	Matching avatar's health bar with changing emotion would be visually appealing to the targeted preschool players.	The relationship between exercise and mood is not the focus of this game.	

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4.9.1.4 Quality of Ideas for Level 3

The purpose of Level 3 was to show the consequences and the danger of childhood obesity. Nine ideas were created by the testers to improve Level 3, as shown in Table 4.17.

In terms of novelty, two ideas (Pair11 & Indiv12) of gameplay were found matching the actual design of *Fight Obesity 2.0*, which involved using the question and answer strategy in a zero-dimension game space (Schell, 2015). Meanwhile, Pair07 and Pair10 suggested the gameplay of card game to improve Level 3. Despite being novel, physical printed cards, such as the paper-based prototype of *Fight Obesity 2.0*, would be more feasible and economical as compared to using visual cards in Level 3.

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Similar to the ideas proposed for Level 1, Pair10 and Indiv13 suggested deploying tactical immersion strategy, rather than strategic immersion measure to engage targeted preschool players in Level 3. However, the same issue mentioned in Section 4.9.1.2 would be applicable in Level 3 (Adams, 2013).

In terms of practicality, a noteworthy idea—presenting feedback using animation rather than static images or text-based information was proposed by Pair11. This idea was in fact a feature in the *Fight Obesity 2.0* mobile game. In conclusion, the actual outcome of Level 3 in *Fight Obesity 2.0* mobile game matched the expected quality proposed by the testers.

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Table 4.17

Assessment of Level 3 Game Ideas Generated by Testers

Group	Game idea	Novelty of gameplay	Aesthetics of game art	Feasibility of game function	Quantity
Pair03	In level 3, make the game more challenge and difficult compare to level 1 and level 2 for player, require player to think for the way to solve that stage and brings the things that the purpose of this game want to tell players	Not enough information to determine the quality of gameplay.	Not enough information to determine the aesthetic quality.	While the general direction of design is logical, there is insufficient information to determine the feasibility of game idea.	1 idea
Pair07	Level 3 - use visual cards to replace text to help the children understand the game content. Players should choose whether the habits shown on the card is good or bad.	The visual card gameplay is novel and sensible for the targeted preschool players.	The visual cards should match the aesthetic expectation of the targeted preschool players.	The alignment between habits or behaviours and obesity prevention contents is feasible. However, physical cards would be more feasible and economical than visual cards.	1 idea
Pair10	I will design the game level 3 by using a quick matching card game with a time constraint. The cards will have images that represent the good and bad habits. For every matching pair, player gets a point. In single player mode, player needs to get at least 10 points before the time runs out to win the game. In multiplayer mode, players have to get more points than the opponent to win.	The dual-mode (single-player and multi-player) card matching gameplay is common in existing games.	The visual cards should match the aesthetic expectation of the targeted preschool players.	This game level should involve strategic immersion rather than tactical immersion, thus it would not be feasible.	1 idea
Pair11	Show image of a situation, where player can choose 2 or more decision toward that situation. And then images of the implication of that situation will be shown.	The gameplay matched the design of *Fight Obesity 2.0.*	Still images may not attract the interest of targeted preschool players.	This idea meets the game level objective, and was implemented in *Fight Obesity 2.0*. Feedback was animated to attract targeted preschool players.	1 idea

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Table 4.17 *(Continued)*

Group	Game idea	Novelty of gameplay	Aesthetics of game art	Feasibility of game function	Quantity
Indiv02	Level 3: Design healthy lifestyle that players have to go through like having healthy 3 meals with have a balanced diet.	This gameplay idea should be set for Level 1.	Dynamic graphics on healthy balanced diet would be needed.	This game idea is suitable for Level 1.	2 ideas
	Occasionally give exercises to players to allow players to know what they need to do for healthy lifestyle and turn these to their habits. So they will do these in their real life too.	This gameplay idea should be set for Level 2.	Animation on healthy lifestyle would be needed.	This game idea is suitable for Level 2.	
Indiv12	Asking questions to the children, give them several choices of answer, and if they pick the wrong answer, show them the right answer.	The gameplay matched the design of *Fight Obesity 2.0*.	Questions can be asked using narration rather than texts.	This idea meets the game level objective, and was implemented in *Fight Obesity 2.0*.	1 idea
Indiv13	Display the image of characteristic of good lifestyle and habit and other image which is characteristic of bad lifestyle and habit. Let players choose the image of characteristics of good lifestyle and habit within a time limit. Rating the player based on their speed, too slow or exceeded time limit will lose.	A typical gameplay of time pressure challenge.	Fast-paced tactical gameplay would require dynamic visual of two contrasting lifestyles and appropriate sound effects.	This game level should involve strategic immersion rather than tactical immersion, thus it would not be feasible.	1 idea
Indiv16	Level 3: A simulation of a college student that lives separately with his/her parents. We let the user play a simulation of an independent character living on his own. He is given selections on every moves that is concerning to a good lifestyle and habit. Examples of good lifestyle and habits are where to eat, what to eat, proportions of meals, when to sleep, amount of sleep etc. The user plays the game by living as the student, with an objective of living throughout his college life smoothly without suffering any diseases or collapsing. Advices might be given on good lifestyle and habits, throughout the game or at the end of the game, which will help the user learn a good lifestyle/habit. Especially if it's a game for children, the game could be simplified into simple graphics and choices which could aid in learning.	A typical gameplay for simulation games.	The story of a college student would not attract targeted preschool players.	Wrong choice of game avatar age group, thus it would not be feasible.	1 idea

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4.9.2 Demographic Profile of Testers

The demographic profile of the playtesters is shown in Table 4.18, while Table 4.19 presents the sorted data of the playtesting screen capture videos. The age of the testers were ranging between 20 to 23 years old, in which all of them were Malaysian Chinese male. Majority of the testers played the role of the Boy game character (30 out of 36 testers), and set up the character with obese body size (13 out of 36).

Most of the testers (16 out of 36) completed *Fight Obesity 2.0* in less than three minutes (ranging from 2:49 to 2:59) without going through the virtual consultation animation. Testers who spent more than four minutes testing the game were those who watched the consultation animation (8 out of 36). This result contradicted to the expectation set by the game production team because the narration and visuals shown in the virtual consultation animation should have played an important contribution in the overall childhood obesity prevention. Perhaps the animation could be split into three parts and inserted to the end of every game level as a reward, rather than as a punishment—forcing players who failed to complete the game to watch the animation and listen to the instructive narration. This outcome triggered the need to make the game-based childhood obesity prevention teacher-led rather than teacher-less game-based obesity prevention. This prompted the need for a module which can guide the teachers on how to optimize the usage of *Fight Obesity 2.0* for childhood obesity prevention. Apart from teachers in kindergarten, caretakers and parents should also take the lead to direct the prevention through game playing.

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Table 4.18

Demographic Profile of Playtesters

Profile			*F*	Total
Age	20 (born in 1996)		24	38
	21 (born in 1995)		8	
	22 (born in 1994)		3	
	23 (born in 1993)		3	
Choice of avatar gender	Male avatar		29	[b]36
	Female avatar		6	
	Both		1	
Choice of body size	Normal		12	36
	Overweight		8	
	Obese		13	
	Mixed		3	
Deliberately make mistake	Level 1		6	14
	Level 3		8	
Virtual exercise in Level 2	Tried hula hoop?	Yes	28	36
		No	8	
	Tried skipping rope?	Yes	35	36
		No	1	
Watched consultation animation	No		28	36
	Yes	Replayed Level 3	2	
		Did not replay Level 3	6	
Range of playtesting duration	≤ 3 minutes		16	[a]36
	3 – 4 minutes		12	
	4 – 5 minutes		4	
	≥ 5 minutes		4	

[a]2 playtesters did not record their playing video.

[b]2 playtesters played the game twice.

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Table 4.19

Sorted Data of Playtesting Screen Capture Videos

ID	Avatar Setup		Level 1	Level 2		Level 3	Watched consultation animation?	Total time spent
	Gender	Body size	Unhealthy food	Hula hoop	Skipping rope	Mistake(s)		
T01	Male	Overweight	0	Yes	Yes	0	No	2:54
T02	Male	Normal	0	Yes	Yes	0	No	2:53
T03	Male	Overweight	0	Yes	Yes	0	No	2:58
T04	Female	Normal	2	Yes	Yes	Q1,Q2,Q3,Q5,Q6,Q10	Yes, without replay, muted.	4:43
T05	Female	Overweight	0	Yes	Yes	0	No	2:52
T06	Male	Overweight	0	Yes	Yes	0	No	2:57
T07	Male	Normal	0	Yes	Yes	0	No	3:35
T08	Male	Normal	0	No	Yes	0	No	3:13
T09	Male	Overweight	1	Yes	Yes	Q3,Q5	Yes, muted, replay L1 & L2	6:08
T10	Male	Obese	0	No	Yes	0	No	2:54
T11	Male	Normal	0	No	Yes	0	No	3:09
T12	Male	Normal	0	Yes	Yes	0	No	3:02
T13	Male	Overweight	0	No	Yes	Q8, Q10	Yes, without replay, muted.	4:36
T14	Male	Overweight	1	Yes	Yes	0	No	2:56
T15	Male	Obese	0	Yes	Yes	Q3,Q4,Q7	Yes, without replay, muted	4:46
T16	Female	Obese	0	Yes	Yes	0	No	2:51
T17	Male	Normal	0	Yes	Yes	0	No	2:56
T18	Male	Overweight	0	Yes	Yes	Q2,Q3,Q5	Replayed, no.	2:57+
		Obese	3	Yes	Yes	Q1,Q3,Q5, Q6,Q8,Q10	Yes, without replay, muted.	6:53
T19	Male	Obese	0	Yes	Yes	0	No	3:02
T20	Male	Normal	0	No	Yes	0	No	2:49

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Table 4.19 *(Continued)*

ID	Avatar Setup		Level 1	Level 2		Level 3	Watched consultation animation?	Total time spent
	Gender	Body size	Unhealthy food	Hula hoop	Skipping rope	Mistake(s)		
T21	Female	Normal	2	Yes	Yes	Q2,Q3,Q4,Q5,Q6	Yes, directed after Q6, muted.	5:55+
	Female	Obese	3	Yes	Yes	Q1,Q3,Q5,Q7,Q9	Yes, without replay, muted.	5:28
T22	Male	Obese	0	No	Yes	0	No	2:54
T23	Male	Normal	0	Yes	Yes	0	No	2:59
T24	Male	Obese	0	Yes	Yes	0	No	3:03
T25	Male	Obese	0	Yes	Yes	0	No	2:58
T26	Male	Normal	0	Yes	Yes	0	No	3:07
T27	Male	Normal	0	Yes	Yes	0	No	2:57
T28	Male	Obese	0	Yes	Yes	Q2,Q3,Q4,Q5,	Yes, without replay, muted	4:43
T29	Female	Obese	0	Yes	Yes	0	No	2:54
T30	Male	Overweight	1	Yes	Yes	0	No	3:19
T31	Male	Obese	0	Yes	Yes	0	No, watched credits	3:36
T32	Male	Obese	0	No	Yes	0	No	2:56
T33	Male	Obese	0	Yes	Yes	0	No	3:35
T34	Male	Obese	0	No	Yes	0	No	3:11
T35	Female	Normal	0	Yes	No	0	No	3:28
T36	Female	Overweight	0	Yes	Yes	Q3	Replayed	3:14+
	Male	Obese	0	Yes	Yes	0	Yes, without replay, muted	7:16

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4.9.3 *Fight Obesity 2.0* Teaching and Training Module

To resolve the issue revealed through the result of the playtesting, a teaching and training module titled Shaping Healthy Childhood Lifestyle through *Fight Obesity 2.0* was prepared for parents, caretakers, teachers and doctors (see Figure 4.45). The module consists of detailed explanation on how game-based obesity prevention could be implemented in kindergarten or at home. It consists of elaboration of three game levels in *Fight Obesity 2.0*, facilitation guide for every level and a glossary of key terms used in the module. This module introduces a game-based obesity prevention approach which can be applied in kindergarten, healthcare centre or at home. This invention was meant to use games to shape healthy lifestyle and it should be conducted and monitored by adult facilitators, whom could be parents, kindergarten teachers, care takers, or doctors. These adult facilitators should have full control of the play sessions which involve *Fight Obesity 2.0* and hardware that contained the game.

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In practice, game-based obesity prevention through *Fight Obesity 2.0* can be divided into three phases: pre-game playing, during game playing, and post-game playing. In the second phase, obesity prevention can be subdivided into two interweaving modes: in-game and off-game. In-game mode is the world of computer-generated imagery (CGI) within the game, such as game levels and virtual consultation; while off-game mode is the physical contexts outside the game where children playing *Fight Obesity 2.0*, such as kindergarten, canteen, home, and others.

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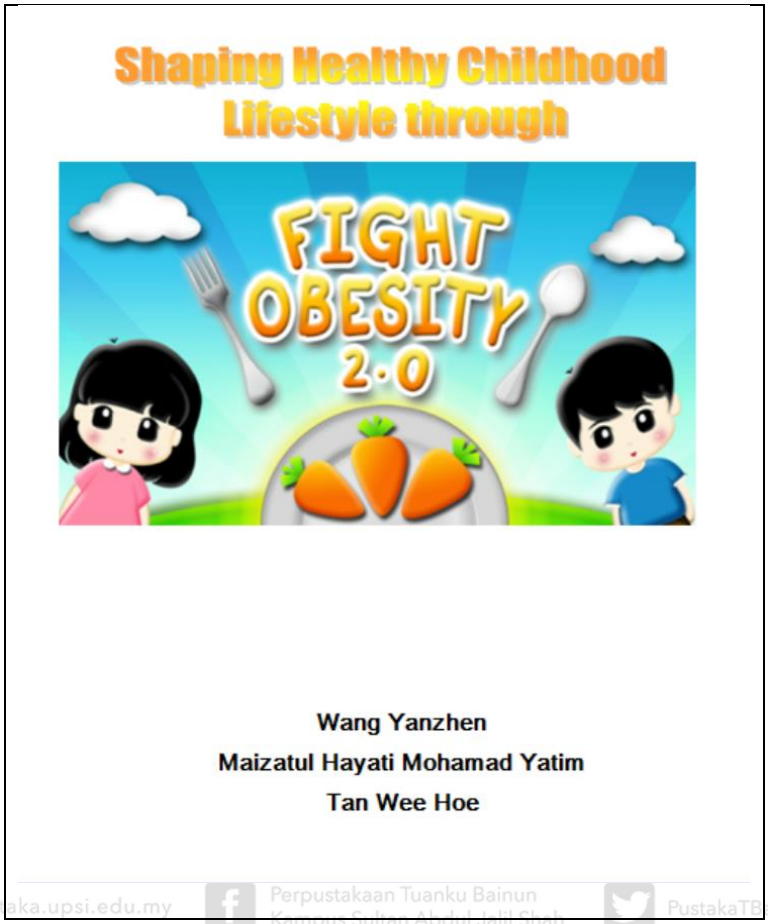


Figure 4.45. The Module of *Fight Obesity 2.0*

4.9.3.1 The Pre-game Playing Phase

Four research assistants were recruited and trained as facilitators in this study. All facilitators in this research played *Fight Obesity 2.0* in advanced, in order to estimate the duration of the whole game-based obesity prevention session. After playing the game, a pre-game playing phase was conducted by a facilitator in the form of a briefing. The duration of the briefing was around four minutes. Facilitators generally covered three matters in the briefing:

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i) explained causes and effects of childhood obesity.

ii) informed players the intended outcomes of the upcoming game playing session:

- knowing the relationship between body size and obesity
- knowing how to choose healthy food and drink
- knowing the relationship between physical exercise and obesity
- knowing the characteristics of healthy lifestyle
- knowing the consequences of obesity

iii) set rules for a specific playing session, informing what players can do and cannot do during game playing, such as taking turns to use a tablet or mobile device.

Facilitators rewarded players for being obedient or punish them accordingly for breaking the rules which had been stated explicitly to all players. If the game was related to prior knowledge which players supposed to have acquired in previous activities, facilitators briefed learners on how their prior knowledge could be applied in winning the game. Occasionally, they conducted a verbal quiz to stimulate recall of the knowledge, and then explained what kind or which portion of the prior knowledge was related to the game to be played.

4.9.3.2 The Game Playing Phase

The game playing session started after players pressing the "Play" button on the Main Menu. A typical game playing session ranged from 2 minutes 35 seconds (without

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watching virtual consultation animation) to 4 minutes and 55 seconds. Facilitators encouraged all players to play from the beginning until the end of *Fight Obesity 2.0*.

When players made a decision or took an action, in-game immediate feedbacks were given to them automatically to avoid interference of game flow. Off-game immediate feedback was provided by facilitators who physically watched specific player's play. These off-game feedbacks were constructive and positive, which meant to help scaffolding the player's completion of the game.

At the gender and body size setting menus, facilitators helped players in matching their gender and contrasting healthy body size, overweight body size and obese body size. Players were made aware that their choice of game character represented them in the game world.

Level 1 in *Fight Obesity 2.0* typically lasted for 15 seconds. Facilitators informed players the intended outcome, which was to feed the male or female game character of their choice with healthy food and drink. When players chose a type of food or drink, facilitators guided players to differentiate healthy diet and unhealthy diet. Facilitators picked a type of food or drink and explained why the choice was healthy or unhealthy for children. At the end of Level 1, facilitators asked players what they could do if they ended up being overweight or obese.

Level 2 typically lasted for 40 seconds. Facilitators informed players the intended outcome, which meant to keep a healthy body size through constant exercise.

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Facilitators connected the act of rapid tapping of skipping rope or hula hoop button to the need for constant exercise in order to maintain healthy body size. Facilitators encouraged players to try again if they failed in this level.

Level 3 typically lasted for 1 minute and 40 seconds. Facilitators informed players the intended outcome, which meant to understand the importance of doing exercise; the importance of right food choice and the importance of right drinks and drinking water. Facilitators explained the characteristics of healthy lifestyle in every question answered by players.

At the end of Level 3, players who made mistake when answering any question were given a chance to retry questions they answered incorrectly. If they chose not to retry those questions, they would be directed to watch a consultation animation on childhood obesity. A virtual doctor was featured in this animation, where he advised players about the consequences of childhood obesity. The duration of the animation was 1 minute and 40 seconds. When watching the virtual consultation animation, facilitators informed players the intended outcome and then echoed the consequences of childhood obesity.

4.9.3.3 The Post-game Playing Phase

Upon the completion of *Fight Obesity 2.0,* facilitators praised players for their in-game performance and for reaching the end of the game. A post-game playing phase was conducted by a facilitator in the form of a debriefing. The duration of the

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debriefing was enough for players to reflect and share their playing experience. The reflection and sharing focused on what players had learned in the game.

After that, facilitators guided players to relate overweight or obesity problem they faced in daily living to healthy lifestyle. Players were encouraged to explain characteristics of healthy lifestyle using their own words.

4.9.4 Usability Ratings

After playing *Fight Obesity 2.0*, individual playtesters were requested to fill in an online form that consists of 50 test items, covering five constructs of usability, i.e. likeability, efficiency, helpfulness, control, and learnability, in which each construct consists of ten items. The responses of testers were measured on a three-point ordinal scale: agree, undecided, or disagree.

The form was adapted from the Software Usability Measurement Inventory (SUMI) developed by Kirakowski and Corbett (1993). The adaptation was merely changing "software" into "game". A copy of the adapted instrument is attached as Appendix K.

There are 19 positive items and 31 negative items in the instrument, in which *Fight Obesity 2.0* gained 16 modes on "Agree" in positive items and 24 modes on

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"Disagree" in negative items. In other words, the overall usability result was 80% (40 out of 50 items), as shown in Table 4.20.

Table 4.20

Frequency of Modes Attained by Fight Obesity 2.0 in the Playtesting

		Disagreed	Undecided	Agreed	Scored items	
					Sub	Total
Likeability	5 positive Items	0	1	4	4	8
	5 negative items	4	0	1	4	10
Efficiency	6 positive Items	0	1	5	5	8
	4 negative items	3	1	0	3	10
Helpfulness	5 positive Items	0	1	4	4	7
	5 negative items	3	1	1	3	10
Control	3 positive Items	0	0	3	3	8
	7 negative items	5	0	2	5	10
Learnability	10 negative items	9	0	1	9	9
						10
Positive items (n = 19)		0	3	16		40
Negative items (n = 31)		24	2	5		50

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Further analysis on individual constructs was done by assigning one score to every agreed positive item and every disagreed negative item. In total, testers gave 433 scores for 19 positive items and 608 scores for 31 negative items, summing up to 1041 total scores (see Table 4.22). On average, *Fight Obesity 2.0* received 27.39 out of 50 scores in the playtesting. Table 4.22 summarized scores given to the game. The game received more than 50% scores in efficiency (61%), helpfulness (52%) and learnability (64%). Its usability on likeability (49%) and control (48%) were slightly below 50% (see Figure 4.46). The results of specific usability construct were organized into five sections, in which collected data were analysed using Microsoft Excel and IBM SPSS to indicate the frequency, mode, and median on every test item.

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Table 4.21

Summary of Scores Given to Fight Obesity 2.0

		Disagreed		Undecided		Agreed		Score	
		f	Score	f	Score	f	Score	Sub	Total
Positive items (n = 19)		122	0	167	0	433	1	433	1041
Negative items (n = 31)		608	1	204	0	366	0	608	1900
Likeability	5 positive Items	46	0	56	0	88	1	88	185
	5 negative items	97	1	50	0	43	0	97	380
Efficiency	6 positive Items	28	0	40	0	160	1	160	231
	4 negative items	71	1	41	0	40	0	71	380
Helpfulness	5 positive Items	20	0	52	0	118	1	118	197
	5 negative items	79	1	67	0	44	0	79	380
Control	3 positive Items	23	0	24	0	67	1	67	184
	7 negative items	117	1	67	0	82	0	117	380
Learnability	10 negative items	244	1	80	0	56	0	244	244
									380

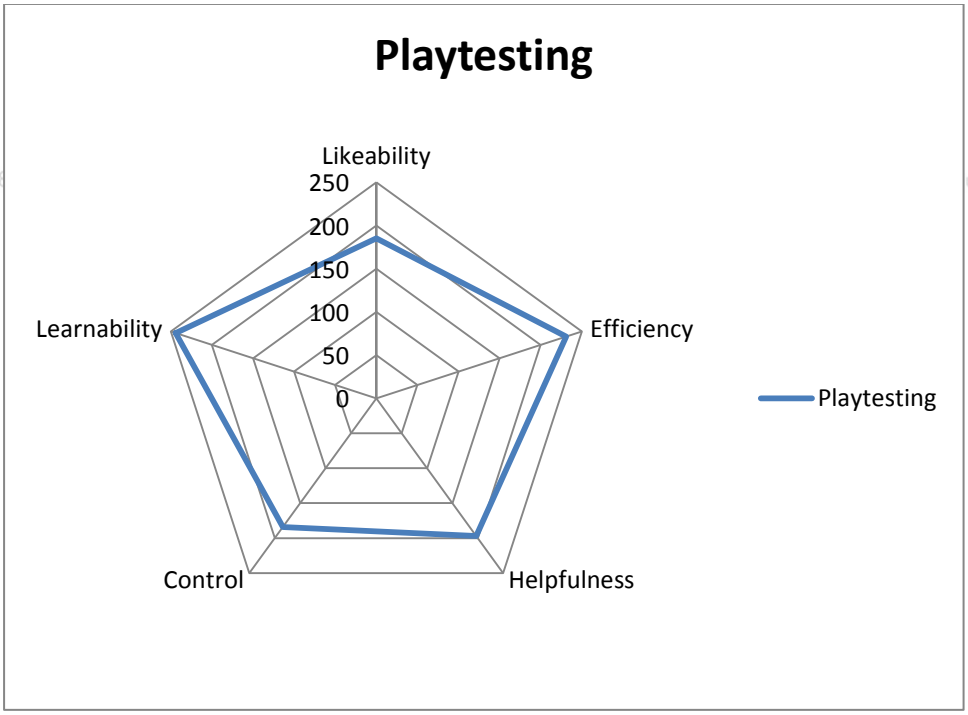


Figure 4.46. The Overall Usability Performance of *Fight Obesity 2.0*

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4.9.4.1 Likeability of *Fight Obesity 2.0*

Likeability or affect towards *Fight Obesity 2.0* measured the testers' general emotional reaction to the game (Kirakowski & Corbett, 1993). Eight of the ten items related to likeability showed positive outcomes. Testers agreed with four positive items and disagreed with four negative items (see Table 4.23).

Most of them did not feel headache (Mode = Disagree), frustrating (Mode = Disagree) or tense (Mode = Disagree) when playing the game. Nearly half of the testers enjoyed their sessions with *Fight Obesity 2.0* (Mode = Agree) and regarded playing the game as a satisfying experience (Mode = Agree).

However, the testers were unsure whether they would recommend the game to their peers or not (Mode = Undecided) because the game was actually not designed for the testers. They were also unsure whether *Fight Obesity 2.0* was inconsistent or not (Mode = Disagree & Undecided). The majority of the testers would not like to use the game every day, probably because the game was too short (ranging from 2:50 to 5:00 per play session), and it was not meant for their age level. Therefore, the design of *Fight Obesity 2.0* should focus on enhancing its replay-ability and stickiness in order to make targeted players keep coming back to it.

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Table 4.22

Testers' Perception on Likeability of Fight Obesity 2.0 (D: Disagree; U: Undecided; A: Agree; N: Sample Size)

Item		**Perception**			**Mode**	**N**
		D	**U**	**A**		
Positive	I would recommend *Fight Obesity 2.0* to my peers	9	17	12	U	38
	I enjoy my sessions with *Fight Obesity 2.0*.	9	12	17	A	38
	Playing with *Fight Obesity 2.0* is satisfying.	12	11	15	A	38
	Playing with *Fight Obesity 2.0* is mentally stimulating.	9	9	20	A	38
	Fight Obesity 2.0 has a very attractive presentation.	7	7	24	A	38
Negative	I would not like to use *Fight Obesity 2.0* every day.	7	7	24	A	38
	I think *Fight Obesity 2.0* is inconsistent.	15	15	8	D & U	38
	I think *Fight Obesity 2.0* has made me have a headache on occasion.	25	9	4	D	38
	Playing *Fight Obesity 2.0* is frustrating.	23	11	4	D	38
	There have been times in playing *Fight Obesity 2.0* when I have felt quite tense.	27	8	3	D	38

4.9.3.2 Efficiency of *Fight Obesity 2.0*

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When *Fight Obesity 2.0* was playtested, the efficiency construct measured the degree to which testers felt that the game assisted them in understanding childhood obesity and was related to concept of transparency (Kirakowski & Corbett, 1993). Three aspects of *Fight Obesity 2.0* were tested, i.e. speed, ease of use, and visual organization.

As a whole, six out of ten items yielded positive outcomes in the efficiency construct (see Table 4.24). Testers agreed with five positive items and disagreed with one negative item. Most of the testers agreed that the speed of *Fight Obesity 2.0* was fast enough (Mode = Agree), affording task to be performed in a straightforward manner (Mode = Agree). The organisation of the menus seems quite logical (Mode =

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Agree), in which options at each stage can be seen at a glance easily at each game level (Mode = Agree). Also, the way information was presented in a clear and understandable manner. Most of the testers disagreed that the game responded too slowly to inputs (Mode = Disagree). However, since testers were using emulator rather than tablet or smart phone to play test *Fight Obesity 2.0*, delay responses were possible, causing certain testers to agree with this item. Most of the testers disagreed that it was difficult to get data in and out of the game or not (Mode = Disagree), but no data files can be get in or out of the game actually, and this may be why some testers agreed or undecided on this item.

Testers were not sure whether it was easy to restart the game or not if it stopped (Mode = Undecided). None of the 38 screencast videos captured in this playtesting sessions crushed or required testers to restart, so it made sense for them to be undecided on this item.

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Table 4.23

Testers' Perception on Efficiency of Fight Obesity 2.0

	Item	Perception			Mode	N
		D	U	A		
Positive	The speed of *Fight Obesity 2.0* is fast enough.	13	5	20	A	38
	Tasks can be performed in a straightforward manner using *Fight Obesity 2.0*.	3	9	26	A	38
	The organisation of the menus or information lists seems quite logical.	3	2	33	A	38
	The way that system information is presented is clear and understandable.	2	1	35	A	38
	It is easy to see at a glance what the options are at each stage.	1	4	33	A	38
	Fight Obesity 2.0 allows the player to be economic of keystrokes.	6	19	13	U	38
Negative	If *Fight Obesity 2.0* stops, it is not easy to restart it.	12	18	8	U	38
	Fight Obesity 2.0 responds too slowly to inputs.	17	9	12	D	38
	There are too many steps required to get something to work.	25	7	6	D	38
	Getting data files in and out of the game is not easy.	17	7	14	D	38

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4.9.4.3 Helpfulness of *Fight Obesity 2.0*

In the playtesting, helpfulness measured the degree to which *Fight Obesity 2.0* was self-explanatory, as well as more specific things like the adequacy of help facilities and documentation (Kirakowski & Corbett, 1993).

In terms of helpfulness, half of the items under this construct generated positive outcomes in the playtesting (see Table 4.25). Testers agreed with four positive items and disagreed with one negative item. Testers generally agreed that instructions and prompts in the game were helpful (Mode = Agree). To them, *Fight Obesity 2.0* documentation was very informative (Mode = Agree), and testers can understand and act on the information (Mode = Agree). It was obvious that the needs

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of players had been fully taken into consideration (Mode = Agree), and they disagreed that there was too much to read before they can play the game (Mode = Disagree). Half of the testers disagreed that the help information given by the game, particularly at the beginning of every game level was not useful (Mode = Disagree).

Although most of the testers (15 out of 38) disagreed that there was never enough information on the screen when it was needed, more than half testers were either disagreed or undecided on this proposition. Most of them were unsure whether error prevention messages were adequate or not (Mode = Undecided). Therefore, more formative feedback would be needed to assure players on this matter. Nonetheless, testers were uncertain whether or not the game has helped them overcome any problems they had in playing it (Mode = Undecided). A screencast video captured by T12 actually echoed this finding, in which he made a mistake when starting to play Level 1.

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Table 4.24

Testers' Perception on Helpfulness of Fight Obesity 2.0

	Item	Perception			Mode	N
		D	U	A		
Positive	The instructions and prompts are helpful.	2	9	27	A	38
	Fight Obesity 2.0 documentation is very informative.	3	13	22	A	38
	I can understand and act on the information provided by *Fight Obesity 2.0*.	1	3	34	A	38
	Fight Obesity 2.0 has helped me overcome any problems I have had in playing it.	9	16	13	U	38
	It is obvious that user needs have been fully taken into consideration.	5	11	22	A	38
Negative	I find that the help information given by *Fight Obesity 2.0* is not very useful.	19	15	4	D	38
	There is never enough information on the screen when it's needed.	15	11	12	D	38
	There is too much to read before you can play *Fight Obesity 2.0*.	29	3	6	D	38
	Error prevention messages are not adequate.	13	21	4	U	38
	Either the amount or quality of the help information varies across the system.	3	17	18	A	38

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4.9.4.4 Control of *Fight Obesity 2.0*

In the playtesting, the control construct measured to what extent testers felt in control of *Fight Obesity 2.0*, as opposed to being controlled by the game when playing a specific game level. As shown in Table 4.26, most of the testers felt in command when playing the game (Mode = Agree), where it was relatively easy to move from one part of a task to another (Mode = Agree) and make the game do exactly what they want (Mode = Agree).

Testers disagreed that the game stopped unexpectedly sometimes (Mode = Disagree), had not always done what they were expecting (Mode = Disagree), or disrupted the way they normally like to play game (Mode = Disagree). They also

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disagreed that sometimes they did not know what to do next (Mode = Disagree) or wonder if they were using the right command (Mode = Disagree).

However, testers agreed that they felt safer if they used only a few familiar commands or operations (Mode = Agree), and preferred to stick to the facilities they knew best (Mode = Agree). Actually, it was on purpose since *Fight Obesity 2.0* was designed specifically for preschool children, the only command needed to master was tapping on the screen. There were maximum two tap-able buttons on any screen of the game.

Table 4.25

Testers' Perception on Control of Fight Obesity 2.0

	Item	Perception			Mode	N
		D	U	A		
Positive	I feel in command of *Fight Obesity 2.0* when I am using it.	6	12	20	A	38
	It is easy to make *Fight Obesity 2.0* do exactly what you want.	12	8	18	A	38
	It is relatively easy to move from one part of a task to another.	5	4	29	A	38
Negative	*Fight Obesity 2.0* has at some time stopped unexpectedly.	24	11	3	D	38
	Fight Obesity 2.0 hasn't always done what I was expecting.	21	13	4	D	38
	Fight Obesity 2.0 seems to disrupt the way I normally like to play game.	16	13	9	D	38
	I sometimes don't know what to do next with *Fight Obesity 2.0*.	25	4	9	D	38
	I sometimes wonder if I'm using the right command.	21	7	10	D	38
	I feel safer if I use only a few familiar commands or operations.	6	11	21	A	38
	I prefer to stick to the facilities that I know best.	4	8	26	A	38

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4.9.4.5 Learnability of *Fight Obesity 2.0*

When *Fight Obesity 2.0* was tested, the learnability construct measured the speed and facility with which testers felt that they had been able to master the game, or to learn how to use new features when necessary. As shown in Table 4.27, most of the testers disagreed with nine negative items under the learnability construct. The only negative item they agreed was that *Fight Obesity 2.0* was awkward when they wanted to do something not standard (Mode = Agree). The game was actually designed to stop preschool players from doing something that is non-standard. In general, as long as players follow instruction, the testers would not find *Fight Obesity 2.0* awkward (Mode = Disagree).

In general, learning to operate *Fight Obesity 2.0* initially was not full of problem (Mode = Disagree), especially when learning how to use new functions (Mode = Disagree). Testers did not take too long to learn all commands (Mode = Disagree), and they did not think that it was easy to forget how to do things with the game (Mode = Disagree). The game did not occasionally behaved in a way which cannot be understood (Mode = Disagree). Consistent with findings on screencast videos, none of the testers went back to look at guides (Mode = Disagree) or look for assistance most times when playing *Fight Obesity 2.0* (Mode = Disagree). Most of them disagreed that they would never learn to use all that was offered in the game (Mode = Disagree).

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Table 4.26

Testers' Perception on Learnability of Fight Obesity 2.0

Item	Perception			Mode	N
	D	U	A		
Learning to operate *Fight Obesity 2.0* initially is full of problems.	23	13	2	D	38
Learning how to use new functions is difficult.	21	6	11	D	38
It takes too long to learn the *Fight Obesity 2.0* commands.	33	5	0	D	38
It is easy to forget how to do things with *Fight Obesity 2.0*.	25	9	4	D	38
Fight Obesity 2.0 is awkward when I want to do something which is not standard.	13	11	14	A	38
Fight Obesity 2.0 occasionally behaves in a way which can't be understood.	29	6	3	D	38
Fight Obesity 2.0 is really very awkward.	17	11	10	D	38
I keep having to go back to look at the guides.	32	2	4	D	38
I will never learn to use all that is offered in *Fight Obesity 2.0*.	17	14	7	D	38
I have to look for assistance most times when I play *Fight Obesity 2.0*.	34	3	1	D	38

4.10 Findings of Semi-structured Interview with Pediatricians

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An information sheet (Appendix R) and a consent form (Appendix J) were prepared for inviting volunteering pediatricians to respond to this study. Two pediatricians accepted the invitation, in which one of them was a Malaysian Chinese male doctor, Dr LKF, and another was a female Chinese doctor from Mainland China, Dr LZY.

After accepting the invitation, both of the pediatricians were directed to visit the *Fight Obesity 2.0* website, in order to examine paratextual materials prepared for the mobile game. They were also led to watch the game trailer which gave them an overview of childhood obesity prevention features embedded in the mobile game. Next, they were guided to download, install and play the game themselves on their personal smart phones which run on Android operating system. Upon the completion

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of the play session, an appointment was set with them individually for an online interview session. The purpose of the interview was to validate the use of *Fight Obesity 2.0* mobile game in healthcare practices, and also to confirm the ecological validity of the game-based childhood obesity prevention framework.

In general, both of the pediatricians were having interests in the use of serious games in childhood obesity treatment and prevention. The following sub-sections present the specific accounts of their views on the *Fight Obesity 2.0* mobile game and the framework of game-based childhood obesity prevention .

4.10.1 Interview with a Pediatrician in China

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The first interviewee, Dr LZY is a female pediatrician working at the Child Healthcare Specialist Clinic in Ningbo Women and Children's Hospital. The hospital is a tertiary specialized hospital for women and children, which offers medical treatment, health care, teaching, scientific research, disease prevention, first aid and rehabilitation (Ningbo Women and Children's Hospital, 2016). It was established in 1975 and as of January 2017, it has 2010 staff members, including 328 medical and nursing specialists.

After completing a Master's degree in pediatrics, Dr LZY joined the hospital six years ago. She had chosen to be a pediatrician because she loved children. At the beginning of her career in Ningbo Women and Children's Hospital, she was rotated to

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serve every clinic under the pediatrics department. After getting hold of knowledge and experiences from every clinic, she was assigned to work as a specialist in the Child Healthcare Clinic.

Dr LZY was keen to share her thought related to the game-based childhood obesity framework. Since Google Play Store was not accessible in the Mainland China, a link to download the 69.5 MB Android Application Package (APK) file of the *Fight Obesity 2.0* mobile game was sent to her privately. She played the game, watched the game trailer, and browsed through the *Fight Obesity 2.0* website before the interview session. The online interview session with Dr LZY was held on 5 January 2017, in which she answered six interview questions and then she was asked to justify her answers one-by-one.

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Dr LZY believed that the use of *Fight Obesity 2.0* as a childhood obesity prevention strategy is a good and fun way to teach children what is healthy food. However, she was afraid that children might lose their interest in the game very soon. In other words, the re-playability of *Fight Obesity 2.0* ought to be enhanced to make targeted players keep coming back to the game. Also, having the knowledge and conception is one thing, but whether the targeted preschool children actually practice what they knew about healthy food preferences or not is another matter. According to Dr LZY, game features which require players to follow healthy food diet were missing in *Fight Obesity 2.0*, and this made her unsure about the effectiveness of the game in preventing childhood obesity. “Children choose their food based on their

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taste, not on the healthy facts they knew", she explained. Similar conditions would apply to adults, whom obviously knew what is healthy lifestyle but do not follow it.

Nonetheless, based on the professional knowledge and experience of working in the Child Healthcare Clinic, Dr LZY agreed that the content knowledge on childhood obesity prevention incorporated in the *Fight Obesity 2.0* mobile was accurate.

When she was asked whether the childhood obesity prevention strategy in *Fight Obesity 2.0* would be practical in Malaysia or not, she answered, "I am in China, so I don't know the situation in Malaysia." Her genuine answer on this matter revealed that despite facing the same childhood obesity problems, pediatricians from different countries would not know whether a prevention strategy is practical or not unless they actually know the context where preschool children grow up. The game-based obesity prevention proposed in this research could only be feasible after teachers, caretakers or doctors get hold of information associated to the contexts where specific child lives and grows up.

Next, Dr LZY was asked when and where a game like *Fight Obesity 2.0* can be used to prevent childhood obesity. She proposed that "it" could be used bat home or at school, before eating time or when the children request for unhealthy food". In other words, she saw serious games like *Fight Obesity 2.0* as yardstick, in which children could refer to its contents and got themselves influenced on what should be eaten and what should not be eaten for healthy lifestyle.

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Based on the demand for cognition and psychomotor skills upon the game contents, Dr LZY would recommend children aged from three to seven years old to use games like *Fight Obesity 2.0* as a part of their daily entertainment activity.

4.10.2 Interview with a Malaysian Pediatrician

The second interviewee, Dr LKF was a male pediatrician working at the Specialist Pediatric Clinic in Hospital Tuanku Ja'afar Seremban, Negeri Sembilan. He started his career in the field of medicine by pursuing a medical degree at the Universiti Sains Malaysia. After that, Dr LKF had his housemanship at the Hospital Tuanku Ampuan Najihah in Kuala Pilah, Negeri Sembilan, from September 2007 to September 2008. Upon the completion of the housemanship programme, he was appointed as a pediatric medical officer at the same hospital, and served for three years. In year 2010, he received the Excellence Service Award from the Ministry of Health.

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In year 2011, Dr LKF began to purse a Master's degree in medicine, specializing in pediatrics under Universiti Malaya. He managed to complete the postgraduate study on part-time basis successfully in year 2015. While pursuing his Master's study in Universiti Malaya, Dr LKF applied to transfer his service from Kuala Pilah to Seremban. With the approval of transfer, he served at the Specialist Pediatric Clinic in Hospital Tuanku Ja'afar Seremban (HTJS) ever since. To date, the HTJS is the largest public hospital funded by the Malaysia Ministry of Health in the state of Negeri Sembilan. It was opened as Seremban General Hospital to serve the

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public in year 1972. The hospital was renamed as Tuanku Ja'afar Hospital on 27 July 2006 (Seremban Municipal Council, 2016).

Getting a time slot to interview medical professionals in a Malaysian government hospital was indeed quite difficult due to their busy and packed work schedule. Nonetheless, an online interview session with Dr LKF was carried out on 11 January 2017, after being rescheduled for several times. Dr LKF was very keen in exploiting the potential and practicality of *Fight Obesity 2.0* mobile game. He actually let his four-year-old son played the game on his mobile phone a day before the interview session. After observing how his son got through all three levels of the game, he tried playing the game once himself, before answering interview questions sent to him on 26 December 2016.

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Dr LKF regarded the use of *Fight Obesity 2.0* as a childhood obesity prevention strategy as a good initiative. However, he insisted that a parent, either the father or the mother, would be needed to play the game together with preschool children.

Next, Dr LKF was informed that *Fight Obesity 2.0* was purposely created for preschool children to learn the following three things:

- To differentiate healthy food and unhealthy food,
- To understand the relationship between healthy lifestyle and obesity, and
- To the danger of overweight and childhood obesity.

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After matching the intended outcomes and the features shown in three game levels, Dr LKF agreed that the content knowledge on childhood obesity prevention incorporated in the *Fight Obesity 2.0* mobile was accurate. He further justified that, "diet and exercise are the main things for prevention of obesity." He also agreed that the childhood obesity prevention strategy in the *Fight Obesity 2.0* mobile game was effective. Again, he stressed that the involvement of parent(s) would be essential to make the prevention strategy effective.

He believed that the childhood obesity prevention strategy in *Fight Obesity 2.0* would be practical in Malaysia. He explained, "I found out that majority of childhood obesity, their parent (is) also obese". The prevention strategy would be practical if the parent lead the child. "In clinic, we found the obese child very difficult to reduce weight", he added. In fact, parents play important roles which affect their children' body size.

When Dr LKF was asked when and where a game like *Fight Obesity 2.0* can be used to prevent childhood obesity, he suggested that it "can be used before ordering food". In his opinion, both parents and children may use a game like *Fight Obesity 2.0* to prevent childhood obesity. In practice, the game should emphasize on the bad things or the danger of obesity on both adulthood and childhood. At the end of the interview session, Dr LKF highlighted once again, "Parents need to involve!"

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4.11 Summary

Fight Obesity 2.0 is an educational mobile app dedicated to teach preschool children the importance of maintaining a healthy diet and lifestyle. *Fight Obesity 2.0* is created using researched information on obesity, and it is explored by allowing preschool children to interact with the app in a fashion similar to a mobile game. This novelty of *Fight Obesity 2.0* has been enriched by game-based treatment framework drawn from an empirical study.

The semi-structured interview sessions with pedestrians verified the accuracy of content knowledge on childhood obesity prevention contained in *Fight Obesity 2.0*. However, a game-based obesity prevention could only be feasible and effective after teachers, caretakers or doctors get hold of information associated to the contexts where specific child lives and grows up. In particular, the success of game-based obesity prevention would require parents to get involved.

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CHAPTER 5

FINDINGS

5.1 Introduction

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This chapter aims to achieve three objectives of this research. In particular, it examined the food preference, the conception on the relationship between obesity and healthy lifestyle, and the conception on the danger of obesity among preschool children. Derived from the three hypotheses explained in Section 1.5, twenty subsidiary hypotheses were formulated and tested through a nonequivalent control group pre-test / post-test quasi-experiment. This was followed by a one-week non-participant observation, carried out with 14 selection children to triangulate the findings revealed through the quasi-experiment. The kindergarten supervisor and two pediatricians were interviewed to assure the trustworthiness of the findings, which in turn validated the effects of the game-based childhood obesity prevention framework.

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5.2 Findings of the Quasi-experiment

The aim of the nonequivalent control group pre-test / post-test quasi-experiment was to test three null hypotheses set in this research. The quasi-experiment was conducted from 14 June 2016 to 19 July 2016 with 60 preschool children at Tadika NCDRC, UPSI. The data collected from this quasi-experiment was included in this thesis as Appendix L.

5.2.1 Demographic Profiles of Research Participants

The quasi-experiment was carried out with 60 children at Tadika NCDRC, UPSI. Table 5.1 shows the demographic profile of the children. The average weight of the children was 16.535kg, in which the average weight for male children was 16.315kg while the average weight of female children was 16.804kg. As for the height, the average height of the children was 108.933cm, in which the average height for male children was 108.849cm while the average height of female children was 109.037cm.

No significant differences were found between the control group (mean weight = 17.04kg, Std. Deviation = 4.1525; mean height = 109.77cm, Std. Deviation = 5.374) and the experimental group (mean weight = 16.03kg, Std. Deviation = 2.4928; mean height = 108.10cm, Std. Deviation = 5.732) of the children (Weight: $p < .259$; Height: $p < .250$). In a word, the physical profile of samples between the control group and the experimental group was similar when they involved in this research on 14 June 2016.

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Table 5.1

Demographic Profile of Sixty Preschool Children

Gender		**Male**	**Female**	**Total**
		33	**27**	**60**
Age	5	18	15	33
	6	15	12	27
Ethnicity	Malay	33	26	59
	Chinese	0	1	1
Weight (kg)	12.0 – 12.9	0	1	1
	13.0 – 13.9	5	2	7
	14.0 – 14.9	7	2	9
	15.0 – 15.9	5	7	12
	16.0 – 16.9	3	7	10
	17.0 – 17.9	6	3	9
	18.0 – 18.9	1	0	1
	19.0 – 19.9	3	1	4
	20.0 – 20.9	0	2	2
	21.0 – 21.9	1	0	1
	22.0 – 22.9	0	0	0
	23.0 – 23.9	1	1	2
	24.0 – 24.9	1	0	1
	> 25.0	0	1	1
Height (cm)	96-100	2	2	4
	101-105	8	3	11
	106-110	10	11	21
	111-115	9	8	17
	116-120	3	3	6
	121	1	0	1
BMI	Underweight	11	10	21
	Healthy weight	21	16	37
	Overweight	1	0	1
	Obese	0	1	1

The BMI of individual children was calculated using the standard formula proposed by Adolphe Quetelet in the 1900's, as shown in Figure 5.1.

Bodyweight in kilograms divided by height in meters squared or

BMI = xKG /(yM*yM) where x = bodyweight in KG and y = height in M.

Figure 5.1. Standard Formula for Calculating BMI of Individual Children

As stated by the World Health Organization, different BMI ranges have been set for boys and girls when determining whether they are underweight, healthy, overweight or obese (WHO, 2007). Two charts were included in this thesis for

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references, one for boys (see Appendix M) and another for girls (see Appendix N). Based on these charts, the BMI ranges for Year-Five and Year-Six children were extracted and presented as Table 5.2. Although the majority of the children were healthy (37 out of 60), more than one third or 21 children were found underweight. Only one male child was overweight while one female child was obese.

Table 5.2

Comparison of Body Size Based on BMI

Body size	**Age**	**Boy**		**Girl**		**Subtotal**	**Total**
		BMI	***f***	**BMI**	***f***		
Underweight	5 years old	< 13.00	6	< 12.75	3	9	21
	6 years old	< 13.00	5	< 13.75	7	12	
Healthy weight	5 years old	13.00 – 16.75	12	12.75 – 17.00	12	24	37
	6 years old	13.00 – 16.75	9	13.75 – 17.00	4	13	
Overweight	5 years old	16.75 – 18.25	0	17.00 – 18.95	0	0	1
	6 years old	16.75 – 18.5	1	17.00 – 19.25	0	1	
Obese	5 years old	> 18.25	0	> 18.95	0	0	1
	6 years old	> 18.50	0	> 19.25	1	1	

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5.2.2 Sample Characteristics

A normality test using SPSS was conducted to check whether the scores of pre-test collected in the quasi-experiment was normally distributed or not for both the control group and the experimental group. The null hypothesis for this test of normality was that the data were normally distributed in both control and experimental groups. Three numerical and visual outputs generated from SPSS were examined to determine whether the scores of pre-test collected in the quasi-experiment was normally distributed or not for both the control group and the experimental group. First of all,

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the skewness and kurtosis z-values should be somewhere between -1.96 and +1.96. Next, the Shapiro-Wilk test p-value should be above 0.05. Then, the histograms, Normal Q-Q plots and Box plots should visually show the test scores were approximately normally distributed.

A Shapiro-Wilk's test ($p<.05$) (Shapiro & Wilk, 1965; Razali & Wah, 2011) and a visual inspection of their histograms (Figure 5.2), normal Q-Q plots (Figure 5.3) and box plots (Figure 5.4) indicated that while the pre-test scores of the control were from a normally distributed population, with a skewness of -0.127 (Standard Error = 0.427) and a kurtosis of -0.361 (Standard Error = 0.833) the pre-test scores of the experimental group were not from a normally distributed population, a skewness of 0.663 (Standard Error = 0.427) and a kurtosis of 0.674 (Standard Error = 0.833) (Cramer, 1998; Doane & Seward, 2011), as shown in Table 5.3. In conclusion, the null hypothesis was rejected and the data were not normally distributed in terms of skewness and kurtosis. Therefore non-parametric rather than parametric statistical tests were used to test the hypotheses formulated in this study, following the guidelines indicated by Siegel and Castellan (1988).

Table 5.3

Tests of Normality

Group	Skewness			Kurtosis			Shapiro-Wilk test		
	Statistic	Std. Error	z-value	Statistic	Std. Error	z-value	Statistic	df	Sig.
Control (N = 30)	.024	.427	.056	.116	.833	.139	.956	30	.250
Experimental (N = 30)	.663	.427	1.55	.674	.833	.809	.923	30	.032

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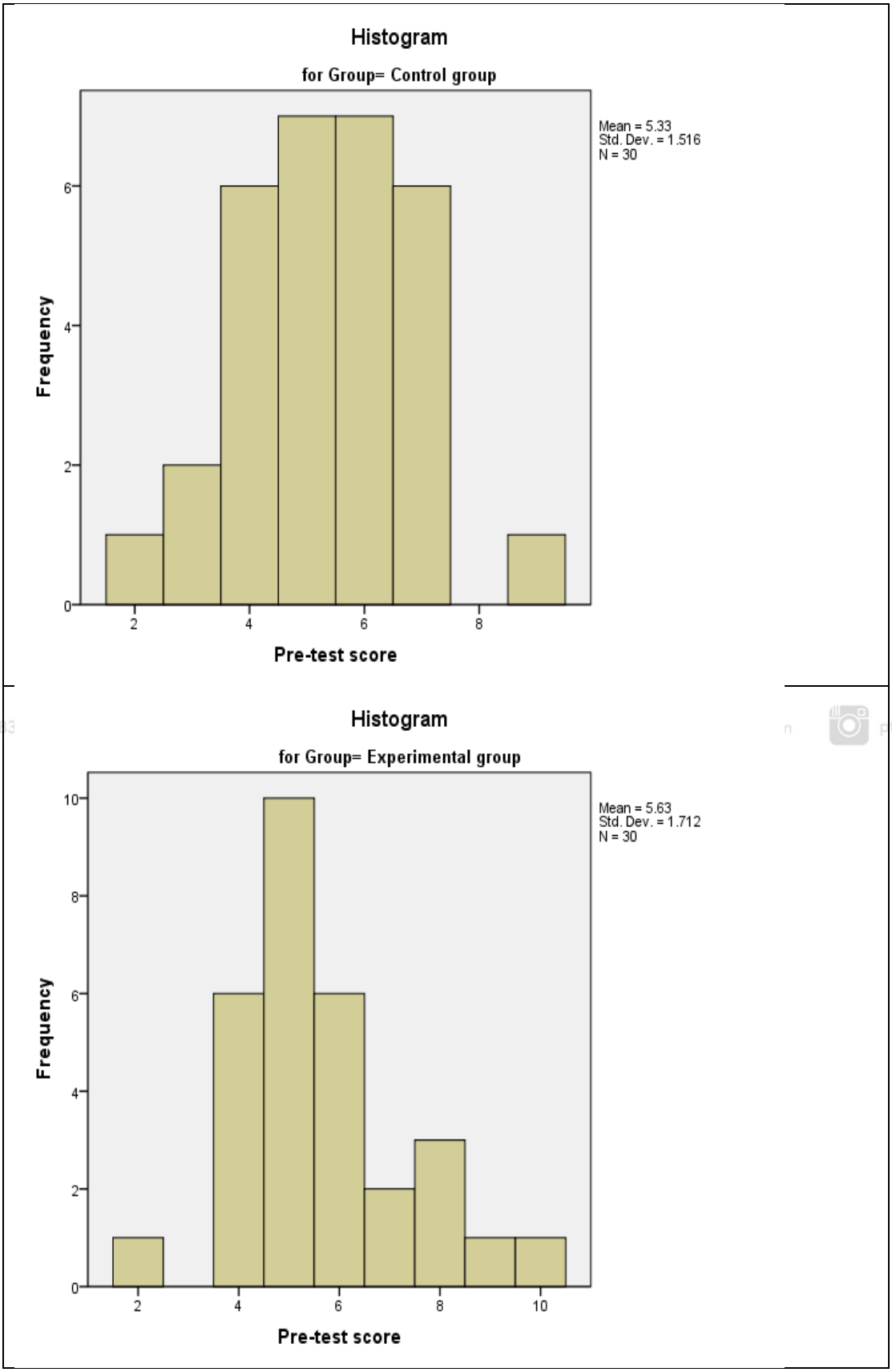


Figure 5.2. Histograms of Pre-test Scores

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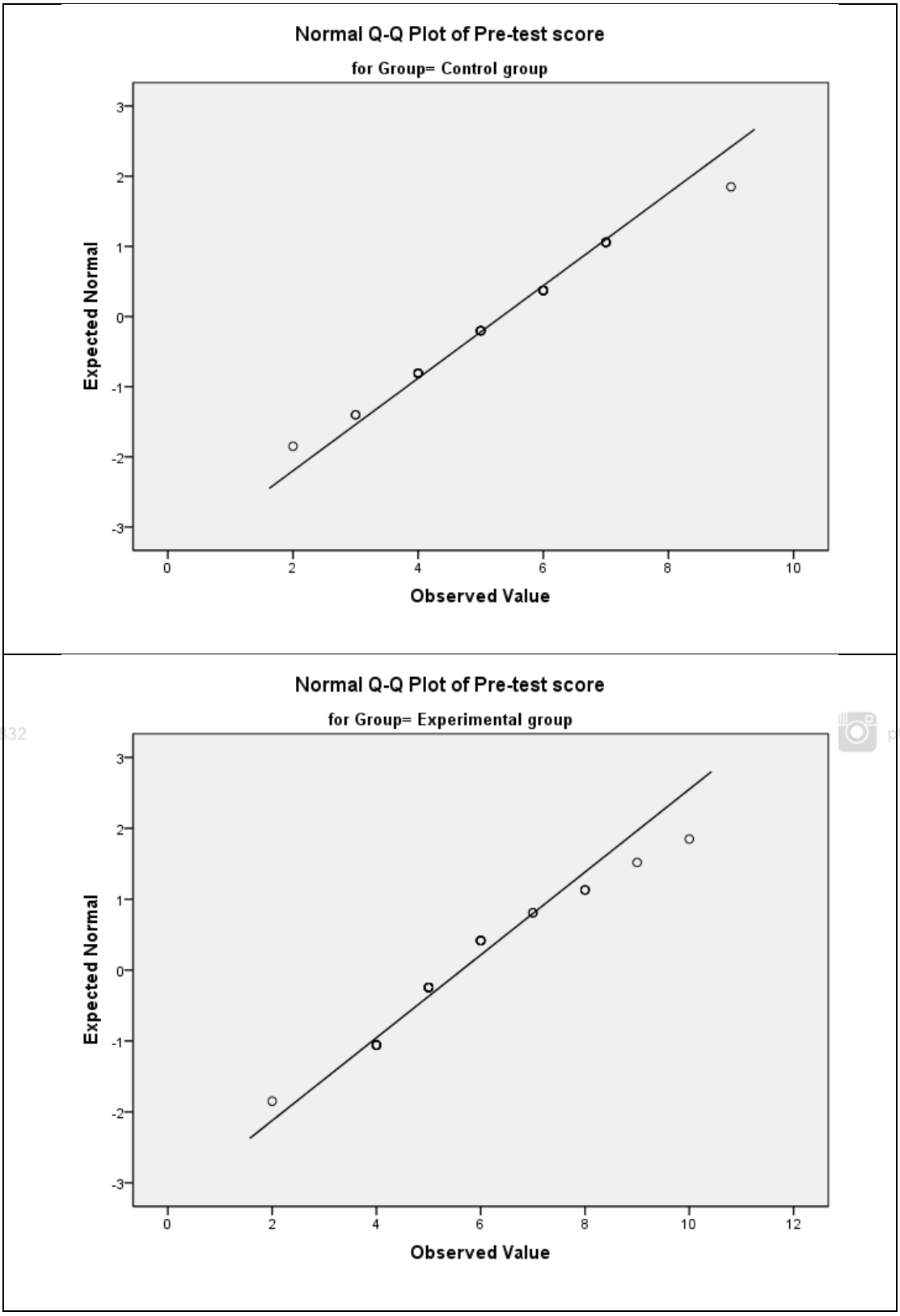


Figure 5.3. Normal Q-Q Plot of Pre-test Scores in the Pre-test and the Post-test

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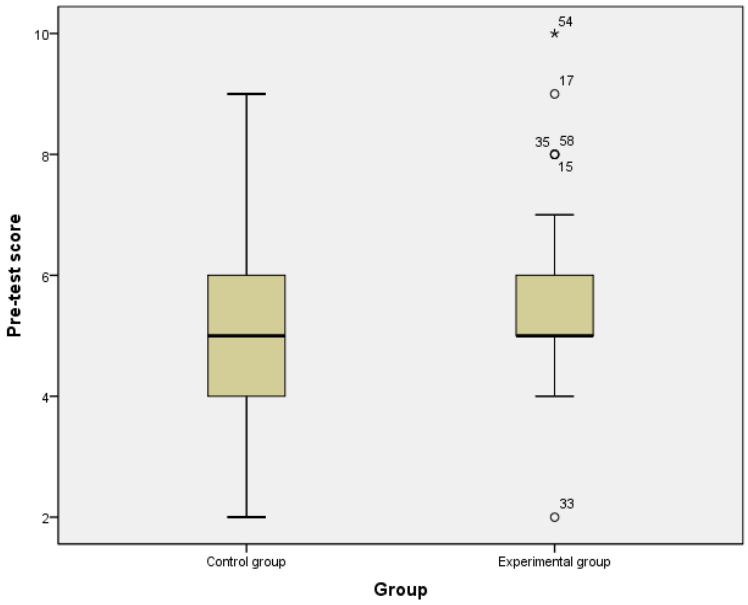


Figure 5.4. Comparison of Box Plots between the Experimental Group and the Control Group

Throughout the study, a comparison was made between the control group and the experimental group. The experimental group was the group that received exposure to game-based childhood obesity prevention, specifically through playing *Fight Obesity 2.0* once every Tuesday for 10 to 15 minutes, from 21 June 2016 to 19 July 2016 in Tadika NCDRC. The control group was controlled from not getting exposure to the game at all, within the same timeframe, at least in Tadika NCDRC. Wilcoxon Signed Rank tests were carried out to compare the children's performance in the pre-test on 14 June 2016 and the post-test on 19 July 2016. Two levels of performance comparison were made in this study. The first level compared the differences of performance of both the control group and the experimental group; while the second level compared the differences of performance within the control group and the experimental group. Four types of nonparametric techniques employed in this research were shown in Table 5.4.

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Table 5.4

Types of Nonparametric Statistical Analyses Conducted in the Quasi-experiment

Nonparametric techniques	**Analyses were carried out to identify…**
Shapiro-Wilk Test	…whether pre-test scores in both the control group and the experimental group were normally distributed on not.
Mann-Whitney U Test	…differences of pre-test scores and post-test scores between the control group and the experimental group.
	…gender differences of pre-test scores and post-test scores between the control group and the experimental groups
	…gender differences of pre-test scores and post-test scores in the control group
	…gender differences of pre-test scores and post-test scores in the experimental group.
	…age differences of pre-test scores and post-test scores between the control group and the experimental groups
	…age differences of pre-test scores within the control group and the experimental group.
	…age differences of post-test scores within the control group and the experimental group.
Wilcoxon Signed Rank Test	…differences between pre-test scores and post-test scores in the control group.
	…differences between pre-test scores and post-test scores in the experimental group.
McNemar Test	…differences of food preference in pre-test and post-test between the control group and the experimental group.
	…differences of food preference in pre-test and post-test between male and female children.
	…differences of food preference in pre-test and post-test between Year-Five and Year-Six children.

5.2.3 Overall Pre-test and Post-test Performance

The first part of the findings in the quasi-experiment was the overall comparison on the performance of the 60 children in the pre-test and the post-test. The findings were essential as the overall effects of the game-based childhood obesity prevention framework, and specifically the general effectiveness of *Fight Obesity 2.0* were revealed. Positive outcomes drawn from these findings would justify the edumetric reliability and validity of the game and the framework.

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5.2.3.1 Pre-test Scores Comparison between the Control Group and the Experimental Group

The overall mean pre-test score of the children who participated in the quasi-experiment was 5.48 (out of 11, Std. Deviation = 1.61), in which the minimum score was 2 and the maximum was 10. A Mann-Whitney U-Test was performed to examine whether there was a significant difference in the pre-test scores between the control group (Mean = 5.33, Std. Deviation = 1.516; Minimum = 2; Maximum = 9) and the experimental group (Mean = 5.63; Std. Deviation = 1.712; Minimum = 2; Maximum = 10). Since samples for each group were randomly assigned, there should be no significant difference between those groups in the pre-test scores, else any difference shown in the post-test scores would not be caused by the game-based obesity prevention, that was the exposure to playing *Fight Obesity 2.0*. The null and alternative hypotheses of the Mann-Whitney U-Test are shown in Figure 5.5.

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H_0: There was no significant difference between the ranks of the two groups.
H_1: There was a significant difference between the ranks of the two groups.

Figure 5.5. Null and Alternative Hypotheses for Testing the Difference between the Ranks of the Control Group and the Experimental Group in Pre-test

The alpha level was set as 0.05 and the Mann-Whitney U follows a Z distribution when the sample size is greater than twenty. Thus, 60 samples collected in this study met this requirement. In this sense, if Z is less than -1.96, or greater than 1.96, the null hypothesis would be rejected. Table 5.5 shows the results of the Mann-Whitney U test, in which $p > .05$, $Z = -.408$, so the null hypothesis was not rejected.

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In conclusion, there was no significant difference between of the two groups in terms of pre-test scores.

Table 5.5

Comparison of Pre-test Scores between the Control Group and the Experimental Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
Pre-test scores	Control group	30	29.60	888.00
	Experimental group	30	31.40	942.00
	Total	60		

Test Statistics[a]

	Pre-test scores
Mann-Whitney U	423.000
Wilcoxon W	888.000
Z	-.408
Asymp. Sig. (2-tailed)	.683

a. Grouping Variable: Group

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5.2.3.2 Post-test scores comparison between the control and the experimental group

The overall mean post-test score of the children who participated in the quasi-experiment was 6.35 (out of 11, Std. Deviation = 1.867), in which the minimum score was 3 and the maximum was 11. A Mann-Whitney U-Test was performed to examine whether there was a significant difference in the post-test scores between the control group (Mean = 5.77, Std. Deviation = 1.223; Minimum = 3; Maximum = 8) and the experimental group (Mean = 6.93; Std. Deviation = 2.212; Minimum = 4; Maximum = 11). Any significant difference shown in the post-test scores between the two groups would be caused by the game-based obesity prevention, which was the exposure to playing *Fight Obesity 2.0*. The null and alternative hypotheses of the Mann-Whitney U-Test are shown in Figure 5.6.

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H_0: There was no significant difference between the ranks of the two groups.
H_1: There was a significant difference between the ranks of the two groups.

Figure 5.6. Null and Alternative Hypotheses for Testing the Difference between the Ranks of the Control Group and the Experimental Group in Post-test

The same Alpha level ($\alpha = 0.05$) and the same decision rule mentioned in section 5.2.3 was set. Table 5.6 shows the results of the Mann-Whitney U test, in which p = .050, Z = -1.958, so the null hypothesis was rejected. In conclusion, there was a significant difference between of the two groups in terms of post-test scores. In other words, the exposure to *Fight Obesity 2.0* had improved the performance of children in the experimental group, in which the improvement was significant as compared to the performance of children in the control group. This conclusion was verified in Section 5.2.5, where a comparison was made between the pre-test scores and the post-test scores using Wilcoxon Signed Rank test.

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Table 5.6

Comparison of Post-test Scores between the Control Group and the Experimental Group

Ranks

	Group	N	Mean Rank	Sum of Ranks
Post-test scores	Control group	30	26.15	784.50
	Experimental group	30	34.85	1045.50
	Total	60		

Test Statistics[a]

	Post-test scores
Mann-Whitney U	319.500
Wilcoxon W	784.500
Z	-1.958
Asymp. Sig. (2-tailed)	.050

a. Grouping Variable: Group

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5.2.3.3 Performance comparison between the pre-test and the post-test

Wilcoxon Signed Rank tests were conducted to examine whether there was a significant difference on performance in two different timeframes: the pre-test on 14 June 2016 and the post-test on 19 July 2016. The Alpha level was set as 0.05. Two null hypotheses of the Wilcoxon Signed Rank Test are shown in Figure 5.7.

H_0: There was no significant difference between the pre-test scores and the post-test scores of the control group. H_0: There was no significant difference between the pre-test scores and the post-test scores of the experimental group.

Figure 5.7. Null Hypotheses for Testing the Difference between the Pre-test Scores and the Post-test Scores of the Control Group and the Experimental Group

Table 5.7 shows the results of the Mann-Whitney U test. No significant difference was found between the pre-test scores (Mean = 5.33, Std. Deviation = 1.516) and the post-test scores (Mean = 5.77, Std. Deviation = 1.223) of the control group ($p = .224$, $Z = -1.217$), so the first null hypothesis was not rejected. However, a significant difference was found between the pre-test scores (Mean = 5.63; Std. Deviation = 1.712) and the post-test scores (Mean = 6.93; Std. Deviation = 2.212) of the experimental group ($p < .003$, $Z = -3.000$), thus the second null hypothesis was rejected. In conclusion, the performance of children in the experimental group improved significantly after the game-based childhood obesity prevention, specifically through the use of *Fight Obesity 2.0*.

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Table 5.7

Comparison of Pre-test Scores and Post-test Scores

Ranks

		N	Mean Rank	Sum of Ranks
Control group Post-test score - Pre-test score	Negative Ranks	7[a]	14.07	98.50
	Positive Ranks	16[b]	11.09	177.50
	Ties	7[c]		
	Total	30		
Experimental group Post-test score - Pre-test score	Negative Ranks	8[a]	10.06	80.50
	Positive Ranks	21[b]	16.88	254.50
	Ties	1[c]		
	Total	30		

a. Post-test score < Pre-test score
b. Post-test score > Pre-test score
c. Post-test score = Pre-test score

Test Statistics[b]

	Control group Post-test score - Pre-test score	Experimental group Post-test score - Pre-test score
Z	-1.217[a]	-3.000[a]
Asymp. Sig. (2-tailed)	.224	.003

a. Based on negative ranks.
b. Wilcoxon Signed Ranks Test

5.2.3.4 Gender difference

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Table 5.8 shows the comparison of performance between male and female children in the pre-test and the post-test. In general, female children (pre-test mean = 5.68; post-test mean = 6.79) performed better than male children (pre-test mean = 5.31; post-test mean = 5.97) in both the pre-test and the post-test. However, Mann-Whitney U tests showed no significant gender differences in both the pre-test scores (p =.198) and the post-test scores (p =.077).

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Table 5.8

Comparison of Pre-test and Post-test Scores between Male and Female Children

Gender		Pre-test score	Post-test score
Female	Mean	5.68	6.79
	N	28	28
	Std. Deviation	1.679	1.931
Male	Mean	5.31	5.97
	N	32	32
	Std. Deviation	1.554	1.750
Total	Mean	5.48	6.35
	N	60	60
	Std. Deviation	1.610	1.867

Ranks

	Gender	N	Mean Rank	Sum of Ranks
Pre-test scores	Female	28	33.54	939.00
	Male	32	27.84	891.00
	Total	60		
Post-test scores	Female	28	34.70	971.50
	Male	32	26.83	858.50
	Total	60		

Test Statistics[a]

	Pre-test scores	Post-test scores
Mann-Whitney U	363.000	330.500
Wilcoxon W	891.000	858.500
Z	-1.288	-1.767
Asymp. Sig. (2-tailed)	.198	.077

a. Grouping Variable: Gender

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Further analyses on gender differences were carried out within the control group and also within the experimental group in terms of the pre-test scores and the post-test scores. Table 5.9 presents the outputs of Mann-Whitney U tests. No significant gender difference on the scores of pre-test (p = .949) and post-test (p = .781) was found in the control group. However, despite showing no significant gender difference on the pre-test scores (p = .053, Z = -1.936), a significant difference was found in the post-test scores between male (mean = 6.06) and female (mean = 8.08) children in the experimental group (p =.01, Z = -0.278). In conclusion, the exposure to *Fight Obesity 2.0* had results a significant gender difference in the experimental group, where female performed significantly better than male after

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playing *Fight Obesity 2.0*. This conclusion reinforced the findings revealed through Wilcoxon Signed Rank test in Section 5.2.5.

Table 5.9

Gender Differences of Pre-test Scores and Post-test Scores in the Control Group and the Experimental Group

Ranks

	Gender	N	Mean	Mean Rank	Sum of Ranks
Control group Pre-test scores	Female	15	5.20	15.40	231.00
	Male	15	5.47	15.60	234.00
	Total	30			
Control group Post-test scores	Female	15	5.67	15.07	226.00
	Male	15	5.87	15.93	239.00
	Total	30			
Experimental group Pre-test scores	Female	15	6.23	18.96	246.50
	Male	15	5.18	12.85	218.50
	Total	30			
Experimental group Post-test scores	Female	15	8.08	20.15	262.00
	Male	15	6.06	11.94	203.00
	Total	30			

Test Statistics[b]

	Control group		Experimental group	
	Pre-test score	Post-test score	Pre-test score	Post-test score
Mann-Whitney U	111.000	106.000	65.500	106.000
Wilcoxon W	231.000	226.000	218.500	226.000
Z	-.064	-.278	-1.936	-.278
Asymp. Sig. (2-tailed)	.949	.781	.053	.010
Exact Sig. [2*(1-tailed Sig.)]	.967[a]	.806[a]	.059[a]	.010[a]

a. Not corrected for ties.
b. Grouping Variable: Gender

5.2.3.5 Age Difference

Table 5.10 shows the comparison of performance between Year-Five and Year-Six children in the pre-test and the post-test. In general, Year-Five children (mean = 5.52) performed better than Year-Six children (mean = 5.44) in the pre-test; but in the post test, Year-Six children (mean = 6.78) performed better than Year-Five children (mean

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= 6.00). However, Mann-Whitney U tests showed no significant age differences in both the pre-test scores (p =.790) and the post-test scores (p =.105).

Table 5.10

Comparison of Pre-test and Post-test Scores Between Year-Five and Year-Six Children

Gender		Pre-test score	Post-test score
Year-Five	Mean	5.52	6.00
	N	33	33
	Std. Deviation	1.326	1.696
Year-Six	Mean	5.44	6.78
	N	27	27
	Std. Deviation	1.928	2.006
Total	Mean	5.48	6.35
	N	60	60
	Std. Deviation	1.610	1.867

Ranks

	Age	N	Mean Rank	Sum of Ranks
Pre-test scores	Year-Five	33	31.03	1024.00
	Year-Six	27	29.85	806.00
	Total	60		
Post-test scores	Year-Five	33	27.24	899.00
	Year-Six	27	34.48	931.00
	Total	60		

Test Statistics[a]

	Pre-test scores	Post-test scores
Mann-Whitney U	428.000	338.000
Wilcoxon W	806.000	899.000
Z	-.266	-1.621
Asymp. Sig. (2-tailed)	.790	.105

a. Grouping Variable: Age

Further analyses on age differences were carried out within the control group and also within the experimental group in terms of the pre-test scores and the post-test scores. Table 5.11 presents the outputs of Mann-Whitney U tests. No significant age difference on the scores of pre-test (p =.053) and post-test (p =.177) was found in the control group. Also, no significant age difference on the pre-test scores (p =.085) and post-test scores (p = .196) between Year-Five and Year-Six children in the experimental group. In conclusion, the significant difference on performance between

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pre-test scores and post-test scores found in the experimental group (see Section 5.2.5) was not caused by age differences.

Table 5.11

Age Differences of Pre-test Scores and Post-test Scores in the Control Group and the Experimental Group

Ranks

	Gender	N	Mean	Mean Rank	Sum of Ranks
Control group Pre-test scores	Year-Five	16	5.75	18.34	293.50
	Year-Six	14	4.86	12.25	171.50
	Total	30			
Control group Post-test scores	Year-Five	16	5.50	13.53	216.50
	Year-Six	14	6.07	17.75	248.50
	Total	30			
Experimental group Pre-test scores	Year-Five	17	5.29	13.15	223.50
	Year-Six	13	6.08	18.58	241.50
	Total	30			
Experimental group Post-test scores	Year-Five	17	6.47	13.71	233.00
	Year-Six	13	7.54	17.85	232.00
	Total	30			

Test Statistics[b]

	Control group		Experimental group	
	Pre-test score	Post-test score	Pre-test score	Post-test score
Mann-Whitney U	66.500	80.500	70.500	80.000
Wilcoxon W	171.500	216.500	223.500	233.000
Z	-1.931	-1.350	-1.721	-1.292
Asymp. Sig. (2-tailed)	.053	.177	.085	.196
Exact Sig. [2*(1-tailed Sig.)]	.058[a]	.193[a]	.094[a]	.213[a]

a. Not corrected for ties.
b. Grouping Variable: Age

5.2.4 Comparison on Food Preferences

In the quasi-experiment, the food preferences of the children were examined in the pre-test and the post-test. The examination was done using six questions set in the observation instrument discussed in Section 3.4.3.1. The first question was asking children what they want for breakfast, lunch, and dinner. Subsequently, two questions were asked to unfold their preferences for healthy food, specifically under the fruits and vegetables category. Then, three questions were asked to understand their

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preferences for unhealthy food and drink, particularly under the food, drink and snack which are high in fat and sugar.

Answers given by the children were gathered, sorted, and analysed using both qualitative and quantitative approaches, in order to juxtapose their food preferences for regular meals. For qualitative data, coding for themes was used to present results of analysis; while non-parametrical statistics were employed to generate results of quantitative data. In particular, McNemar Tests were used on paired nominal data, specifically on 2 x 2 contingency tables with a dichotomous trait (Yes or No), with the following matched pairs of children in this study:

- pre-test and post-test;
- the control group and the experimental group;
- male and female; and
- Year-Five and Year-Six;

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The tests were conducted to determine whether the row and column marginal frequencies in five questions asked in the pre-test and post-test on food preferences were equal or not. The overall null hypothesis of these tests was actually the first null hypothesis formulated for this study (see Figure 5.8).

H_0: Preschool children's food preference shows no significant difference before and after playing *Fight Obesity 2.0*.

Figure 5.8. Null Hypothesis for Testing Preschool Children's Feed Preference

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5.2.4.1 Preferences for Breakfast, Lunch, and Dinner

The children who participated in the quasi-experiment were asked to answer an open question: What do you want for breakfast, lunch and dinner? All children answered the question by suggesting up to five types of food for each meal (see Table 5.12). Most of the children suggested one type, and this was consistent in both the pre-test and the post-test. The complete lists of food choices were included in the thesis as Appendix O (data collected in the pre-test) and Appendix P (data collected in the post-test).

Table 5.12

Variety and Count of Food Suggested by the Children for Breakfast, Lunch and Dinner

Variety	Breakfast				Lunch				Dinner			
	Pre-test	*f*	Post-test	*f*	Pre-test	*f*	Post-test	*f*	Pre-test	*f*	Post-test	*F*
Nil	1	0	1	0	0	0	1	0	0	0	0	0
1 type	40	40	37	37	39	39	33	33	36	36	34	34
2 types	13	26	14	28	13	26	18	36	16	32	15	30
3 types	4	12	6	18	4	12	5	15	7	21	7	21
4 types	2	8	2	8	3	12	1	4	0	0	1	4
5 types	0	0	0	0	1	5	2	10	1	5	3	15
Total	60	86	60	91	60	94	60	98	60	94	60	104

Wilcoxon Signed Ranks Tests were conducted to compare the variety of food preferences mentioned by the children in pre-test and post-test. As shown in Table 5.13, no statistically significant difference was found in breakfast (p = .437), lunch (p = .767) and dinner (p = .340). Further comparison was done within the experimental group (Table 5.14), but no statistically significant difference was found across three meals (breakfast: p =.222; lunch: p =.751; dinner: p =.778).

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Table 5.13

General Comparison on Food Variety between Pre-test and Post-test

Ranks

		N	Mean Rank	Sum of Ranks
Post-test: Breakfast food count - Pre-test: Breakfast food count	Negative Ranks	10[a]	10.35	103.50
	Positive Ranks	12[b]	12.46	149.50
	Ties	38[c]		
	Total	60		
Post-test: Lunch food count - Pre-test: Lunch food count	Negative Ranks	17[d]	17.50	297.50
	Positive Ranks	18[e]	18.47	332.50
	Ties	25[f]		
	Total	60		
Post-test: Dinner food count - Pre-test: Dinner food count	Negative Ranks	13[g]	12.50	162.50
	Positive Ranks	15[h]	16.23	243.50
	Ties	32[i]		
	Total	60		

a. Post-test: Breakfast food count < Pre-test: Breakfast food count
b. Post-test: Breakfast food count > Pre-test: Breakfast food count
c. Post-test: Breakfast food count = Pre-test: Breakfast food count
d. Post-test: Lunch food count < Pre-test: Lunch food count
e. Post-test: Lunch food count > Pre-test: Lunch food count
f. Post-test: Lunch food count = Pre-test: Lunch food count
g. Post-test: Dinner food count < Pre-test: Dinner food count
h. Post-test: Dinner food count > Pre-test: Dinner food count
i. Post-test: Dinner food count = Pre-test: Dinner food count

Test Statistics[b]

	Post-test: Breakfast food count - Pre-test: Breakfast food count	Post-test: Lunch food count - Pre-test: Lunch food count	Post-test: Dinner food count - Pre-test: Dinner food count
Z	-.777[a]	-.296[a]	-.954[a]
Asymp. Sig. (2-tailed)	.437	.767	.340

a. Based on negative ranks.
b. Wilcoxon Signed Ranks Test

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Table 5.14

Comparison on Food Variety between Pre-test and Post-test in the Experimental Group

Ranks

		N	Mean Rank	Sum of Ranks
Post-test: Breakfast food count - Pre-test: Breakfast food count	Negative Ranks	6[a]	4.42	26.50
	Positive Ranks	2[b]	4.75	9.50
	Ties	22[c]		
	Total	30		
Post-test: Lunch food count - Pre-test: Lunch food count	Negative Ranks	9[d]	8.22	74.00
	Positive Ranks	7[e]	8.86	62.00
	Ties	14[f]		
	Total	30		
Post-test: Dinner food count - Pre-test: Dinner food count	Negative Ranks	8[g]	5.31	42.50
	Positive Ranks	4[h]	8.88	35.50
	Ties	18[i]		
	Total	30		

a. Post-test: Breakfast food count < Pre-test: Breakfast food count
b. Post-test: Breakfast food count > Pre-test: Breakfast food count
c. Post-test: Breakfast food count = Pre-test: Breakfast food count
d. Post-test: Lunch food count < Pre-test: Lunch food count
e. Post-test: Lunch food count > Pre-test: Lunch food count
f. Post-test: Lunch food count = Pre-test: Lunch food count
g. Post-test: Dinner food count < Pre-test: Dinner food count
h. Post-test: Dinner food count > Pre-test: Dinner food count
i. Post-test: Dinner food count = Pre-test: Dinner food count

Test Statistics[b]

	Post-test: Breakfast food count - Pre-test: Breakfast food count	Post-test: Lunch food count - Pre-test: Lunch food count	Post-test: Dinner food count - Pre-test: Dinner food count
Z	-1.222[a]	-.317[a]	-.282[a]
Asymp. Sig. (2-tailed)	.222	.751	.778

a. Based on positive ranks.
b. Wilcoxon Signed Ranks Test

In terms of specific food choice, rice (including fried rice, soy sauce rice and spicy rice) was the most preferred choice across three meals (see Table 5.15). This finding indicated that although all the children aged three to six were fed with cereals and milk in Tadika NCDRC every weekday morning, they actually preferred rice, which they may have eaten at home before going to the kindergarten. Bread was ranked second for breakfast in both the pre-test and the post-test, which was not in the kindergarten menu as well. In other words, the influence of home breakfast menu on food preferences was greater as opposed to the menu set by the kindergarten daily.

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Therefore, parents play very important role in preventing childhood obesity, as suggested in the game-based childhood prevention framework.

While rice, particularly white rice, was preferred as the main source of carbohydrate in Malaysia, the children seemed to change their choice of dishes for lunch from chicken and bread in the pre-test, to vegetables and fish in the post-test. As for dinner, similar change occurred, where chicken especially fried chicken was substituted by fish. One notable change between pre-test and post-test was the increment on water (Pre-test = 12; Post-test = 26) in their meals. Further investigate showed that the noteworthy change of including water as preferred diet occurred in the experimental group (pre-test: 2; post-test: 13), as compared to slight increment in the control group (pre-test: 10; post-test: 13).

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In terms of food category, grains food category was the dominant choice in breakfast, lunch and dinner. As shown in Table 5.16, although there was a changed from chicken to fish in lunch between the pre-test and the post, both food types falls under the same food category, thus keeping the top three food categories constant in lunch and dinner. Figure 5.9 and Figure 5.10 show a comparison of food categories across three meals between the pre-test and the post-test.

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Table 5.15

Top Three Ranked Food Choice in Breakfast, Lunch, and Dinner.

Meal	Rank	Pre-test	*f*	Rank	Post-test	*f*
Breakfast	1st	Rice / fried rice / say sauce rice	21	1st	Rice / fried rice/ rice with sambal	17
	2nd	Bread / toast	8	2nd	Bread / chocolate bread / sugar bread	12
		Cereals	8			
		Milk	8			
	3rd	Fruits (apple/ strawberry / watermelon)	5	3rd	Vegetables	10
					Drink (iced Milo / Milo / orange juice / syrup / tea)	10
Lunch	1st	Rice / fried rice / soy sauce rice / pulut	23	1st	Rice / fried rice/soy sauce rice / spicy fried rice	28
	2nd	Chicken / fried chicken	9	2nd	Vegetables	10
	3rd	Bread / jam bread	7	3rd	Fish	7
					Drink (iced Milo / apple juice / orange juice / soft drink)	7
Dinner	1st	Rice / fried rice / say sauce rice	32	1st	Rice / fried rice/ spicy fried rice	32
	2nd	Chicken / fried chicken	6	2nd	Fish	9
		Fruits	6		Plain water	9
	3rd	Fish	5	3rd	Drink (iced Milo / Milo / orange juice / syrup / tea)	7
					Noodle	7

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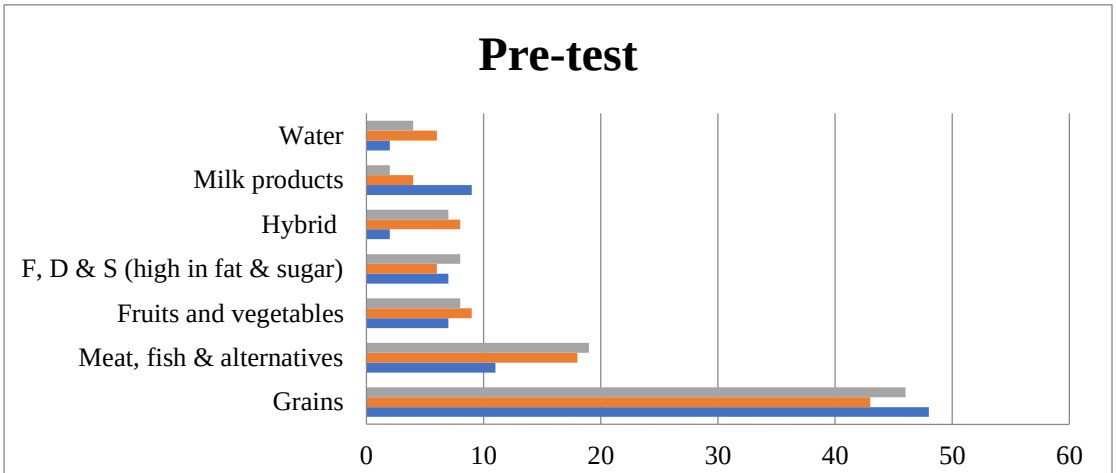
Table 5.16

Ranking of Top Three Food Categories in Breakfast, Lunch, and Dinner.

Meal	Rank	Pre-test	*f*	Rank	Post-test	*f*
Breakfast	1st	Grains	48	1st	Grains	46
	2nd	Meat, fish and alternatives	11	2nd	Food, drink and snack (high in fat and sugar)	16
	3rd	Milk products	9	3rd	Fruits and vegetables	14
Lunch	1st	Grains	13	1st	Grains	43
	2nd	Meat, fish and alternatives	18	2nd	Meat, fish and alternatives	19
	3rd	Fruits and vegetables	9	3rd	Fruits and vegetables	12
Dinner	1st	Grains	46	1st	Grains	44
	2nd	Meat, fish and alternatives	19	2nd	Meat, fish and alternatives	22
	3rd	Fruits and vegetables	8	3rd	Water	12
		Food, drink and snack (high in fat and sugar)	8		Food, drink and snack (high in fat and sugar)	12

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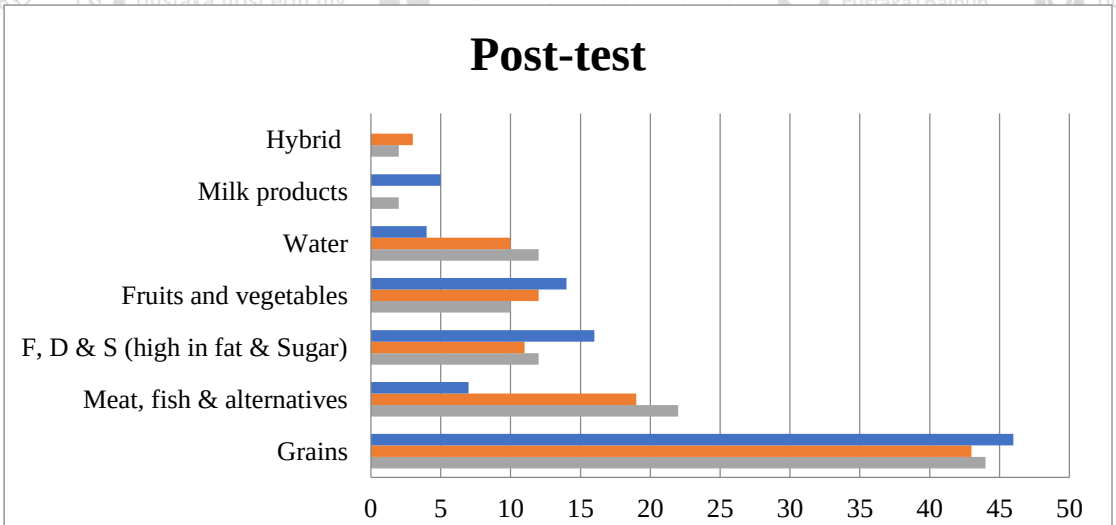
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	Grains	Meat, fish & alternatives	Fruits and vegetables	F, D & S (high in fat & sugar)	Hybrid	Milk products	Water
Dinner	46	19	8	8	7	2	4
Lunch	43	18	9	6	8	4	6
Breakfast	48	11	7	7	2	9	2

Figure 5.9. Food Categories Comparison in the Pre-test across Three Meals

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	Grains	Meat, fish & alternatives	F, D & S (high in fat & Sugar)	Fruits and vegetables	Water	Milk products	Hybrid
Breakfast	46	7	16	14	4	5	0
Lunch	43	19	11	12	10	0	3
Dinner	44	22	12	10	12	2	2

Figure 5.10. Food Categories Comparison in the Post-test across Three Meals

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5.2.4.2 Preferences for Healthy Food

With reference to the null hypothesis stated in Section 5.2.4, two null hypotheses were formed based on two questions asked in the pre-test and the post-test (see Figure 5.11).

$H_0$1: There was no significant difference on the preference of eating fruits between the pre-test and the post-test. $H_0$2: There was no significant difference on the preference of eating vegetables between the pre-test and the post-test.

Figure 5.11. Null Hypotheses for Testing the Difference on the Preference for Healthy Food

All modes and means in two test items were “Yes”, indicating that all children involved in this research like eating fruits and vegetables. This positive phenomenon should be maintained throughout their childhood to prevent obesity. McNemar Tests were run on these test items, with the 0.05 alpha level. No significant difference was found in both the pre-test and the post-test (see Table 5.17).

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Table 5.17

Healthy Food Preferences of Children

Test item			Post-test No	Post-test Yes	Mode	Median	p
Do you like to eat fruits?	Pre- test	No	1	1	Yes	Yes	.375
		Yes	4	54			
Do you like to eat vegetables?	Pre- test	No	2	7	Yes	Yes	.774
		Yes	5	46			

Test Statistics[b]

	Pre: Do you like to eat fruits? & Post: Do you like to eat fruits?	Pre: Do you like to eat vegetables? & Post: Do you like to eat vegetables?
N	60	60
Exact Sig. (2-tailed)	.375[a]	.774[a]

a. Binomial distribution used.

b. McNemar Test

Further analysis was carried out within the control group and then within the experimental group ($\alpha = 0.05$), in which four null hypotheses were tested (see Figure 5.12). The result of McNemar Tests on hypotheses associated to the control group was shown in Table 5.18. All modes and medians were "Yes", but no significant difference was found.

$H_0$3: There was no significant difference on the preference of eating fruits between the pre-test and the post-test within the control group.
$H_0$4: There was no significant difference on the preference of eating vegetables between the pre-test and the post-test within the control group.
$H_0$5: There was no significant difference on the preference of eating fruits between the pre-test and the post-test within the experimental group.
$H_0$6: There was no significant difference on the preference of eating vegetables between the pre-test and the post-test within the experimental group.

Figure 5.12. Null Hypotheses for Testing the Difference on the Preference of Eating Fruits and Eating Vegetables

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Table 5.18

Healthy Food Preferences of Children within the Control Group and within the Experimental Group.

Group	Test item			Post-test		Mode	Median	p
				No	Yes			
Within control group	Do you like to eat fruits?	Pre-test	No	0	0	Yes	Yes	.500
			Yes	2	28			
	Do you like to eat vegetables?	Pre-test	No	1	2	Yes	Yes	1.000
			Yes	3	24			
Within experimental group	Do you like to eat fruits?	Pre-test	No	1	1	Yes	Yes	1.000
			Yes	2	26			
	Do you like to eat vegetables?	Pre-test	No	1	5	Yes	Yes	.453
			Yes	2	22			

Test Statistics[b]

	Within the control group		Within the experimental group	
	Pre: Do you like to eat fruits? & Post: Do you like to eat fruits?	Pre: Do you like to eat vegetables? & Post: Do you like to eat vegetables?	Pre: Do you like to eat fruits? & Post: Do you like to eat fruits?	Pre: Do you like to eat vegetables? & Post: Do you like to eat vegetables?
N	30	30	30	30
Exact Sig. (2-tailed)	.500[a]	1.000[a]	1.000[a]	.453[a]

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5.2.4.3 Preferences for unhealthy food and drink

With reference to the null hypothesis stated in Section 5.2.4 three subsidiary null hypotheses were formed based on three questions asked in the pre-test and the post-test (see Figure 5.13).

$H_0$7: There was no significant difference on the preference of eating fried food between the pre-test and the post-test.
$H_0$8: There was no significant difference on the preference of drinking soft drink between the pre-test and the post-test.
$H_0$9: There was no significant difference on the preference of eating fast food between the pre-test and the post-test.

Figure 5.13. Null Hypotheses for Testing the Difference on the Preference of Eating Fried Food, Drinking Soft Drink, and Eating Fast Food

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All modes and means in three test items were "Yes", indicating that the children like eating fried food and fast food, and they also like soft drink. Precaution must be made to avoid building unhealthy food preference that would cause childhood obesity. After running through McNemar Tests with the alpha level of 0.05, two significant differences were found, in which $H_0$7 and $H_0$9 were rejected (see Table 5.19). In particular, the preference of eating fried food reduced significantly, from 56 children (out of 60) liked eating fried food in the pre-test to 46 children liked eating fried food in the post-test (p = .031). Meanwhile, this finding was echoed by a positive outcome, in which the preference of eating fast food reduced significantly, from 53 children (out of 60) liked eating fast food in the pre-test to 39 children liked eating fast food in the post-test (p =.001).

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Table 5.19

Unhealthy Food Preferences of the Children

Test item			Post-test No	Post-test Yes	Mode	Median	p
Do you like to eat fried food?	Pre-test	No	0	4	Yes	Yes	.031
		Yes	14	42			
Do you like soft drink?	Pre-test	No	11	7	Yes	Yes	.189
		Yes	14	28			
Do you want to eat fast food?	Pre-test	No	6	1	Yes	Yes	.001
		Yes	15	38			

Test Statistics[b]

	Pre: Do you like to eat fried food? & Post: Do you like to eat fried food?	Pre: Do you like to eat sweet drink? & Post: Do you like sweet drink?	Pre: Do you like to eat fast food? & Post: Do you want to eat fast food?
N	60	60	60
Exact Sig. (2-tailed)	.031[a]	.189[a]	.001[a]

a. Binomial distribution used.
b. McNemar Test

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Further analysis using McNemar Test was done within the control group and then within the experimental group ($\alpha = 0.05$). Six null hypotheses were formed based on three questions asked in the pre-test and the post-test (see Figure 5.14).

$H_0$10: There was no significant difference on the preference of eating fried food between the pre-test and the post-test within the control group.
$H_0$11: There was no significant difference on the preference of drinking soft drink between the pre-test and the post-test within the control group.
$H_0$12: There was no significant difference on the preference of eating fast food between the pre-test and the post-test within the control group.
$H_0$13: There was no significant difference on the preference of eating fried food between the pre-test and the post-test within the experimental group.
$H_0$14: There was no significant difference on the preference of drinking soft drink between the pre-test and the post-test within the experimental group.
$H_0$15: There was no significant difference on the preference of eating fast food between the pre-test and the post-test within the experimental group.

Figure 5.14. Null Hypotheses for Testing the Difference within Groups on the Preference of Eating Fried Food, Drinking Soft Drink, and Eating Fast Food

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The result of the McNemar Tests on hypotheses associated to the control group and the experimental group was shown in Table 5.20. All modes and means in five test items were "Yes", except in the experimental group, when the children were asked whether they want to eat fast food or not, where their preference changed from 'Yes' in the pre-test to 'No' in the post-test. Two significant differences were found in the experimental group, where $H_0$13 and $H_0$15 were rejected. The preference of eating fried food reduced significantly, from 29 children (out of 30) liked eating fried food in the pre-test to 22 children liked eating fried food in the post-test ($p = .039$). Also, the preference of eating fast food reduced significantly, from 24 children (out of 30) liked eating fast food in the pre-test to 13 children liked eating fast food in the post-test ($p = .001$), while both the Mode and the Median changed from "Yes" to "No". These results were identical to outcomes shown in Table 5.14, therefore the overall

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significant differences in these two items were actually caused by the significant differences on food preferences found within the experimental group. In conclusion, exposure to game-based childhood obesity prevention, specifically by playing *Fight Obesity 2.0* for four sessions in Tadika NCDRC had significantly changed the food preferences of eating fried food and fast food.

Table 5.20

Food Preferences of Children in the Control Group

	Test item			Post-test No	Post-test Yes	Mode	Median	p
Within control group	Do you like to eat fried food?	Pre-test	No	0	3	Yes	Yes	.508
			Yes	6	21			
	Do you like soft drink?	Pre-test	No	4	3	Yes	Yes	.727
			Yes	5	18			
	Do you want to eat fast food?	Pre-test	No	0	1	Yes	Yes	.375
			Yes	4	25			
Within experimental group	Do you like to eat fried food?	Pre-test	No	0	1	Yes	Yes	.039
			Yes	8	21			
	Do you like soft drink?	Pre-test	No	7	4	Yes	Yes	.267
			Yes	9	10			
	Do you want to eat fast food?	Pre-test	No	6	0	Pre-test: Yes; Post-test: No		.001
			Yes	11	13			

Test Statistics[b]

	Within the control group			Within the experimental group		
	Pre: Do you like to eat fried food? & Post: Do you like to eat fried food?	Pre: Do you like to eat sweet drink? & Post: Do you like sweet drink?	Pre: Do you like to eat fast food? & Post: Do you want to eat fast food?	Pre: Do you like to eat fried food? & Post: Do you like to eat fried food?	Pre: Do you like to eat sweet drink? & Post: Do you like sweet drink?	Pre: Do you like to eat fast food? & Post: Do you want to eat fast food?
N	30	30	30	30	30	30
Exact Sig. (2-tailed)	.508[a]	.727[a]	.375[a]	.039[a]	.267[a]	.001[a]

a. Binomial distribution used.
b. McNemar Test

Having rejected two null hypotheses ($H_0$13 & $H_0$15), further analysis was carried out to investigate whether or not the gender and the age of children in the experimental group had contributed to the significant differences. McNemar Tests were run on the above test items, in which a significant difference was found in

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female children (p = .031), in which the Mode and Mean changed from "Yes" in the pre-test to "No" in the post-test (see Table 5.21). In other words, the effects of *Fight Obesity 2.0* had significantly changed female children's eating preference.

Table 5.21

Food Preferences of Male and Female Children in the Experimental Group

Gender	Test items with significant difference			Post-test No	Post-test Yes	Mode	Median	p
Female (n=13)	Do you like to eat fried food?	Pre-test	No	0	0	Yes	Yes	.125
			Yes	4	9			
	Do you want to eat fast food?	Pre-test	No	3	0	Pre-test: Yes; Post-test: No		.031
			Yes	6	4			
Male (n=17)	Do you like to eat fried food?	Pre-test	No	0	1	Yes	Yes	.375
			Yes	4	12			
	Do you want to eat fast food?	Pre-test	No	3	0	Yes	Yes	.063
			Yes	5	9			

Test Statistics[b]

	Female		Male	
	Pre: Do you like to eat fried food? & Post: Do you like to eat fried food?	Pre: Do you like to eat fast food? & Post: Do you like to eat fast food?	Pre: Do you like to eat fried food? & Post: Do you like to eat fried food?	Pre: Do you like to eat fast food? & Post: Do you like to eat fast food?
N	13	13	17	17
Exact Sig. (2-tailed)	.125[a]	.031[a]	.375[a]	.063[a]

a. Binomial distribution used.
b. McNemar Test

When McNemar Tests were run on the above test items to examine age differences in the experimental group, a significant difference was found in Year 6 children, in which the Mode and Mean of the item "do you want to eat fast food" changed from "Yes" in the pre-test to "No" in the post-test (see Table 5.22). In other words, the effects of *Fight Obesity 2.0* had significantly changed the Year-Six children's eating preference.

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Table 5.22

Food Preferences of Year-Five and Year-Six Children in the Experimental Group

Age	Test items with significant difference			Post-test No	Post-test Yes	Mode	Median	p
Six (n=13)	Do you like to eat fried food?	Pre-test	No	0	0	Yes	Yes	.063
			Yes	5	8			
	Do you want to eat fast food?	Pre-test	No	3	0	Pre-test: Yes; Post-test: No		.031
			Yes	6	4			
Five (n=17)	Do you like to eat fried food?	Pre-test	No	0	1	Yes	Yes	.625
			Yes	3	13			
	Do you want to eat fast food?	Pre-test	No	3	0	Yes	Yes	.063
			Yes	5	9			

Test Statistics[b]

	Year-Six		Year-Five	
	Pre: Do you like to eat fried food? & Post: Do you like to eat fried food?	Pre: Do you like to eat fast food? & Post: Do you like to eat fast food?	Pre: Do you like to eat fried food? & Post: Do you like to eat fried food?	Pre: Do you like to eat fast food? & Post: Do you like to eat fast food?
N	13	13	17	17
Exact Sig. (2-tailed)	.063[a]	.031[a]	.625[a]	.063[a]

a. Binomial distribution used.
b. McNemar Test

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5.2.5 Comparison on conception upon the relationship between obesity and physical exercise

The conception upon the relationship between obesity and physical exercise of the children were examined in the pre-test and the post-test using McNemar Tests. These tests involved the same four matched pairs of children explained in Section 5.2.4.2. The overall null hypothesis of these tests was actually the second null hypothesis formulated for this study (see Figure 5.15).

H_0: Preschool children's conception on the relationship between obesity and physical exercise shows no significant difference before and after playing *Fight Obesity 2.0*.

Figure 5.15. Null Hypotheses for Testing the Preschool Children's Conception on the Relationship between Obesity and Physical Exercise

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5.2.5.1 Conception on body size and obesity

Based the null hypothesis mentioned in Section 5.2.5, a null hypothesis was formed according to the question asked in the pre-test and the post test (see Figure 5.16). This null hypothesis was tested by asking children to determine whether they were fat or thin and then cross-check with their actual BMI to determine whether they had correct conception on their personal body size or not.

$H_0$16: There was no significant difference on the conception of personal body size between the pre-test and the post-test.

Figure 5.16. Null Hypotheses for Testing the Difference on the Conception of Personal Body Size

Initially, two test items were set for in this research, but one of these items was discarded because the actual weight and height of the mother of children who participated in this research were not provided by NCDRC due to Personal Data Protection Act 2010 (Perintah Kerajaan Malaysia, 2010). As a result, although data was collected for Item 7 in pre-test and post-test, analysis cannot be done without referring to the actual BMI of individual children's mother. The analysis of item 8 is shown in Table 5.23. Most of the children held correct conception on personal body size in both the pre-test and the post-test. No statistical significant difference was found in the comparison ($p = .375$, $\alpha = 0.05$). Thus, null hypothesis $H_0$16 was not rejected. Subsequent comparison of matched pairs on gender and age within the control group and the experimental group also showed no significant difference. The children had prior conception on personal body size, which was established prior the conduct of this research. This prior conception was consistent through the study.

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Table 5.23

McNemar Test on the Conception of Personal Body Size

Crosstabs

Pre-test: Conception on body size & Post-test: Conception on body size

Pre-test: Conception on body size	Post-test: Conception on body size	
	Incorrect conception	Correct conception
Incorrect conception	2	4
Correct conception	1	53

Test Statistics[b]

	Pre-test: Conception on body size & Post-test: Conception on body size
N	60
Exact Sig. (2-tailed)	.375[a]

a. Binomial distribution used.
b. McNemar Test

5.2.5.2 Conception on Healthy and Unhealthy Lifestyle

Based on the null hypothesis stated in Section 5.2.5, two subsidiary null hypotheses were formed based on two questions asked in the pre-test and the post-test (see Figure 5.17). The null hypothesis $H_0$17 was tested by asking children whether they like to watch TV at home or not. As elaborated in Section 3.4.3.2, their daily activities in Tadika NCDRC were governed by the pre-set timetable. Thus, asking the children to state their preference at home, where they might have freedom to do so, would reveal their tendency in natural settings. Similar reason was applied to null hypothesis $H_0$18, in which the children were asked whether they like to do exercise or not.

$H_0$17: There was no significant difference on the preference of watching TV at home between the pre-test and the post-test.
$H_0$18: There was no significant difference on the preference of doing exercise between the pre-test and the post-test.

Figure 5.17. Null Hypotheses upon the Difference on the Preference of Watching TV at Home and Doing Exercise

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The results of analyses were shown in Table 5.24. Most of the children preferred to watch TV at home and do exercise in both the pre-test and the post-test. No statistical significant difference was found in the comparison (watch TV: p = .344; do exercise: p = 1.000). Therefore, null hypotheses $H_0$17 and $H_0$18 were not rejected. Subsequent comparison of matched pairs on gender and age within the control group and the experimental group also showed no significant difference.

Table 5.24

The Overall Children's Preferences for Physical Activities

Test item			Post-test		Mode	Median	p
			No	Yes			
Do you like to watch TV at home?	Pre-test	No	2	3	Yes	Yes	.344
		Yes	7	48			
Do you like to do exercise?	Pre-test	No	5	6	Yes	Yes	1.000
		Yes	7	42			

Test Statistics[b]

	Q9_pre: Do you like to watch TV at home? & Q9_post: Do you like to watch TV at home?	Q10_pre: Do you like to do exercise? & Q10_post: Do you like to do exercise?
N	60	60
Exact Sig. (2-tailed)	.344[a]	1.000[a]

a. Binomial distribution used.
b. McNemar Test

The game-based childhood obesity prevention, specifically though playing *Fight Obesity 2.0*, did not yield positive effects on the children's preferences for watching TV at home and doing exercise. Thus, the efforts of game-based prevention might need to be extended to children's activities at home in order to achieve significant outcomes. Also, games used for childhood prevention ought to be more engaging and attractive than TV programmes watched by the children at home. In terms of physical exercise, the children had established and maintained the preference

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of doing exercise prior to the conduct of this study. This preference must be kept to prevent childhood obesity, with or without game-based obesity prevention.

5.2.6 Comparison on Conception upon the Danger of Obesity

The conception upon the danger of obesity among the children was examined in the pre-test and the post-test using McNemar Tests. These tests involved the same four matched pairs of children explained in Section 5.2.8. The overall null hypothesis of these tests was actually the third null hypothesis formulated for this study (see Figure 5.18). Three subsidiary null hypotheses were formed based on two same questions asked in the pre-test and the post-test (see Figure 5.19). The null hypothesis H019 and H020 was tested by checking whether the children know that obesity can cause heart problem and diabetes.

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H_0: Preschool children's conception on the danger of obesity shows no significant difference before and after playing *Fight Obesity 2.0*.

Figure 5.18. Null Hypotheses for Testing the Preschool Children's Conception on the Danger of Obesity

$H_0$19: There was no significant difference on the conception that obesity can cause heart problem between the pre-test and the post-test. $H_0$20: There was no significant difference on the conception that obesity can cause diabetes between the pre-test and the post-test. $H_0$21: There was no significant difference on the conception of what to do after became obese between the pre-test and the post-test.

Figure 5.19. Null Hypotheses for Testing the Difference on the Conception of the Consequences of Obesity

The results of analyses were shown in Table 5.25. No statistical significant difference was found in the comparison (heart problem: p = .345; do exercise: p =

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1.000). Therefore, null hypotheses $H_0$19 and $H_0$20 were not rejected. Subsequent comparison of matched pairs on gender and age within the control group and the experimental group also showed no significant difference.

Table 5.25

McNemar Tests on the Conception of the Danger of Obesity

Pre: Conception on heart problem & Post: Conception on heart problem

Pre: Conception on heart problem	Post: Conception on heart problem	
	Incorrect conception	Correct conception
Incorrect conception	16	17
Correct conception	11	15

Pre: Conception on diabetes & Post: Conception on diabetes

Pre: Conception on diabetes	Post: Conception on diabetes	
	Incorrect conception	Correct conception
Incorrect conception	15	14
Correct conception	13	18

Test Statistics[b]

	Pre: Conception on heart problem & Post: Conception on heart problem	Pre: Conception on diabetes & Post: Conception on diabetes
N	59	60
Chi-Square[a]	.893	.000
Asymp. Sig.	.345	1.000

a. Continuity Corrected
b. McNemar Test

The null hypothesis $H_0$21 was tested by asking the children to answer an open question: "If you become very fat in the future, what would you do?". The answers given by individual children will be checked, either as correct conception or incorrect conception.

A McNemar Test showed a significant difference on the conception between the pre-test and the post-test ($p = .017$), as shown in Table 5.26. The number of children answered question 13 correctly increased significantly, from 27 people (out of 60) in the pre-test to 39 people in the post-test (see Figure 5.20). Mann-Whitney U

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Test was run but no significant difference was found in the pre-test (p =.440, Z = -.772) and the post-test (p = .421, Z = -.805) between the control group and the experimental group. Also, no significant gender difference (pre-test: p =.409, post-test = .914) or age difference (pre-test: p =.938, post-test = .434) in either the pre-test or the post-test. Thus, both gender and age were not the reason why the children had improved their knowledge on how to handle obese conditions.

Table 5.26

Difference on Conception Found between the Pre-test and the Post-test

Pre: Conception on what to do after became obese & Post: Conception on what to do after became obese

Pre: Conception on what to do after became obese	Post: Conception on what to do after became obese	
	Incorrect conception	Correct conception
Incorrect conception	16	17
Correct conception	5	22

Test Statistics[b]

	13Pre: Conception on what to do after obese & 13Post: Conception on what to do after obese
N	60
Exact Sig. (2-tailed)	.017[a]

a. Binomial distribution used.
b. McNemar Test

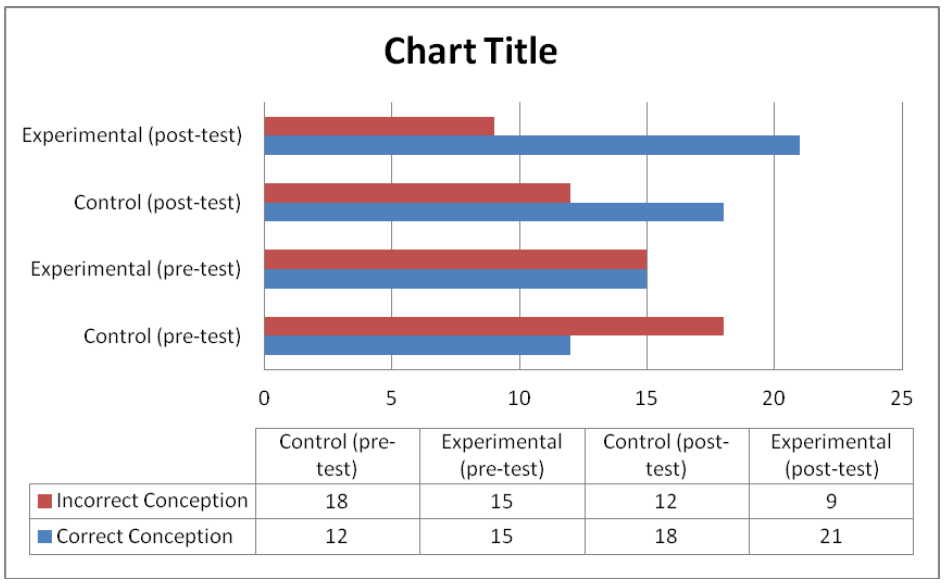


Figure 5.20. Comparison between Correct and Incorrect Conception on How to Handle Obesity

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In general, the children had prior conception and misconception on the danger of obesity, which was established before joining this research. This prior conception or misconception did not change significantly through the span of the study. This result indicated that playing *Fight Obesity 2.0*, particularly the virtual consultation animation which reveals the danger of diabetes did not yield positive effects on the children's conception on the danger of obesity. This could mean more efforts should be put on the game design and the prevention pedagogy, especially on how to highlight the danger of obesity to preschool children.

5.3 Findings of Non-Participant Observation

A one-week non-participant observation was conducted at the Tadika NCDRC from 15 August 2016 to 19 August 2016. The purpose of the observation was to examine whether or not knowledge gained from playing *Fight Obesity 2.0* was transferred to daily behaviours in the kindergarten one month after the completion of the quasi-experiment.

5.3.1 Selection of Children for the Observation

Fourteen children who showed significant improvement between the pre-test and the post-test were chosen as the participants of this observation (see Table 5.27). They were observed in group since the schedule for breakfast, snack and lunch time were identical across ages and classes.

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Table 5.27

Children Involved in the Non-Participant Observation

		Five Orchid		Five Jasmine		Six Lavender		Six Carnation	
		ID	f	ID	f	ID	f	ID	f
Control Group	Male		0		0		0	53	1
	Female		0		0	42	1		0
Experimental Group	Male	06	1	29	1	39	1	51 & 54	2
	Female	01,14 & 17	3	30	1	35 & 41	2	58	1

5.3.2 Food Provision and Activities in Tadika NCDRC

Throughout the one week observation, the actual food consumption of the participants generally matched the menu set by Tadika NCDRC. Table 5.28 shows the actual food prepared and provided to the children in Year-Five and Year-Six classes. Prior to the serving of breakfast and snack in the classroom, all children were instructed to sit around a row of joined tables or on the floor in a circle. Then either the teacher or a pupil management assistant would distribute food prepared and delivered by food preparation assistants from the NCDRC Kitchen. Individual children started to eat immediately after they received food. After they finished eating, they left their tableware on the table or a food delivery tray. Either the teacher or the assistant would clear the table and put all tableware on the food delivery tray for the food preparation assistant to take away. Then both the teacher and children moved on to next session of activity.

For lunch, all Year-Five and Year-Six children who arrived at the Bitara Transit Class in the Sultan Abdul Jalil Shah Campus would queue for lunch. Lunch had been prepared by food preparation assistants and sorted out to serve all children.

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After taking food and drink, the children would sit around a row of dining tables and start eating together in a big group. At the end of the lunch time, all children would be directed to a big room and got themselves ready for a bath and then a nap. One notable point of the observation was the increase of interest in eating fruits.

The non-participant observation revealed that, since all meals and physical activities in weekdays were planned and governed by the Tadika NCDRC, it would not be surprising when no significant difference were found in test items in the nonequivalent control group pre-test / post-test quasi-experiment, including the preference of eating fruits, vegetables and drinking sweet drinks.

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Table 5.28

Actual Food Prepared and Served to Year-Five and Year-Six Children in One Week

Day	Breakfast 7:30 am - 8:00am	Snack 10:00 am – 10:30am	Lunch 12:00 pm – 12:45pm	Remark
Monday 15 Aug	Cereals (Honey Star) and Milk	Cake and fruits (guava and rambutan) Plain water	Spaghetti with meat sauce	Some children brought their own food for snack, such as nasi lemak
Tuesday 16 Aug	Biscuit and Milk	Sandwiches Plain water	White rice Fried squid Stir-fried long beans Fruits: pulasam, cempedak (Given to individual children upon request)	Class Six Carnation had a picnic near the swimming pool. Fried rice, Fried chicken, Biscuit, Hash brown Fish cake Pop corn White bread Curry puff Chocolate bar Orange juice
Wednesday 17 Aug	Cereals (Honey Star) and Milk	Packed in plastic bag: Bread and Nutri Soy drink	Packed food: White rice Grilled chicken wings or drumsticks, Chicken soup One slice of fresh tomato One slice of watermelon Lettuce, cucumber	All Year-Five and Year-Six children went out for an event called *Aspirasi Dunia Islam Kanak-kanak* (ADIK), organized by the Early Childhood Education (Diploma) Association, at Panggung Percubaan, Sultan Azlan Shah Campus, UPSI
Thursday 18 Aug	Biscuit and Milk	Fried bee hoon Plain water	White rice Fried spinach Plain water	Year-Six children attended an outdoor session of Creative Movement for drawing in the morning.
Friday 19 Aug	Cereals (Koko Krunch) and Milk	Cake Plain water	Fried rice Fried boiled eggs	

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5.3.3 Interview Session with the Kindergarten Supervisor

An interview session was conducted with the Supervisor of Tadika NCDRC, Puan NR. Puan NR joined NCDRC with her Master's degree qualification in early childhood education. She was promoted from Grade DG 41 Education Officer to Grade DG44 Education Officer in January 2016, and then she was appointed as the Supervisor of Tadika NCDRC. Puan NR had great passion in children's arts and crafts, in which she kept a web log or blog on this topic, and constantly updated the blog by posting arts and crafts created by children in Tadika NCDRC. Puan NR lived in Taman Segar, Tanjong Malim which afforded her to have access to academics and scholars who shared the same area of interest with her. In particular, she planned to pursue a PhD in theory of early childhood education, specializing in play-based learning through handmade puppets. This was a research area that had been made famous by a senior lecturer from the Faculty of Education and Human Development in UPSI.

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In this research, Puan NR was the gatekeeper for accessing the kindergarten. Instruments used for data collection was presented to her prior to any engagement with the targeted children. In terms of administration responsibilities, Puan NR supervised five Grade DG41 Education Officers, two Grade DG29 Education Officers and five Grade N17 Pupil Management Assistants. She also co-supervised four contract-based Grade C17 Food Preparation Assistants together with the Supervisor of Taska NCDRC. All staff under her supervision was female Muslimahs except two male food preparation assistants. Apart from the being the supervisor of Tadika

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NCDRC, she was also the teacher of Class Five Orchid, accountable for teaching, learning and caretaking of all children in the class from 7:30am to 5:30pm every weekday.

The purpose of the interview was to understand the perception of teacher in Tadika NCDRC on the children's food preferences and their conception of healthy lifestyle. Puan NR was invited as the interviewee as she should be able to represent the general perception of other teachers in Tadika NCDRC. Fifteen questions were prepared for this one-to-one interview session, which was carried out in her office at the end of the quasi-experiment (see Appendix Q). The answers given by Puan NR were analysed and synthesized to form the findings of this research. The findings were organized into the two sections.

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5.3.3.1 Perceived Children's Food Preference

According to Puan NR, there were two meals provided to every child at the Tadika NCDRC. After 12:00 noon, all children were transported from the Sultan Azlan Shah Campus to the Sultan Abdul Jalil Shah Campus, UPSI. The children had their lunch in the Sultan Abdul Jalil Shah Campus. For children who enrolled into the Bitara Transit Class in the campus, they would have afternoon tea at 3:00 pm. The menu for the meals provided to the children is shown as Table 3.10 (see Section 3.6.2).

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Usually, most of the children managed to finish all the food provided to them. According to Puan NR, when children were not feeling well, either physically or emotionally, they might not finish all the food served to them. In terms of diet, children generally like to eat fried food, such as fried chicken and fried banana. In particular, they like fast food from Kentucky Fried Chicken (KFC) and McDonald's. As for drinks, the children like sweet drinks, such as syrup, iced Milo, and concentrated fruit drinks.

In terms of healthy food, the children like to eat fruits very much. During non-participative observation, children would request to eat fruit whenever they saw fruits available in either the classroom or the dining hall. Caretakers and teachers normally did not reject their request and would allocate fruits to those who made request. Vegetable was not a preferred food, subjected to the actual type of vegetable provided to them. According to Puan NR, carrot and potatoes were two types of vegetable preferred by the children.

The findings in the interview were consistent with the preferences of children under observation. Tadika NCDRC had established a routine of food and beverage choices. In a word, the design of daily meals in Tadika NCDRC played more important role as compared to the effects of game-based obesity prevention. The effects of the obesity prevention were found significant only on food which was not provided by the NCDRC Kitchen, which were fried food and fast food.

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5.3.3.2 Perceived Conception of Healthy Lifestyle

Children in Tadika NCDRC liked to watch animations and movies. Animation and movies were shown to the children through SMART Interactive Whiteboard with projector in every classroom. The choice of contents was set by teachers, based on the PERMATA curriculum and aligned to the NCDRC creative media guideline. However, as shown in the timetable (see Table 3.6 in Section 3.6.2), Tadika NCDRC were balanced both indoor and outdoor activities. Outdoor activity, such as free play sessions was scheduled for one hour every day. Some sessions like Learning through Project and Creative Movement might involve outdoor activities. The children seemed to like the balanced combination, and they enjoyed doing exercise outside the classrooms.

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When Puan NR was tested on content knowledge related to the danger of childhood obesity, she passed the test by answering all questions correctly. In other words, teachers in Tadika NCDRC seemed to be equipped with knowledge associated to childhood obesity prevention.

Again, the findings in the interview were consistent with the daily activities of the children under observation. Tadika NCDRC had established a routine of weekday activities. In this sense, the curriculum which directed the composition of children's daily activities in Tadika NCDRC played more important role than the game-based obesity prevention.

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5.4 Synthesis of Results in Relation to the Provisional Prevention Framework

The findings revealed through the nonequivalent control group pre-test / post-test quasi-experiment, and the non-participant observation were synthesized to indicate how the provisional framework of game-based childhood obesity prevention should be improved.

As a whole, no significant difference was found in the pre-test scores between the control group and the experimental group, but a significant difference ($p = .050$) between the two groups were found in the post-test scores. A greater significance ($p = .003$) was revealed when the pre-test scores and the post-test scores of the experimental group were compared. The results indicated that, the obesity prevention game created based on the framework was indeed effective among preschool children because exposure to the game had made significant improvement of children in the experimental group.

In terms of gender difference, female performed significantly better ($p = .01$) than male after playing *Fight Obesity 2.0*. Thus, the game seems to work better among female children than among male children. Actually, gender difference should not occur because the serious game was targeted to both male and female players since obesity is a common problem faced by both genders. Therefore, the look-and-feel of the game and the way feedback provided to male players should be customised in each game level so that they become more appealing to male children.

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When attempting to know whether there was a significant difference of preschool children's food preference before and after playing *Fight Obesity 2.0*, the preference of eating fried food (p = .039) and eating fast food (p =.001) reduced significantly before and after playing *Fight Obesity 2.0*. Such results indicated that, the obesity prevention game created based on the framework was indeed effective among preschool children because exposure to the game had made significant improvement in modeling healthy food choice. However, the game seems to work better with female children because they had significantly changed (p =.031) their preference to eat fast food from "like" to "dislike" after playing the game. Again, this was another potential issue of the game and probably the framework as well, since there should not be gender difference when the framework was used.

However, in the attempt to investigate whether or not there was a significant difference of preschool children's conception on the relationship between obesity and physical exercise before and after playing *Fight Obesity 2.0*, no significant difference was found in this study. This result indicated a failure of the serious game to support conception on the relationship between obesity and physical exercise. Perhaps, the tapping interaction and passive gameplay were unable to connect to the relationship between physical exercise and obesity. In order to yield positive outcomes, the user manual or playbook must be used, ideally by kindergarten teachers or parents to explain the relationship. This will help making the learning meaningful to preschool children.

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Similarly, no significant difference was found before and after playing the game in terms of preschool children's conception on the danger of childhood obesity. This was another indication that the serious game failed to deliver meaningful learning outcomes on the danger of childhood obesity. While this situation prompted the need for using the playbook, future study on game-based obesity prevention among preschool children can focus on how to teach them the danger of childhood obesity through game playing.

Findings unfold in the quasi-experiment were indeed confirmed by the outcomes of non-participant observation. Furthermore, the effects of the obesity prevention were found significant only on food which was not provided by the NCDRC Kitchen, as opposed to food in the menu and activities in the schedule set by Tadika NCDRC. With reference to the framework, this indicated a need to reinforce the role played by kindergarten teachers and child caretakers in obesity prevention. Training on game-based childhood obesity prevention should be conducted with the teachers and caretakers to afford them in developing healthy lifestyle. The same training can be offered to parents to cultivate healthy lifestyle in family food preference and physical activities. Parents, kindergarten teachers, and child caretakers should take the initiative to develop healthy lifestyle without depending on doctors' instructions or obesity diagnosis results which was shown in the provisional framework of game-based childhood obesity prevention. Hence, the framework need to improve on this matter.

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5.5 Summary

This chapter elaborates the findings of quasi-experiment, and the non-participant observation. The obesity prevention game created based on the framework was indeed effective among preschool children because exposure to the game had made significant improvement of children in the experimental group. However, female preschool children performed significantly better (p =.01) than male after playing *Fight Obesity 2.0*. In particular, preschool children's food preference of eating fried food and eating fast food reduced significantly after playing *Fight Obesity 2.0*. This indicated a positive effect of the game for developing health diet. Again, the game seems to work better among female than male in developing healthy food preference. The results of the quasi-experiment were echoed by the non-participant observation. The failure of presenting the relationship between physical activities and the danger of obesity can be resolved by having at least a teacher, caretaker or parent to debrief children's performance in relation to the conception upon the danger of obesity.

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CHAPTER 6

DISCUSSION AND CONCLUSION

6.1 Introduction

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This chapter is a synopsis of this research, which includes matching answers unfolded through multiple methods of study to four research questions. The evidence of the contribution to better understanding was presented, specifically on the design, development and validation of a serious game for childhood obesity prevention, and how a game-based childhood obesity prevention framework can work in actual practice. The chapter also discusses the limitations of the thesis and the recommendations for future studies.

6.2 Answers to the Research Questions

This research aimed to create a framework of game-based childhood obesity prevention which can afford the design, development and validation of serious games

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for use in childhood obesity prevention. To achieve this aim, four research objectives were set (see Section 1.4), as shown in Figure 6.1.

The first objective was to design, develop and validate a mobile game for use in childhood obesity prevention among preschool children, which was accomplished and reported in Chapter 4. A serious game titled *Fight Obesity 2.0* was designed and developed through a collaboration between the subject matter expert who is a pediatrician in China and a team of game experts. The content knowledge of the game was validated by two pediatricians, one in China and another in Malaysia. The design of the game was validated by 38 game designers using the SUMI rating. In a word, experts validation assured that the mobile game should be able to achieve intended childhood obesity prevention outcomes among preschool children.

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Three other research objectives were realized through the methodology and research methods depicted in Chapter 3. In particular, a nonequivalent control group pre-test / post-test quasi-experiment was carried out to test three hypotheses listed in Section 1.5. Twenty-one subsidiary null hypotheses were formulated and tested using nonparametric statistical analysis in IBM SPSS. The results of the hypotheses testing were triangulated with findings drawn from a non-participant observation and semi-structured interviews, in order to answer research questions. This in turn achieved all research objectives.

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Figure 6.1. Relationship between the Research Aim, Research Objectives and Research Questions

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6.2.1 How to Design, Develop and Validate a Serious Game for Use in Childhood Obesity Prevention?

The creation of *Fight Obesity 2.0* tried to avoid four assumptions pointed out by Michael and Chen (2005) when producing serious games. As a result, the game met the minimum viable product requirements for conducting an academic research (York, 2012), as opposed to meeting high quality standards like commercial off-the-shelf games produced in the creative industry. The intention of the serious game was to address issues of using games in childhood obesity prevention (see section 2.3.3). Skeptics who opposed or worried about the use of games condemn games for causing public health problem (such as Daley, 2009). They were looking for evidence to stop parents or child caretakers from permitting children to play video games. While it is

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important to insist that this thesis never perceives mobile games as a substitute for real sports or physical activities, the effects of well-designed serious games should not be denied.

In practice, the five-step gamification approach introduced by Tan (2015) was chosen to gamify three types of content knowledge on childhood obesity: 1) knowledge for Fight Obesity; 2) knowledge of ways and means of treating childhood obesity; and 3) knowledge of the universals and abstraction in treating childhood obesity (see Section 4.4). The content knowledge was dissected into three components, which were intended observable behaviours, conditions of goal attainment and degree of goal attainment. The intended observable behaviours in all game levels were aligned to game goal, the conditions of goal attainment were set as game rules, and the degree of goal attainment were governed through in-game interaction (Tan, 2015). The mapping between the above mentioned three components and three structural elements of games (Prensky, 2007) were called ‘constructive alignment’, a modification of the outcome-based teaching and learning approach introduced by Biggs and Tang (2007).

In order to engage the targeted preschool children, the player-centric emotional design approach (Shahrel, Tan & Zaffwan, 2014) was applied to generate novel gameplay ideas and to meet the aesthetic expectation of children. Once the design reached a satisfactory level, the lean production strategy (York, 2012) was deployed to build a paper-based prototype, and then a minimum viable product—a mobile game with minimum features, alongside with supporting paratextual materials

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and a training module. The overall design and development process of *Fight Obesity 2.0* is shown as Figure 6.2.

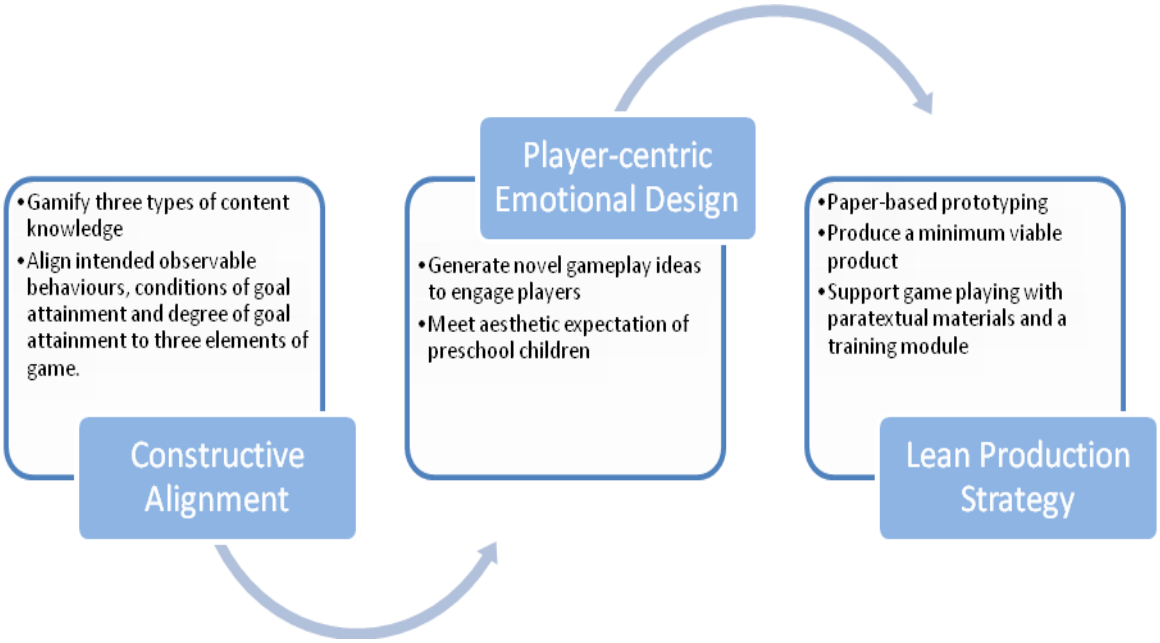


Figure 6.2. The Overall Game Design and Development Process

The validation of serious games was split into three scopes, which were content knowledge, game technology and prevention strategy. Four strategies were deployed to validate three scopes of *Fight Obesity 2.0*, which were 1) age rating; 2) usability rating; 3) expert verification; and 4) edumetric test. The first strategy was using the age rating offered by IARC (refer to Figure 4.43), in which Fight Obesity was rated by the Germany *Unterhaltungssoftware Selbstkontrolle* or Entertainment Software Self-Regulation (USK) as a game without age restriction, which was "directly aimed at children and young person as well as at an adult buyer group" (USK, 2016). Similar rating was given to the game by the Australian Classification Board (ACB), the Brazilian Advisory Rating (ClassInd), and the Entertainment

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Software Rating Board (ESRB) in the United States of America. However, the Pan European Game Information (PEGI) and the IARC gave a 3+ rating to *Fight Obesity 2.0*.

In terms of usability ratings, *Fight Obesity 2.0* obtained a total score of 80% (40 out of 50 test items), in which it gained 16 modes on "Agree" in positive test items and 24 modes on "Disagree" in negative test items (refer to Section 4.9.4). Specifically, the game scored 9 out of 10 in learnability; 8 out of 10 in likeability, efficiency and control; and 7 out of 10 in helpfulness. This positive result was an evidence to show the good quality of *Fight Obesity 2.0*, which in term justified the choice of using Tan's (2015) gamification approach. Same positive propositions were gathered from two pediatricians (see Section 4.10.1), particularly on the accuracy of the content knowledge and fun gameplay.

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The effects of *Fight Obesity 2.0* in actual usage in kindergarten was examined through the nonequivalent control group pre-test / post-test quasi-experiment. An edumetric test using 13 test items (see Appendix C) revealed that, the children's performance in the pre-test and the post-test showed significant improvement ($p = .003$) after playing *Fight Obesity 2.0*. In terms of gender difference, female performed significantly better ($p = .01$) than male after playing *Fight Obesity 2.0*. In conclusion, *Fight Obesity 2.0* can make significant positive effects in the game-based childhood obesity prevention framework.

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6.2.2 Is There a Significant Difference of Preschool Children's Food Preference Before and After Playing an Obesity Prevention Game?

The general null hypothesis set for the second research question was: preschool children's food preference shows no significant difference before and after playing an obesity prevention game. Fifteen subsidiary hypotheses were formulated and tested in order to answer the research question. Table 6.1 shows the overall results of the hypotheses testing.

Four subsidiary null hypotheses were rejected ($H_0$7, $H_0$9, $H_0$13 & $H_0$15), which meant that there was significant difference on the preference of eating fried food and eating fast food between the pre-test and the post-test, in which the significance occurred as a result of playing *Fight Obesity 2.0*. In a word, the game actually yielded positive effects on the children's food preferences, particularly on reducing the choice for unhealthy food.

The conclusion made in this research reinforced the positive effects revealed by other scholars, especially the work done by Baños et al. (2013) who stressed that nutritional knowledge is required to prevent and treat obesity. While active gaming can improve endothelial dysfunction and other risk factors faced by overweight children (Murphy et al., 2009), the findings of this research proved that playing a sedentary game can improve conception of positive food preference, in which issue raised by Pampek and Calvert (2009) on the danger of using advergame to promote unhealthy snack can actually be resolved by playing a obesity prevention game like *Fight Obesity 2.0*.

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Table 6.1

Hypotheses Tested for Answering the Second Research Question

Food type	Hypothesis	Results
Healthy	$H_0$1: There was no significant difference on the preference of eating fruits between the pre-test and the post-test.	Did not reject null hypothesis
	$H_0$2: There was no significant difference on the preference of eating vegetables between the pre-test and the post-test.	Did not reject null hypothesis
	$H_0$3: There was no significant difference on the preference of eating fruits between the pre-test and the post-test within the control group.	Did not reject null hypothesis
	$H_0$4: There was no significant difference on the preference of eating vegetables between the pre-test and the post-test within the control group.	Did not reject null hypothesis
	$H_0$5: There was no significant difference on the preference of eating fruits between the pre-test and the post-test within the experimental group.	Did not reject null hypothesis
	$H_0$6: There was no significant difference on the preference of eating vegetables between the pre-test and the post-test within the experimental group.	Did not reject null hypothesis
Unhealthy	$H_0$7: There was no significant difference on the preference of eating fried food between the pre-test and the post-test.	Rejected null hypothesis
	$H_0$8: There was no significant difference on the preference of drinking soft drink between the pre-test and the post-test.	Did not reject null hypothesis
	$H_0$9: There was no significant difference on the preference of eating fast food between the pre-test and the post-test.	Rejected null hypothesis
	$H_0$10: There was no significant difference on the preference of eating fried food between the pre-test and the post-test within the control group.	Did not reject null hypothesis
	$H_0$11: There was no significant difference on the preference of drinking soft drink between the pre-test and the post-test within the control group.	Did not reject null hypothesis
	$H_0$12: There was no significant difference on the preference of eating fast food between the pre-test and the post-test within the control group.	Did not reject null hypothesis
	$H_0$13: There was no significant difference on the preference of eating fried food between the pre-test and the post-test within the experimental group.	Rejected null hypothesis
	$H_0$14: There was no significant difference on the preference of drinking soft drink between the pre-test and the post-test within the experimental group.	Did not reject null hypothesis
	$H_0$15: There was no significant difference on the preference of eating fast food between the pre-test and the post-test within the experimental group.	Rejected null hypothesis

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6.2.3 Is There a Significant Difference of Preschool Children's Conception on the Relationship between Obesity and Physical Exercise Before and After Playing an Obesity Prevention Game?

The general null hypothesis set for the third research question was: preschool children's conception on the relationship between obesity and physical exercise show no significant difference before and after playing an obesity prevention game. Three specific hypotheses were formulated and tested but none of the null hypotheses were rejected, as shown in Table 6.2. In a word, *Fight Obesity 2.0* did not show either positive or negative effects on the preschool children's conception on the relationship between obesity and physical exercise.

Table 6.2

Hypotheses Tested for Answering the Third Research Question

Activities	Hypothesis	Results
Matching body size	$H_0$16: There was no significant difference on the conception of personal body size between the pre-test and the post-test.	Did not reject null hypothesis
Watching TV	$H_0$17: There was no significant difference on the preference of watching TV at home between the pre-test and the post-test.	Did not reject null hypothesis
Doing Exercise	$H_0$18: There was no significant difference on the preference of doing exercise between the pre-test and the post-test.	Did not reject null hypothesis

Despite showing no significant effects on the conception, this answer to the third research question echoed the results of the game-based obesity treatment using active gaming which was conducted by Radon et al. (2010) under a clinical setting. Therefore, it is fair to conclude that, neither active gaming or cognitive gaming to date can achieve the same effects of conventional obesity treatment (Daley, 2009). More works should be carried out to explore why this is the case, before creating more serious games which aim to teach children the relationship between obesity and physical exercise.

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6.2.4 Is There a Significant Difference of Preschool Children's Conception on the Danger of Obesity Before and After Playing an Obesity Prevention Game?

The general null hypothesis set for the fourth research question was: preschool children's conception on the danger of obesity shows no significant difference before and after playing an obesity prevention game. Three specific hypotheses were formulated and tested but none of the null hypotheses were rejected, as shown in Table 6.3. In conclusion, *Fight Obesity 2.0* did not show either positive or negative effects on the preschool children's conception on the danger of obesity. It also showed no effect on their conception on what to do after they became obese.

Table 6.3

Hypotheses Tested for Answering the Fourth Research Question

Hypothesis	Results
$H_0$19: There was no significant difference on the conception that obesity can cause heart problem between the pre-test and the post-test.	Did not reject null hypothesis
$H_0$20: There was no significant difference on the conception that obesity can cause diabetes between the pre-test and the post-test.	Did not reject null hypothesis
$H_0$21: There was no significant difference on the conception of what to do after became obese between the pre-test and the post-test.	Did not reject null hypothesis

Similar to section 6.2.3, no significant effects on the conception may also contribute to understanding the weaknesses of the provisional framework of game-based childhood obesity prevention. Both commercial off-the-shelf games or serious games may motivate patients to engage in obesity treatment (e.g. Fogel et al., 2010), their actual effects in establishing preschool children's conception on the danger of obesity were very limited. Nonetheless, the effort of obesity prevention can be extended to the family daily activities, as suggested by Dr. LKF in the interview (see

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section 4.10.2). In other words, a blended prevention approach would be more promising than using either serious games or leisure games alone.

6.3 Contributions of the Thesis

Three noteworthy contributions were made to the body of knowledge in the field of child and adolescent development. This thesis presented an innovative obesity prevention approach for preschool children through the creation and validation of a game-based childhood obesity prevention framework. The validation of the framework was achieved by designing and developing a serious game titled *Fight Obesity 2.0*. This mobile game was created using a combination multiple gamification approach, integrating the player-centric emotional design (Shahrel, Tan & Zaffwan, 2014) and the lean game production method (York, 2012). The approach would make current gamification practices more systematic and dynamic, particularly when aligning intended prevention outcomes with structural elements of games. The outcomes—the *Fight Obesity 2.0* and its paratextual materials have been proven effective through the deployment of the three-scope validation strategy. By using this strategy, the quality of serious games for prevention can be assured through the validation of their content knowledge, game technology, and prevention strategy.

This thesis also proved the positive effects of a serious game for changing unhealthy food preference. This contribution should be augmented to benefit a greater community, cultivating a healthy young generation for Malaysia.

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6.3.1 A Revised Framework of Game-based Childhood Obesity Prevention

After conducting the quasi-experiment, the provisional game-based childhood obesity prevention framework was revised by referring to the research findings and answers of research questions in this research. This revised framework is enhanced by revisiting the guides for kindergarten, parents and individual children (see Figure 6.3).

As presented in the framework, all childhood obesity prevention strategies are geared towards guiding obese children to develop healthy lifestyle, by establishing healthy diet and encouraging physical activity through games. Both parents and caretakers from kindergarten should work together to provide early experiences with healthy foods which can help developing their flavours and food preferences. They can also collaborate to monitor the rate of children's weight increment or decrement to prevent early adiposity rebound. In addition, parents are encouraged to practice appropriate parental feeding under this prevention framework.

Comparing to the provisional framework, the revision indicated the beginning and the end of childhood obesity prevention (represented in ovals). Also, the roles of both parents and kindergarten are no longer depended on the results of simple overweight and obesity diagnosis. Instead, they are made independent in the revised framework so they can start developing healthy lifestyle among the children in kindergarten and at home by using an obesity prevention game.

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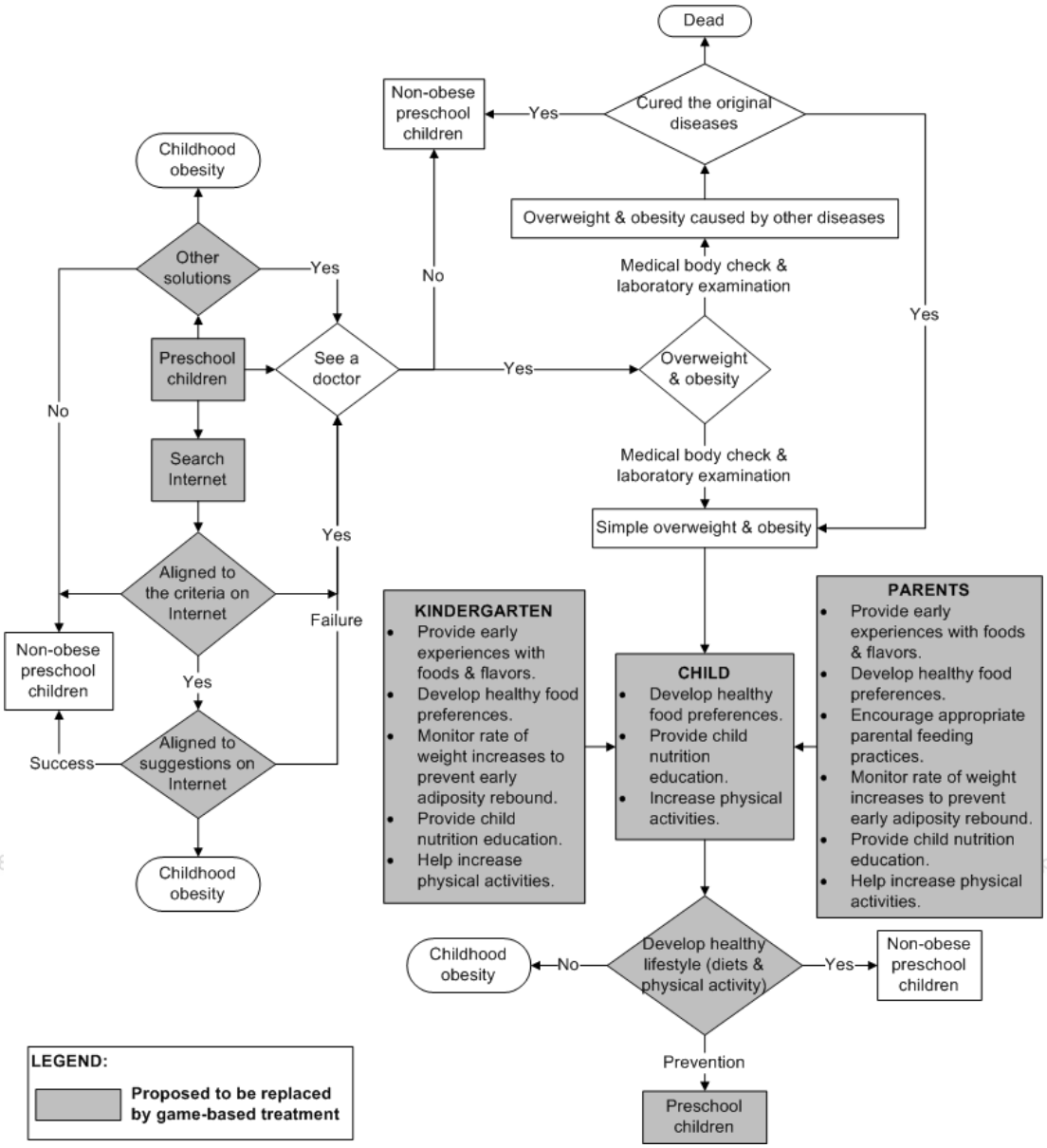


Figure 6.3. The Revised Game-based Childhood Obesity Prevention Framework

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6.3.2 Guiding Principles for Medical Professionals, Game Designers, Preschool Teachers and Parents

A set of guiding principles has been prepared for people who intend to use the framework of childhood obesity prevention. These people are medical professionals, game designers, preschool teachers and parents.

To medical professionals who are interested to create serious games for health, they should prepare three types of content knowledge: knowledge of an illness, knowledge of ways and means of treating or preventing the illness; and knowledge of the universals and abstractions in treating the illness (as shown in section 4.4). They should also determine specific feedback to be given to patients and propose how patient players should interact in the game environment (such as Figure 4.12). Instead of designing the serious game themselves, medical professionals should collaborate with game designers to design and develop games. When the game is playable, they should validate game contents, particularly the illness treatment and prevention strategies. In practice, they should prepare user manual or playbook for preschool teachers and parents to use serious games for health (see section 4.9.3).

For game designers who are interested in creating serious games for health, they should set the gameplay, game level, game story and game space, while collaborating with medical professionals to acquire game contents and feedback to be provided to patients in the game environment (see section 3.4). When the game is playable, game designers should balance the game, particularly by validating the playability and usability of the game (see section 3.5). In addition, they should work

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closely with medical professionals by aligning game features to intended prevention and treatment, and also preparing the user manual or playbook.

To parents and preschool teachers, they should refer to the user manual or playbook when organizing game-based prevention activities. Before or at the beginning of a game playing session, they should brief children about the objective of the game. When children are playing the game, they should monitor the children's performance and taking observation notes. The notes will be used in the debriefing of the end of a game playing session. Parents or preschool teachers should relate the children's achievement in the game to issues or concepts associated to the illness, supporting the children to transfer knowledge from the game environment to the real-life daily living.

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6.4 Limitations of the Prevention Framework and the Thesis

Despite showing promising outcomes, the framework of game-based childhood obesity prevention and the thesis did possess limitations, which would not be resolvable at the time when those limitations emerged. This first limitation was found in the game-based childhood obesity prevention framework. Despite being proven as an effective framework for obesity prevention, the results actually showed unwanted significant gender differences. Thus revision of the framework should be done research-by-research, until the framework reaches the state of saturation (Saunder et al., 2017). The universality of the framework could be questionable as it was

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incubated according to medical practice in China, rather than in Malaysia. Although the SOP of childhood obesity treatment and obesity treatment algorithm were acquired from reliable sources of reference (see National Institutes of Health, 2002), balancing the universality and locality of the framework became a constant challenge throughout the study.

In terms of game design, all the game characters were designed by female game artists. This resulted the underlying feminine design for *Fight Obesity 2.0*. In contrary, all testers who involved in the playtesting session were Malaysian Chinese male, as opposed multiracial testers of both gender. The single race situation reverted from Malaysian Chinese to nearly all Malay when conducting the quasi-experiment at the Tadika NCDRC. Only one Malaysian Chinese female child took part in the quasi-experiment.

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Technical issues were another limitation encountered in this research. Nearly all testers played *Fight Obesity 2.0* using desktop computer, in which they were running the game on an emulator as opposed to actual seven inches tablet computer. As for data collection in Tadika NCDRC, only five tablets were available for use in this research, thus the children had to queue for their turn, in which they might have lost interests before getting their turn to play.

No access was granted to obtain personal data of the parents of the children. Knowing the parents' actual BMI would be helpful to determine whether or not parents' body size correlate with the body size of the preschool children.

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In terms of measurement on the effects of *Fight Obesity 2.0*, the focus of this research was deliberately limited to edumetric tests, rather than including any psychometric tests. In other words, the focus of measurement was focusing on intrapersonal improvement, rather than interpersonal comparison as in psychometrics.

6.5 Potential Future Studies

One possible and potential study in near future would be focusing on cross-cultural differences on the conception of healthy lifestyle. Different versions of Fight Obesity game may be designed and developed with different food choices or combinations that reflect culture-driven food preferences. For instance, actual food choice in the Best Diet for Healthy Eating in 2017 ranked by the Government of the United States of America which is called Dietary Approaches to Stop Hypertension or DASH (see U.S. News and World Report, 2017), could be quite different from the Malaysian Dietary Guidelines published by the Ministry of Health (2010). Nutritionist in the Western countries generally do not recommend eating rice for dinner (Sifferlin, 2016), but rice is commonly included in the main cuisine for dinner in Malaysian family.

An updated 3.0 version of Fight Obesity may be worth designed to move beyond a simplistic classification of “healthy” or “unhealthy” food. Preschool children should be guided to mix and match their daily diet throughout a week time,

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rather than tagging certain food as unhealthy food all the time. The effects of this version of Fight Obesity in developing balanced dietary habit can be studied.

The role of family engagement in game-based childhood obesity prevention is another potential area for future studies. Preschool children generally spend more time at home with their family than children at different age range. Thus the role of their parents and siblings may be investigated to optimize the use of serious games for health to tackle obesity issues. In fact, the importance of involving parents has been stressed by Dr. LKF in section 4.10.2.

The effects of the playbook or training module (see section 4.9.3) may be worth explored in the future. Comparison can be made between parents, kindergarten teachers, child caretakers when using the playbook to implement game-based obesity prevention.

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APPENDIX A: Child Development Milestones

Source: http://www.cdc.gov/ncbddd/childdevelopment/facts.html

Stages of Child Development	Age range	Development Milestones
Infant	0 – 1 year	In the first year, babies learn to focus their vision, reach out, explore, and learn about the things that are around them. Cognitive, or brain development means the learning process of memory, language, thinking, and reasoning. Learning language is more than making sounds ("babble"), or saying "ma-ma" and "da-da". Listening, understanding, and knowing the names of people and things are all a part of language development. During this stage, babies also are developing bonds of love and trust with their parents and others as part of social and emotional development. The way parents cuddle, hold, and play with their baby will set the basis for how they will interact with them and others.
Toddler	1 – 2 years	Skills such as taking a first step, smiling for the first time, and waving "bye-bye" are called developmental milestones. Developmental milestones are things most children can do by a certain age. Children reach milestones in how they play, learn, speak, behave, and move (like crawling, walking, or jumping). During the second year, toddlers are moving around more, and are aware of themselves and their surroundings. Their desire to explore new objects and people also is increasing. During this stage, toddlers will show greater independence; begin to show defiant behavior; recognize themselves in pictures or a mirror; and imitate the behavior of others, especially adults and older children. Toddlers also should be able to recognize the names of familiar people and objects, form simple phrases and sentences, and follow simple instructions and directions.
	2 - 3	Skills such as taking turns, playing make believe, and kicking a ball, are called developmental milestones. Developmental milestones are things most children can do by a certain age. Children reach milestones in how they play, learn, speak, behave, and move (like jumping, running, or balancing). Because of children's growing desire to be independent, this stage is often called the "terrible twos." However, this can be an exciting time for parents and toddlers. Toddlers will experience huge thinking, learning, social, and emotional changes that will help them to explore their new world, and make sense of it. During this stage, toddlers should be able to follow two- or three-step directions, sort objects by shape and color, imitate the actions of adults and playmates, and express a wide range of emotions.

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APPENDIX A Continued

Stages of Child Development	Age range	Development Milestones	
Preschoolers	3 – 5	Skills such as naming colors, showing affection, and hopping on one foot are called developmental milestones. Developmental milestones are things most children can do by a certain age. Children reach milestones in how they play, learn, speak, behave, and move (like crawling, walking, or jumping). As children grow into early childhood, their world will begin to open up. They will become more independent and begin to focus more on adults and children outside of the family. They will want to explore and ask about the things around them even more. Their interactions with family and those around them will help to shape their personality and their own ways of thinking and moving. During this stage, children should be able to ride a tricycle, use safety scissors, notice a difference between girls and boys, help to dress and undress themselves, play with other children, recall part of a story, and sing a song.	
Middle Childhood	6 – 8	Emotional / Social Changes	Children in this age group might: • Show more independence from parents and family. • Start to think about the future. • Understand more about his or her place in the world. • Pay more attention to friendships and teamwork. • Want to be liked and accepted by friends.
		Thinking and Learning	Children in this age group might: • Show rapid development of mental skills. • Learn better ways to describe experiences and talk about thoughts and feelings. • Have less focus on one's self and more concern for others.
	9 – 11	Emotional / Social Changes	Children in this age group might: • Start to form stronger, more complex friendships and peer relationships. It becomes more emotionally important to have friends, especially of the same sex. • Experience more peer pressure. • Become more aware of his or her body as puberty approaches. Body image and eating problems sometimes start around this age.
		Thinking and Learning	Children in this age group might: • Face more academic challenges at school. • Become more independent from the family. • Begin to see the point of view of others more clearly. • Have an increased attention span.

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APPENDIX A Continued

Stages of Child Development	Age range	Development Milestones	
Young Teens	12 – 14	Emotional / Social Changes	Children in this age group might: • Show more concern about body image, looks, and clothes. • Focus on themselves; going back and forth between high expectations and lack of confidence. • Experience more moodiness. • Show more interest in and influence by peer group. • Express less affection toward parents; sometimes might seem rude or short-tempered. • Feel stress from more challenging school work. • Develop eating problems. • Feel a lot of sadness or depression, which can lead to poor grades at school, alcohol or drug use, unsafe sex, and other problems.
		Thinking and Learning	Children in this age group might: • Have more ability for complex thought. • Be better able to express feelings through talking. • Develop a stronger sense of right and wrong.
Teenagers	15 – 17	Emotional / Social Changes	Children in this age group might: • Have more interest in the opposite sex. • Go through less conflict with parents. • Show more independence from parents. • Have a deeper capacity for caring and sharing and for developing more intimate relationships. • Spend less time with parents and more time with friends. • Feel a lot of sadness or depression, which can lead to poor grades at school, alcohol or drug use, unsafe sex, and other problems.
		Thinking and Learning	Children in this age group might: • Learn more defined work habits. • Show more concern about future school and work plans. • Be better able to give reasons for their own choices, including about what is right or wrong.

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APPENDIX B: Test Questions Set for The Pre-test and The Post-test

PART A: About the participant

1. Date of Birth: _____

2. Gender: Male Female

3. Ethnicity: Malay Iban Kadazan / Dusun
Chinese Indian Other (Please specify: _____)

4. Weight: _____kg

5. Height: _____cm

PART B: Food Preferences and Physical Activities Observation

Q1 What do you want for breakfast, lunch and dinner?

Breakfast:	
Lunch:	
Dinner:	

Q2 Do you like to eat fried food? Such as fried chicken and fried bananas.
Yes No

Q3 Do you like soft drinks?
Yes No

Q4 Do you like to eat fruits?
Yes No

Q5 Do you like to eat vegetables?
Yes No

Q6 Do you like to eat fast food? Such as KFC and McDonald's
Yes No

Q7 Do you think your mother is fat or thin?
Yes No

Q8 Do you think you are fat or thin?
Yes No

Q9 Do you like to watch TV?
Yes No

Q10 Do you like to do exercise? Such as running, climbing, swimming, playing badminton.
Yes No

Q11 Can obesity cause heart problems?
Yes No

Q12 Can obesity cause diabetes?
Yes No

Q13 What would you do if you become very fat in the future?

_____

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APPENDIX C: Application to Conduct Research at Tadika NCDRC

UNIVERSITI PENDIDIKAN SULTAN IDRIS
SULTAN IDRIS EDUCATION UNIVERSITY
UNIVERSITI PENDIDIKAN SULTAN IDRIS
35900 Tanjong Malim
Perak Darul Ridzuan, Malaysia
Tel : 605 450 5487 (Dekan), 450 5494, 450 5480, 450 5490, 450 5473
Fax : 605 459 4649
http://ips.upsi.edu.my Email : ips@upsi.edu.my

Institut Pengajian Siswazah

Rujukan Tuan :
Rujukan Kami : UPSI/IPS-1/623.5
Tarikh : 18 May 2016

TO WHOM IT MAY CONCERN

Sir/Madam,

STUDENT VERIFICATION FOR CONDUCTING RESEARCH

I would like to bring your attention regarding the above matter.

2. I hereby verified student mentioned in this letter (as per name and matrix number below) is a student of Graduate Studies Programme at Sultan Idris Education University (UPSI);

Student Name	: Wang Yanzhen
Identity Card Number	: G49743916
Matrix Number	: P20122002052
Programme	: Doctor of Philosophy (Child and Adolescent Development)
Field of Study	: PT140 - Child and Adolescent Development
Faculty	: National Child Development Research Centre
Intake	: Semester II Session 2012/2013

3. Prior to above matter, Institute of Graduate Studies (IGS) is seeking your kindness and co-operation to give permission for the above student to conduct his study and research at UPSI on Friday and Saturday for the completion of her/his study.

Thank you.

Yours Sincerely,

(PROFESOR DR. MAHZAN BIN ARSHAD)
Dean
Institute Of Graduate Studies

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APPENDIX D: Approval Granted to Conduct Research at Tadika NCDRC

UNIVERSITI PENDIDIKAN SULTAN IDRIS
35900 Tanjong Malim,
Perak Darul Ridzuan, Malaysia
Tel : 05-450 6000 / 5085
Faks : 05-459 0169
www.upsi.edu.my Emel : ncdrc@upsi.edu.my

Pusat Penyelidikan Perkembangan Kanak-kanak Negara
National Child Development Research Centre (NCDRC)

UPSI/NCDRC/TAS/7631(2)

Rujukan Tuan :
Rujukan Kami :
Tarikh : 13 Jun 2016

Mrs. Wang Yanzhen
P20122002052

APPROVAL FOR CONDUCTING RESEARCH

2. I'm pleased to inform that your application to conduct research (The Game – based Treatment Among Preschool Children in Malaysia) at our preschool have been approved. Please abide to our rules and ethic as stated in our research policy.

3. For further information and any inquiries, please do not hesitate to contact our officer Mdm. Amelia at 015-48797142.

Thank You,

"COMMITED TO MAKING A DIFFERENCE IN EDUCATION"

PROF. DR.SOPIA BINTI MD YASSIN
(Director of National Child Development Research Centre)

s.k Penolong Pendaftar Kanan NCDRC
Pengurus Taska PERMATA dan Tadika UPSI
Fail

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APPENDIX E: Follow-up Observation Checklist

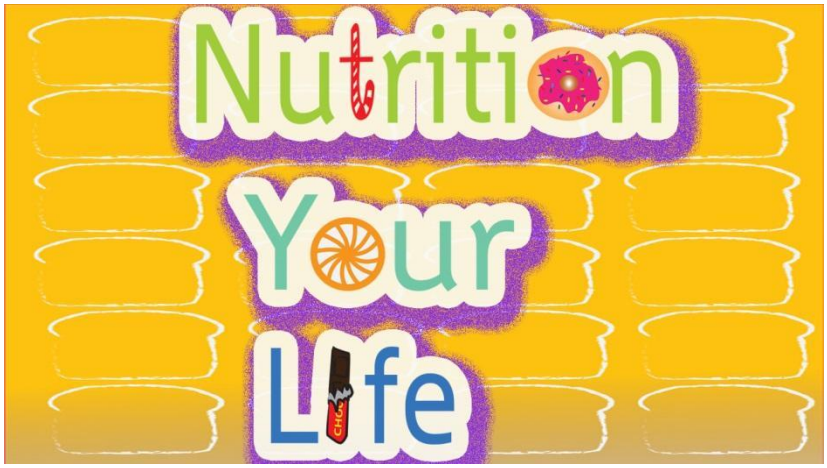
PART A: About the participant			
1. Date of Birth: _____			
2. Gender:	Male	Female	
3. Ethnicity:	Malay	Iban	Kadazan / Dusun
	Chinese	Indian	Other (Please specify: _____)
4. Weight:	_____kg		
5. Height:	_____cm		

PART B: Food Preferences and Physical Activities Observation					
Date	**Begin time**	**End Time**	**Positive Behaviour**	**Negative Behaviour**	**Remark**

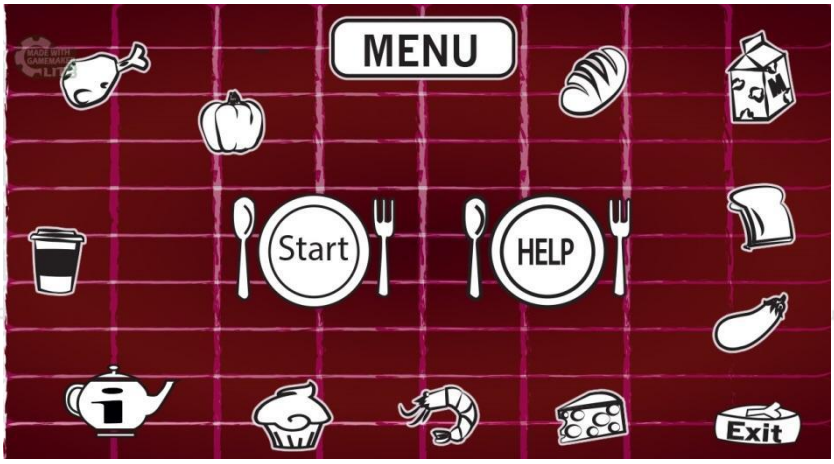
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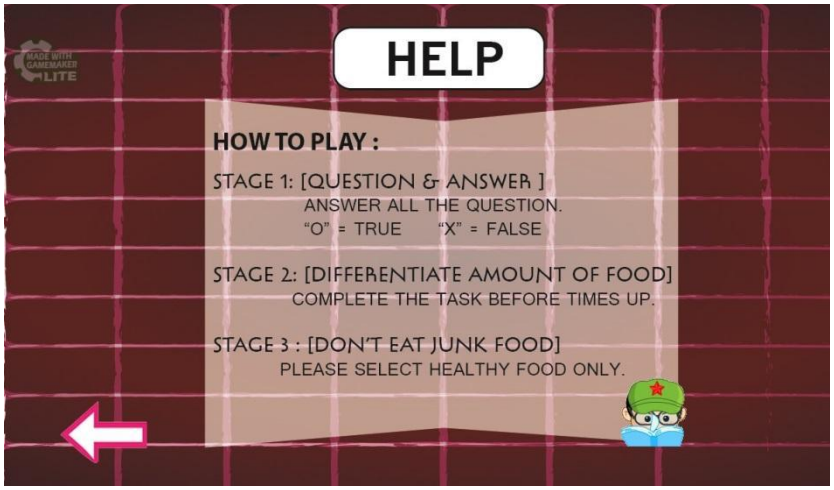
APPENDIX F: Screen Shots of Nutrition Your Life



Splash Screen



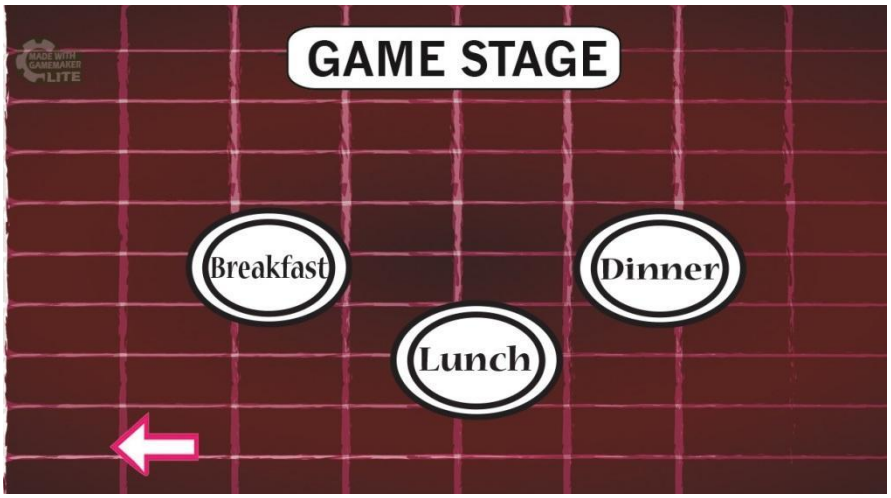
Main Menu



Help: description of gameplay

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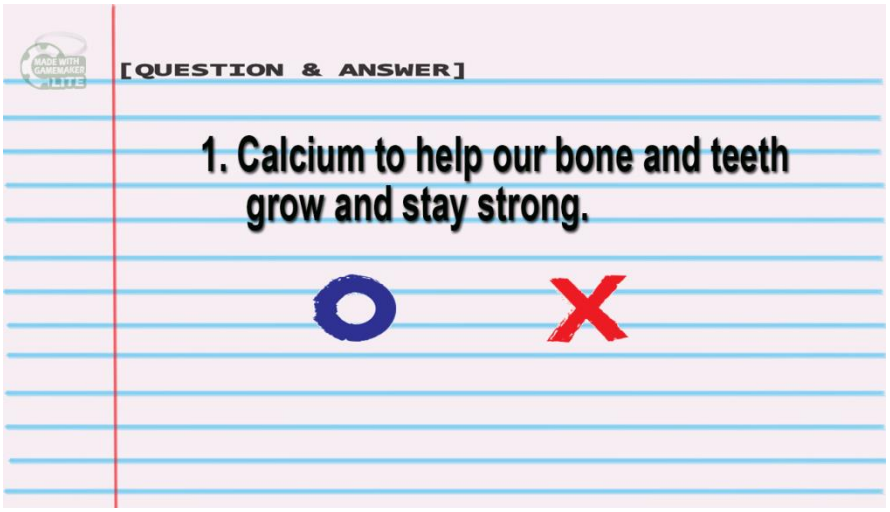
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Game Stage Menu: Choosing one of three levels—Breakfast, Lunch or Dinner



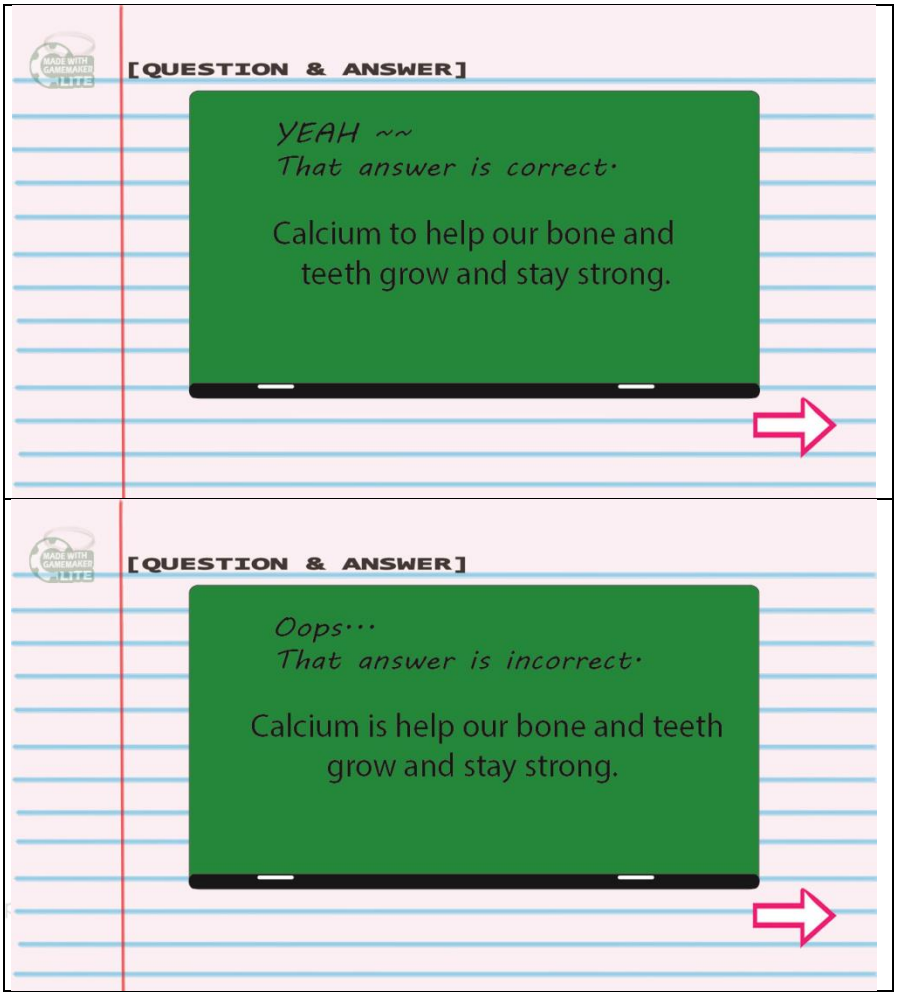
Stage 1 Splash Screen



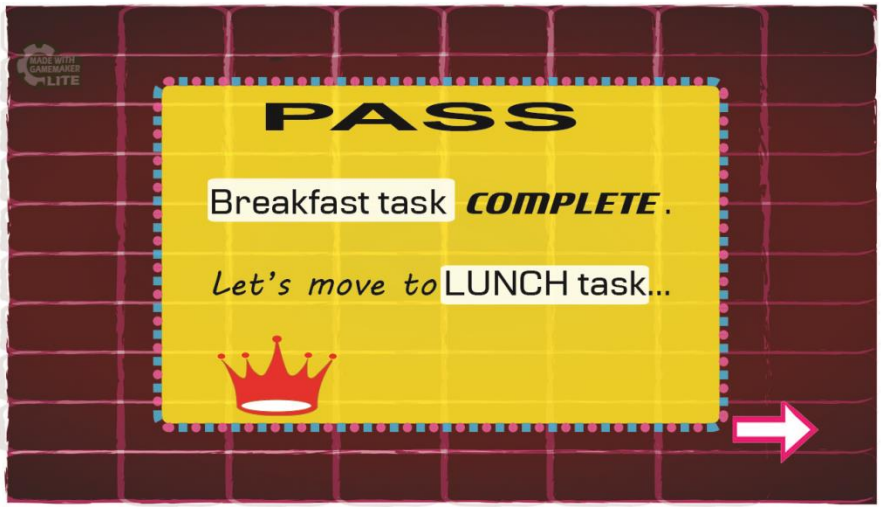
Question 1 in Stage 1

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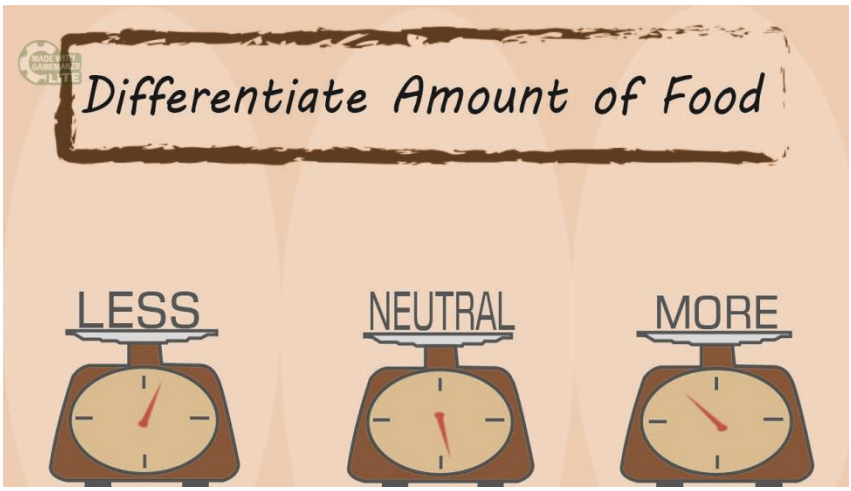
Feedback of correct answer and wrong answer for Questions 1 in Stage 1



Victory scenario in Stage 1

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Stage 2 Splash Screen



Stage 2: Choose whether the avatar should eat more, less or neutral of the give food



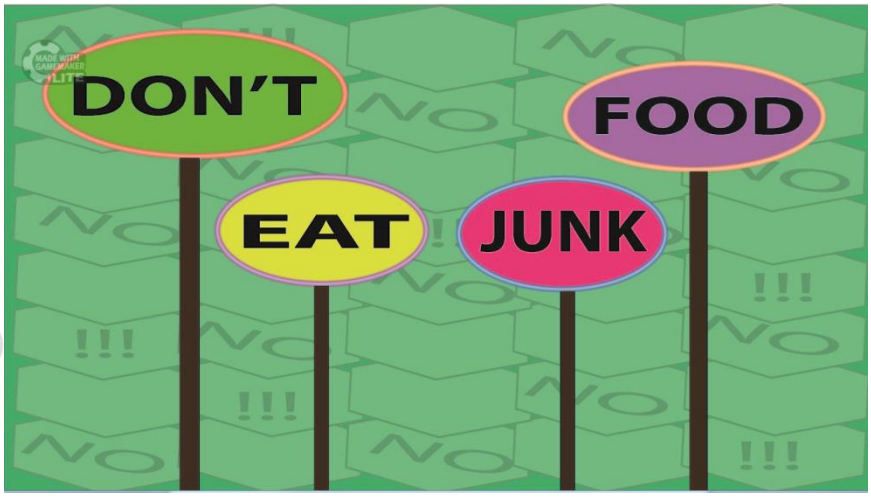
Tips for winning Stage 2

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Victory scenario in Stage 2



Stage 3 Splash Screen



Stage 3: Click on healthy food to win

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Victory scenario in Stage 3



Exit confirmation screen



Game Credits

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APPENDIX G: Screen Shots of Fight Obesity



Game Icon of Fight Obesity



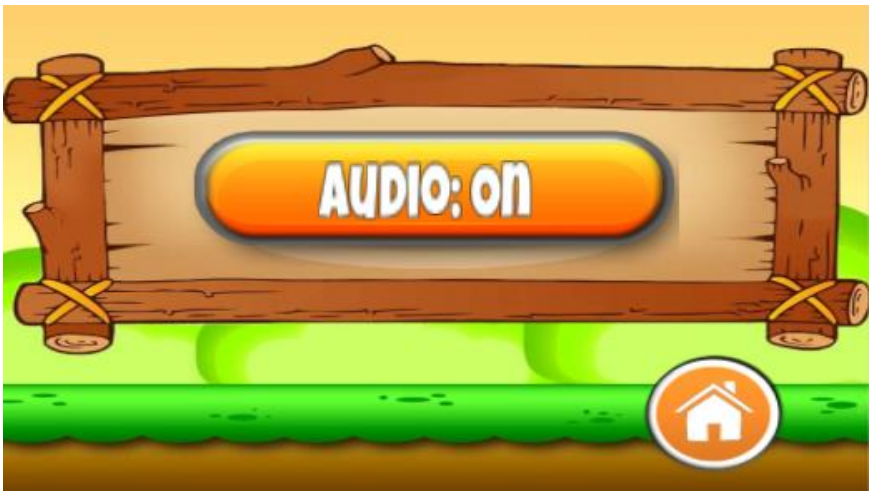
Main Menu



Background story

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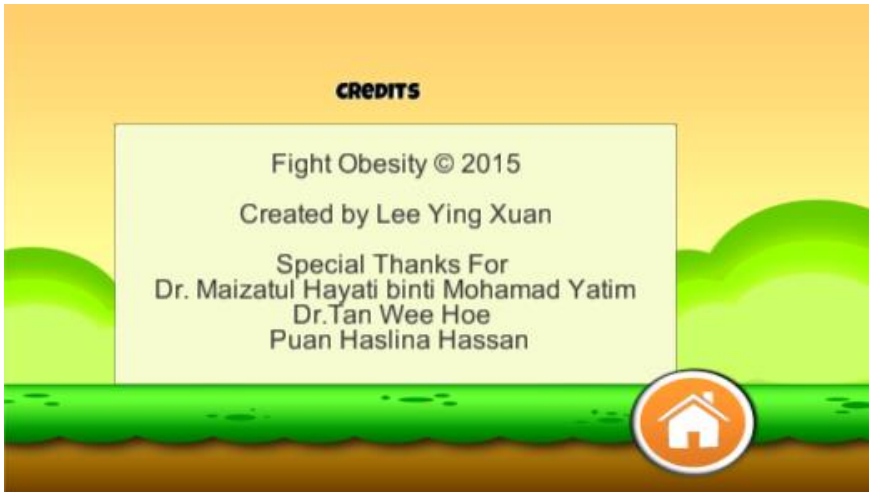
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Option: Turning audio on or off



Stage Selection Menu



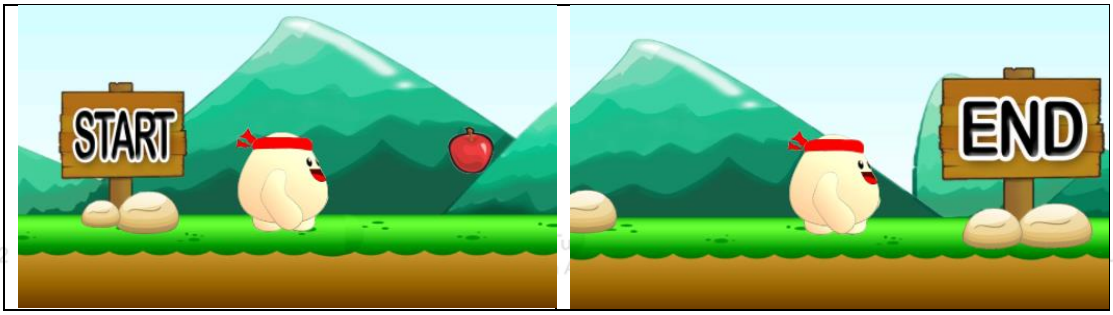
Game Credits

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Stage 1: How to play



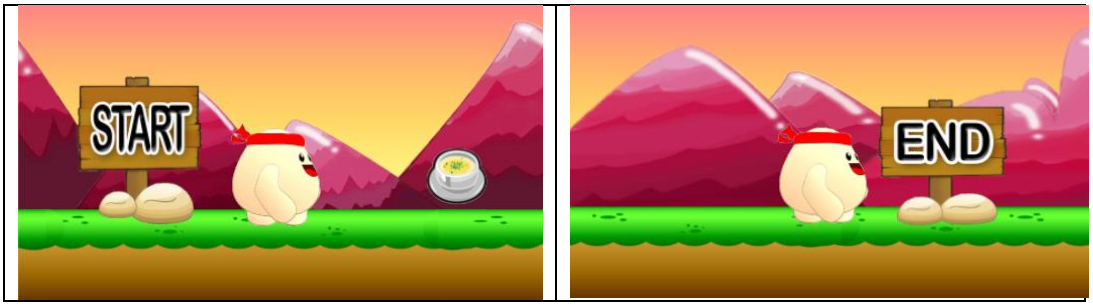
Begin and the end of Stage 1



Stage 2: How to play

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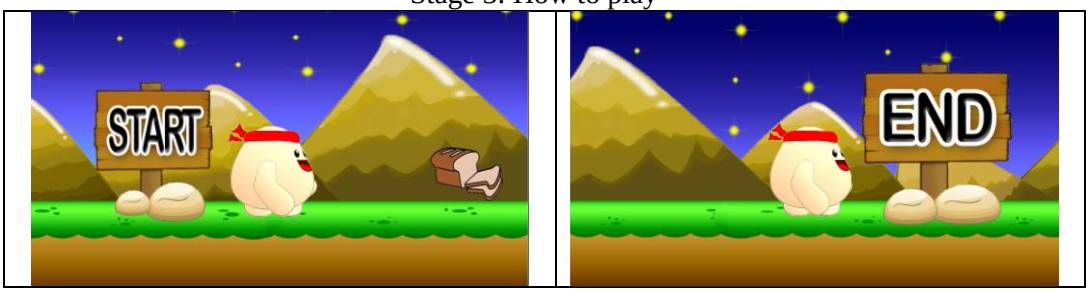
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Begin and the end of Stage 2



Stage 3: How to play



Begin and the end of Stage 3



Victory and game over screens

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All the food featured in Fight Obesity

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APPENDIX H: IARC Rating Questionnaire for Digital Games

A. VIOLENCE

Q1. Does the game contain inferences of, references to, or depictions of violence?

○ Yes (go to Q1.1) ○ No (go to Q2)

A1. VIOLENCE AGAINST HUMANS

Q1.1 Does the game contain violence or implied violence against humans?

○ Yes (go to Q1.1.1) ○ No (go to Q1.2)

Q1.1.1 In what kind of setting (context, storyline) does the violence occur?

○ Childlike ○ Fantastical ○ Realistic

Q1.1.2 How would you describe the portrayals of violence?

○ Unrealistic ○ Realistic

Q1.1.3 How is this violence presented in the game?

☐ Referred to

☐ Implied but not seen

☐ Rarely depicted from a distant perspective

☐ Often depicted from a distant perspective

☐ Rarely depicted from a close-up perspective

☐ Often depicted from a close-up perspective

Q1.1.4 What is the level of blood and/or gore associated with this violence?

○ None

○ Mild/Limited

○ Moderate

○ High

Q1.1.5 Can innocent or defenseless characters be seriously injured or killed?

○ No ○ Yes, with consequences ○ Yes, without consequences

Q1.1.6 Is the player rewarded or otherwise stimulated to use the most aggressive, cruel or bloody violent acts available?

○ Yes ○ No

Q1.1.7 Are there any fierce sounds, dark overtones, or other disturbing elements?

○ Yes ○ No

A2. VIOLENCE AGAINST NON-HUMANS

Q1.2 Does the game contain violence against anything other than humans (e.g., animals, fantasy creatures, robots)?

○ Yes (go to Q1.2.1) ○ No (go to Q2)

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Q1.2.1 In what kind of setting (context, storyline) does the violence occur?

○ Childlike ○ Fantastical ○ Realistic

Q1.2.2 How would you describe the portrayals of violence?

○ Unrealistic ○ Realistic

Q1.2.3 How is this violence presented in the game?

☐ Referred to

☐ Rarely depicted from a distant perspective

☐ Often depicted from a distant perspective

☐ Rarely depicted from a close-up perspective

☐ Often depicted from a close-up perspective

Q1.2.4 What is the level of blood and/or gore associated with this violence?

○ None ○ Mild/Limited ○ Moderate ○ High

Q1.2.5 Do any of these creatures behave or respond like humans?

○ Yes ○ No

Q1.2.6 Is any of this violence against real-world animals?

○ Yes ○ No

Q1.2.7 Are there any fierce sounds, dark overtones, or other disturbing elements?

○ Yes ○ No

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B. FEAR

Q2. Does the game contain pictures or sounds likely to be scary or horrifying?

○ Yes (go to Q2.1) ○ No (go to Q3)

Q2.1 How frequently do scary elements occur?

○ Never ○ Rarely ○ Often

Q2.2 How frequently do horrifying elements occur?

○ Never ○ Rarely ○ Often

C. SEXUALITY

Q3. Does the game contain inferences of, references to, or depictions of sexuality, sexual violence, suggestiveness, provocative attire, or nudity?

○ Yes (go to Q3.1) ○ No (go to Q4)

Q3.1 Does the game contain any sexual activity?
This includes both moving and still images of sexual activity.

○ Yes (go to Q3.1.1) ○ No (go to Q3.2)

Q3.1.1 How often do sexual acts occur?

◉ Rarely ○ Often

Q3.1.2 What is the duration of these scenes?

○ Brief ○ Prolonged

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Q3.1.3 How would you describe the depiction of these scenes?
Please check all that apply.

- ☐ Obscured /Innuendo - Sex act is either entirely off-camera or completely blocked from view
- ☐ Shown with no nudity - Characters are depicted in sexual act but no nudity is shown
- ☐ Shown with partial nudity - Breasts, Buttocks
- ☐ Shown with full frontal nudity

Q3.1.4 Do any of these sex acts feature characters that appear to be younger than 18?

○ Yes ○ No

Q3.2 Does the game contain any suggestive/sexual themes or references?

○ Yes (go to Q3.2.1) ○ No (go to Q3.3)

Q3.2.1 How would you describe the suggestive/sexual themes contained in the game?
Please check all that apply.

- ☐ Suggestive references and innuendo in text, dialogue, or heard
- ☐ Overtly sexual situations or visually depicted innuendo
- ☐ References to sexual activity without descriptive detail
- ☐ References to sexual activity with descriptive detail
- ☐ Sexual situations involving those who appear to be under 18

Q3.3 Does the game contain any nudity or provocative outfits?

○ Yes (go to Q3.3.1) ○ No (go to Q3.4)

Q3.3.1 How would you describe this type of content contained in the game?
Please check all that apply.

Provocative outfits

○ Never ○ Rarely ○ Often

Human buttocks

○ Never ○ Rarely ○ Often

Nipple-less breasts or breasts with minimal coverage, e.g., pasties, long hair

○ Never ○ Rarely ○ Often

Female fantasy creatures' breasts, e.g., harpies

◉ Never ○ Rarely ○ Often

Female human breasts with nipples

○ Never ○ Rarely ○ Often

Genitalia

○ Never ○ Rarely ○ Often

Q3.3.2 Is all of this content in a natural or scientific setting?

○ Yes ○ No

Q3.3.3 Is any of this content in an erotic, provocative setting?

○ Yes ○ No

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Q3.3.4 Does the game depict, in an erotic or unsettling manner, characters that appear to be under the age of 18 naked or partially undressed?

○ No ○ Yes, provocative outfits ○ Yes, naked

Q3.4 Does the game contain any depictions of or references to sexual violence?

○ Yes (go to Q3.4.1) ○ No (go to Q4)

Q3.4.1 How is the sexual violence in the game presented?

○ Visually depicted ○ Referred to only

D. GAMBLING

Q4. Does the game contain simulations of betting or gambling that is normally played/carried out in casinos, gambling halls, or racetracks?

○ Yes ○ No

E. LANGUAGE

Q5. Does the game contain any potentially offensive language?

○ Yes (go to Q5.1) ○ No (go to Q6)

Q5.1 Which of the following potentially offensive words or categories of words are contained in the game? Please check all that apply.

Mild swearing and/or language that could be considered offensive

○ Never ○ Rarely ○ Often

Discriminatory language (against race, religion, sex, etc...)

○ Never ○ Rarely ○ Often

Sexual expletives

○ Never ○ Rarely ○ Often

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F. CONTROLLED SUBSTANCE

Q6. Does the game contain any reference to or use of drugs, alcohol, or tobacco?

○ Yes (go to Q6.1) ○ No (go to Q7)

Q6.1 Does the game reference or depict illegal drugs?

○ Yes (go to Q6.1.1) ○ No (go to Q6.2)

Q6.1.1 Illegal Drugs

☐ Reference

☐ Use

☐ Encourages/Glamorizes

☐ Detailed Instruction for Use

Q6.2 Does the game reference or depict medical drugs?

○ Yes (go to Q6.2.1) ○ No (go to Q6.3)

Q6.2.1 Medical Drugs

☐ Reference ☐ Use ☐ Encourages/Glamorizes

Q6.2.2 How frequently does this content occur?

○ Rarely ○ Often

Q6.3 Does the game reference or depict alcohol?

○ Yes (go to Q6.3.1) ○ No (go to Q6.4)

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Q6.3.1 Alcohol

☐ Reference ☐ Use ☐ Encourages/Glamorizes

Q6.3.2 How frequently does this alcohol content occur?

○ Rarely ○ Often

Q6.4 Does the game reference or depict tobacco?

○ Yes (go to Q6.4.1) ○ No (go to Q7)

Q6.4.1 Tobacco

☐ Reference ☐ Use ☐ Encourages/Glamorizes

Q6.4.2 How frequently does this tobacco content occur?

○ Rarely ○ Often

G. CRUDE HUMOR

Q7. Does the game contain any bodily functions such as belching, flatulence, or vomiting when used for humorous purposes?

○ Yes (go to Q7.1) ○ No (go to Q8.1)

Q7.1 What bodily functions are used for humorous purposes in the game?
Please check all that apply.

☐ Mucus, belching, flatulence sounds

☐ Flatulence (with depiction of "flatulence cloud"), whimsical depictions of feces ("poo coils"), vomiting

☐ Urination, urine, realistically depicted feces

☐ Act of human defecation visually depicted

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H. MISCELLANEOUS

Q8.1 Does the game natively allow users to interact or exchange content with other users through voice communication, text, or sharing images or audio?

○ Yes ○ No

Q8.2 Does the game share user-provided personal information with third parties?

○ Yes ○ No

Q8.3 Does the game share the user's current physical location to other users?

○ Yes ○ No

Q8.4 Does the game allow users to purchase digital goods?

○ Yes ○ No

Q8.5 Does the game contain any Nazi symbols, references, or propaganda?

○ Yes ○ No

Q8.6 Does the game contain detailed descriptions of techniques that could be used in criminal offenses?

○ Yes ○ No

Q8.7 Does the game advocate committing acts of terrorism?

○ Yes ○ No

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APPENDIX I: Information Sheet for Playtesting

Project Title: The Effects of Game-based Childhood Obesity Prevention Framework: A Case of *Fight Obesity 2.0*

Date:

You are invited to playtest a serious game titled *Fight Obesity 2.0* which was created as part of a PhD degree at Sultan Idris Education University. Before you decide whether to playtest the game or not, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please feel free to contact me if you would like more information or you have any concerns regarding this research. Take time to decide whether or not you wish to playtest.

What is the purpose of this study?

The purpose of this study is to test the usability of *Fight Obesity 2.0*, specifically the likeability, efficiency, helpfulness, control and learnability. The game was created as a game-based childhood obesity prevention strategy.

Why is the study being done?

Game-based prevention is a form of player-centred treatment and prevention that use games for health purposes, particularly as a lifestyle intervention. This approach is relatively new which could reinforce the conventional childhood obesity treatment and prevention. Hence this playtesting session is being done to validate the usability of the *Fight Obesity 2.0*.

Why have I been invited to participate?

You have been invited to play test *Fight Obesity 2.0* because this study intends to collect score from game designers who has experience in designing and developing digital games. Your views are particularly valuable and crucial in this research.

Do I have to take part?

It is up to you to decide whether or not to playtest *Fight Obesity 2.0*. If you decide to playtest, you have to sign a consent form for this study. You will be free to withdraw at any time and without giving a reason. This decision will not affect you or your rights in any way.

What do I have to do?

The playtesting session consists of three parts. In the first part, you will be shown a game design document and a demonstration of a mobile game titled Fight Obesity. Then, you will be facilitated in a group of three to four people to propose game design ideas to improve the quality of the demo game. In the second part, you will be directed to playtest *Fight Obesity 2.0* and capture the whole of your play session using Screencast-O-Matic. After completing the game and saving the screencast video, you will be directed to fill in an online usability feedback form. Please fill in all test items.

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What are the possible benefits of taking part?

There are no direct benefits to you from playtesting the game. I am hoping that the data collected will validate or improve the provisional serious game for childhood obesity prevention. However, at the end of your participation, you might observe how serious games could be validated.

What are the possible disadvantages of taking part?

Playtesting *Fight Obesity 2.0* in the study will take some of your time. Every effort has been made to keep any inconvenience to a minimum.

Will my taking part in the study be kept confidential?

The use of any information that identifies you during the course of the research will be kept strictly confidential. This information will be kept in a secure place and only people involved in the study or authorised individuals will have access to it.

What happens when the research stops?

The data obtained will be used for internal publication for a PhD thesis and submitted for assessment with a view to being published in academic journals/ conferences. I can also send you a summary of the study results on request.

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Contact details

If you would like any further information please contact:

DR Wang Yanzhen
National Child Development Research Centre
Sultan Idris Education University
35900 Tanjong Malim, Perak
Malaysia

Tel: 0164127926
Email: wyz2479@gmail.com
Web: http://fightobesityv2.wixsite.com/fightobesity2

Thank you for taking the time to read this information.

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APPENDIX J: Consent Form

Project Title: The Effects of Game-based Childhood Obesity Prevention Framework: A Case of *Fight Obesity 2.0*

Name of Researcher: DR Wang Yanzhen

I confirm that I have read and understood the information sheet dated __/__/20__ for the above project which I may keep for my records and have had the opportunity to ask any questions I may have.

I agree to take part in the above study and am willing to have my involvement in the interview recorded.

I understand that my information will be held and processed for the following purposes:

- To be used anonymously for internal publication for a PhD project and submitted for assessment with a view to being published in academic journals / conferences.

I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason without being penalised or disadvantaged in any way.

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Name of Participant	Date	Signature

Researcher	Date	Signature

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APPENDIX K: Usability Measurement Inventory

(Adapted from Kirakowsky & Corbett, 1993)

Tester name: . . . . . .
Title of the game: . . . . . .
Date:. . . . . .

NB *the information you provide is kept completely confidential, and no information is stored on computer media that could identify you as a person.*

This inventory has fifty statements. Please answer every one of them. Against each statement there are three boxes.

You should mark the first box if you generally AGREE with the statement. Mark the central box if you are UNDECIDED, can't make up your mind, or if the statement has no relevance to your game or to your situation. Mark the right box if you generally DISAGREE with the statement.

In marking the left or right box you are not necessarily indicating *strong* agreement or disagreement but just your general feeling most of the time.

Put a x mark in the box of your choice.

No.	Item	Agree	Undecided	Disagree
1.	This game responds too slowly to inputs.			
2.	I would recommend this game to my peers			
3.	The instructions and prompts are helpful.			
4.	The game has at some time stopped unexpectedly.			
5.	Learning to operate this game initially is full of problems.			
6.	I sometimes don't know what to do next with this game.			
7.	I enjoy my sessions with this game.			
8.	I find that the help information given by this game is not very useful.			
9.	If this game stops, it is not easy to restart it.			
10.	It takes too long to learn the game commands.			
11.	I sometimes wonder if I'm using the right command.			
12.	Working with this game is satisfying.			
13.	The way that system information is presented is clear and understandable.			
14.	I feel safer if I use only a few familiar commands or operations.			
15.	The game documentation is very informative.			
16.	This game seems to disrupt the way I normally like to arrange my work.			
17.	Working with this game is mentally stimulating.			
18.	There is never enough information on the screen when it's needed.			
19.	I feel in command of this game when I am using it.			
20.	I prefer to stick to the facilities that I know best.			

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21.	I think this game is inconsistent.			
22.	I would not like to use this game every day.			
23.	I can understand and act on the information provided by this game.			
24.	This game is awkward when I want to do something which is not standard.			
25.	There is too much to read before you can use the game.			
26.	Tasks can be performed in a straightforward manner using this game.			
27.	Using this game is frustrating.			
28.	The game has helped me overcome any problems I have had in using it.			
29.	The speed of this game is fast enough.			
30.	I keep having to go back to look at the guides.			
31.	It is obvious that user needs have been fully taken into consideration.			
32.	There have been times in using this game when I have felt quite tense.			
33.	The organisation of the menus or information lists seems quite logical.			
34.	The game allows the user to be economic of keystrokes.			
35.	Learning how to use new functions is difficult.			
36.	There are too many steps required to get something to work.			
37.	I think this game has made me have a headache on occasion.			
38.	Error prevention messages are not adequate.			
39.	It is easy to make the game do exactly what you want.			
40.	I will never learn to use all that is offered in this game.			
41.	The game hasn't always done what I was expecting.			
42.	The game has a very attractive presentation.			
43.	Either the amount or quality of the help information varies across the system.			
44.	It is relatively easy to move from one part of a task to another.			
45.	It is easy to forget how to do things with this game.			
46.	This game occasionally behaves in a way which can't be understood.			
47.	This game is really very awkward.			
48.	It is easy to see at a glance what the options are at each stage.			
49.	Getting data files in and out of the system is not easy.			
50.	I have to look for assistance most times when I use this game.			

Please check you have ticked each item.
Thank you.

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APPENDIX L: Data Collected in the Quasi-Experiment

ID	G	Age	Sex	E	W	H	BMI	Pre-test	Post-test	Q2 pre	Q2 post	Q3 pre	Q3 post	Q4 pre	Q4 post	Q5 pre	Q5 post	Q6 pre	Q6 post	Q7 pre	Q7 post	Q8 pre	Q8 post	Q9 pre	Q9 post	Q10 pre	Q10 post	Q11 pre	Q11 post	Q12 pre	Q12 post
1	1	5	0	1	16.0	111	12.99	5	8	1	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1	0	1	0	1	0	1
2	0	5	0	1	17.0	107	14.85	6	5	1	0	1	0	1	1	1	1	1	1	1	99	0	0	1	0	0	0	0	1	0	1
3	1	5	1	1	17.0	106	15.13	5	4	1	1	0	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
4	0	5	1	1	17.0	109	14.31	5	5	1	1	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0
5	1	5	1	1	16.0	105	14.51	4	5	1	0	1	0	1	0	1	0	0	0	99	0	0	0	1	0	1	0	0	0	0	0
6	1	5	1	1	13.0	103	12.25	5	9	1	0	0	1	1	1	1	1	1	0	0	0	0	0	1	0	1	1	0	1	0	1
7	0	5	1	1	14.0	114	10.77	7	4	1	1	0	1	1	1	1	1	1	0	1	1	2	0	0	1	1	1	1	0	0	1	0
8	0	5	1	1	14.0	106	12.46	6	7	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1
9	0	5	0	1	15.0	104	13.87	6	4	1	1	1	0	1	1	1	1	1	1	0	0	0	0	1	1	1	0	1	0	1	0
10	0	5	0	1	15.0	110	12.40	6	6	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	1
11	1	5	1	1	14.4	107	12.58	5	7	1	1	0	0	1	1	0	1	1	0	1	0	0	0	1	1	0	1	1	1	1	0
12	1	5	1	1	13.8	101	13.53	5	4	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	0	0	0
13	0	5	0	1	14.0	106	12.46	7	4	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	0	1	0	1	0
14	1	5	0	1	16.5	111	13.39	5	9	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	1	0	1	0	1
15	1	5	0	1	13.0	99	13.26	8	6	1	1	0	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1	1
16	0	5	1	1	15.0	102	13.46	5	7	1	1	0	0	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	0	1
17	1	5	0	0	15.0	107	13.10	9	10	1	0	0	0	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1
18	0	5	1	1	19.0	114	14.62	5	6	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	0	1	0	1
19	1	5	1	1	14.8	105	13.42	4	7	1	1	1	0	1	1	1	1	1	1	0	0	0	0	1	0	1	1	0	0	0	0
20	0	5	1	1	13.5	102	12.98	4	5	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	1
21	1	5	1	1	16.0	110	13.22	5	5	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	1	0
22	1	5	1	1	13.0	97	13.82	5	4	1	1	0	0	1	1	0	1	1	1	0	0	0	0	1	1	0	0	1	0	1	0
23	0	5	0	1	15.0	108	12.86	3	6	1	0	1	0	1	0	1	1	1	1	0	0	0	0	1	1	0	1	0	0	0	1
24	0	5	1	1	14.0	106	12.46	7	7	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1
25	0	5	0	1	16.0	110	13.22	7	6	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1

*G: Group; E: Ethnicity; W: Weight; H: Height; BMI: Body Mass Index

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APPENDIX L Continued

ID	G	Age	Sex	E	W	H	BMI	Pre-test	Post-test	Q2 pre	Q2 post	Q3 pre	Q3 post	Q4 pre	Q4 post	Q5 pre	Q5 post	Q6 pre	Q6 post	Q7 pre	Q7 post	Q8 pre	Q8 post	Q9 pre	Q9 post	Q10 pre	Q10 post	Q11 pre	Q11 post	Q12 pre	Q12 post
26	1	5	1	1	15.0	98	15.62	7	4	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	0	1	0
27	0	5	0	1	12.5	98	13.02	6	6	1	1	0	0	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
28	0	5	0	1	19.0	106	16.91	7	5	0	1	1	1	1	0	1	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1
29	1	5	1	1	15.0	106	13.35	4	8	0	1	0	1	1	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	0	1
30	1	5	0	1	16.3	104	15.07	4	9	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	0	1	0	1
31	1	5	0	1	16.0	107	13.98	4	6	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0	0	0	0
32	1	5	0	1	13.0	101	12.74	6	5	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	0	1	0
33	1	6	1	1	17.5	115	13.23	2	4	1	1	1	0	0	1	0	1	1	1	0	0	0	1	1	1	0	0	1	0	0	0
34	1	6	0	1	15.0	112	11.96	6	7	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	1	1
35	1	6	0	1	17.5	110	14.46	8	10	1	0	0	0	1	1	1	1	0	0	0	0	0	0	1	0	1	0	1	1	0	1
36	1	6	1	1	21.0	116	15.61	5	4	1	1	1	1	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	0
37	1	6	1	1	18.5	116	13.75	4	7	1	1	1	0	1	1	0	1	1	0	0	0	0	0	1	1	1	1	0	0	1	0
38	1	6	1	1	15.0	108	12.86	6	5	1	1	1	1	1	1	1	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1
39	1	6	1	1	14.5	105	13.15	7	9	1	1	0	0	1	1	1	1	0	1	1	0	0	0	1	1	1	1	0	1	1	1
40	0	6	1	1	14.5	106	12.90	4	5	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	1
41	1	6	0	1	15.0	111	12.17	6	9	1	1	1	0	1	1	1	1	1	0	0	1	0	0	1	1	1	1	0	1	1	1
42	0	6	0	1	15.5	110	12.81	7	8	1	0	1	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	0	1	0
43	0	6	0	1	23.3	118	16.73	4	6	0	1	1	0	1	1	1	1	1	0	1	0	2	0	0	1	0	1	0	0	0	0
44	1	6	0	1	16.4	114	12.62	6	7	1	1	1	1	1	1	1	1	1	0	1	0	0	0	1	1	1	1	1	1	0	0
45	0	6	1	1	17.0	115	12.85	6	6	1	1	0	0	1	1	1	1	1	1	0	0	0	0	1	1	1	0	0	0	0	1
46	0	6	0	1	20.5	118	14.72	3	7	1	0	1	1	1	1	0	1	1	0	0	0	0	0	1	1	0	1	99	0	0	0
47	0	6	0	1	16.2	113	12.69	5	7	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1	1	1
48	0	6	1	1	13.5	104	12.48	5	5	1	1	1	1	1	1	1	0	1	1	0	0	0	0	1	1	0	0	1	1	1	1
49	0	6	1	1	23.5	121	16.05	4	6	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	0	0
50	0	6	0	1	14.5	106	12.17	5	7	1	0	1	1	1	1	1	1	1	0	0	0	99	0	1	1	1	0	0	1	1	1

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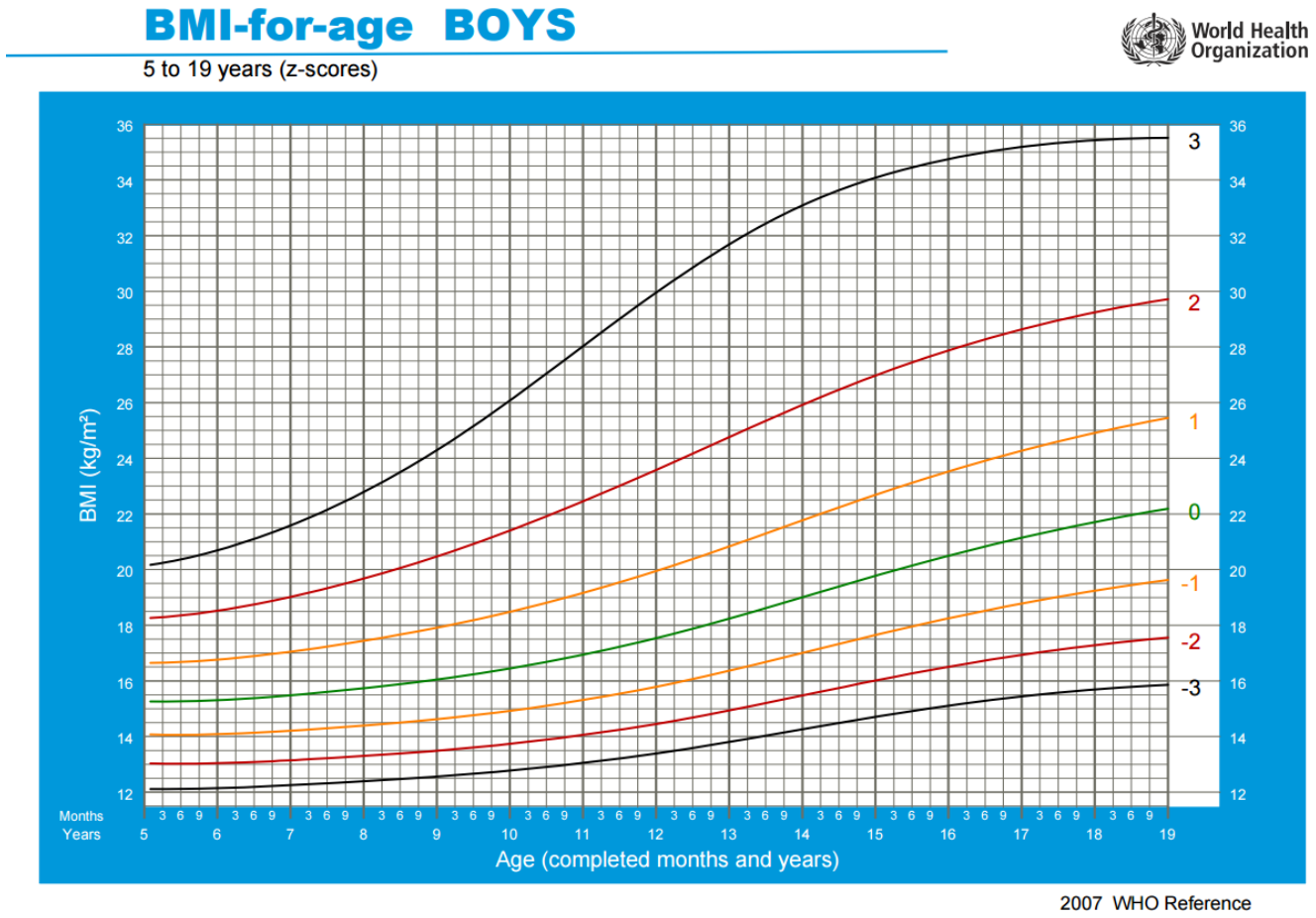
APPENDIX L Continued

ID	G	Age	Sex	E	W	H	BMI	Pre-test	Post-test	Q2 pre	Q2 post	Q3 pre	Q3 post	Q4 pre	Q4 post	Q5 pre	Q5 post	Q6 pre	Q6 post	Q7 pre	Q7 post	Q8 pre	Q8 post	Q9 pre	Q9 post	Q10 pre	Q10 post	Q11 pre	Q11 post	Q12 pre	Q12 post
51	1	6	0	1	24.5	118	17.60	6	10	1	0	1	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0	1	1	1
52	0	6	1	1	16.2	113	16.69	9	5	0	1	0	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1
53	0	6	1	1	19.0	115	14.37	6	8	1	1	0	0	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	0	1
54	1	6	1	1	17.0	113	13.31	10	11	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1
55	1	6	1	1	15.2	110	12.56	5	6	1	0	1	1	1	0	1	1	1	0	0	0	0	0	1	1	1	1	1	0	0	0
56	0	6	0	1	17.0	113	13.31	4	5	1	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
57	0	6	0	1	33.5	113	26.24	2	3	1	1	1	1	1	1	0	0	1	1	1	1	0	0	1	1	1	1	0	0	0	0
58	1	6	0	1	20.0	117	14.61	8	9	1	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0
59	0	6	1	1	17.2	113	13.47	4	7	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	0	1	0	1	1	1
60	0	5	1	1	19.8	113	15.51	5	5	1	1	1	1	1	1	0	1	1	1	99	0	0	0	1	1	1	1	1	0	1	0

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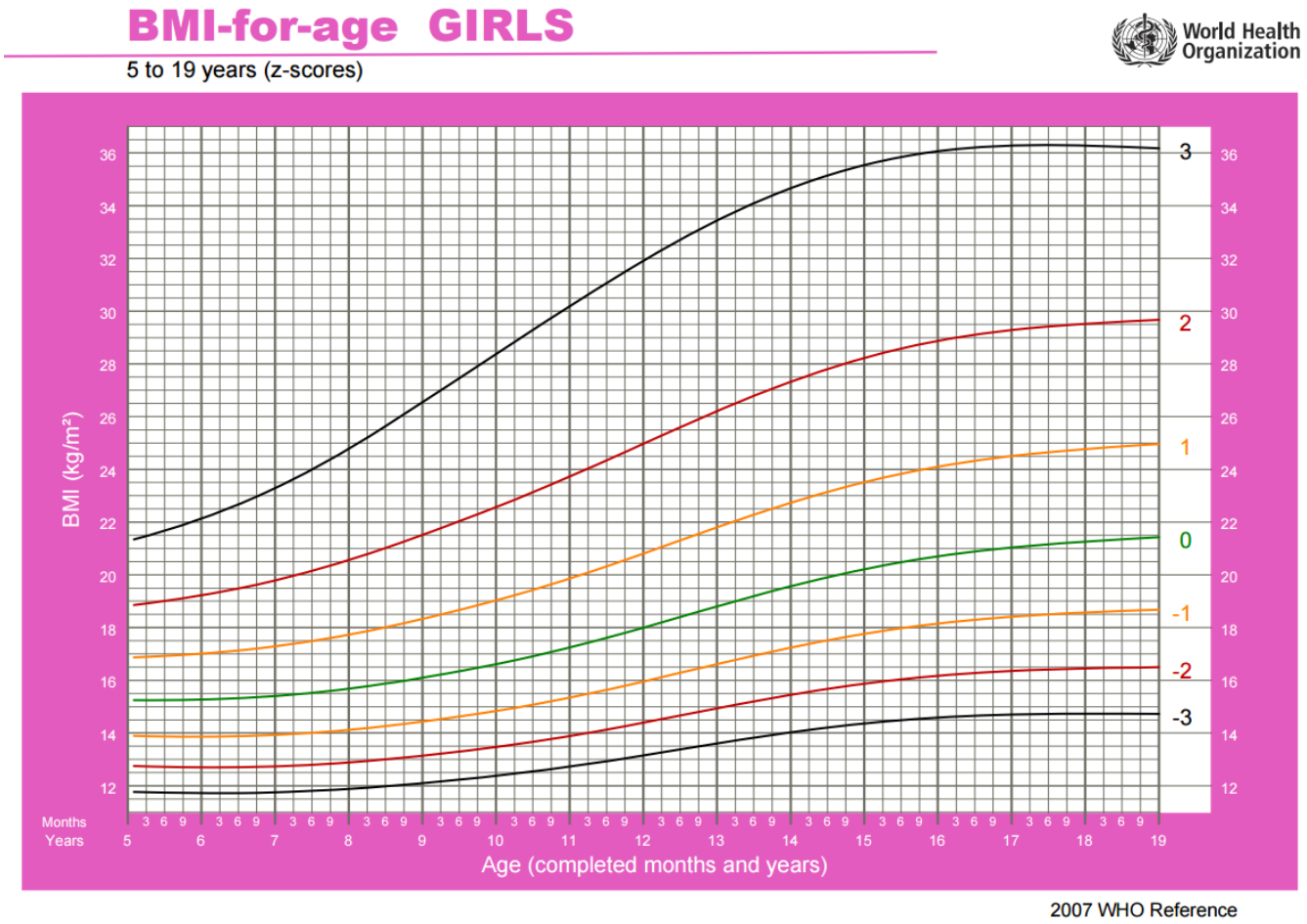
APPENDIX M: BMI for Boys



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APPENDIX N: BMI for Girls



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APPENDIX O: Food Choice Stated by the Children in the Pre-test

ID	BREAKFAST				LUNCH						DINNER					
	Sum	Food choice			Sum	Food choice					Sum	Food choice				
1	2	Honey star	milk		2	Rice	Fish				1	Milk				
2	1	Rice			1	Pulut					1	Fried rice				
3	1	Kway teow			1	Pizza					2	Rice	Egg			
4	1	Kway teow			1	Biscuit					1	Rice				
5	1	Milk			1	Chicken					3	Bread	Pizza	KFC		
6	1	Burger			1	Chicken					1	Noodle				
7	1	Biscuits.			1	Bread					1	Mee hoon				
8	2	Cereals	milk		2	Soy sauce rice	Chocolate				2	Rice	Squid			
9	1	Nasi lemak.			1	Rice					3	Rice	Chicken	Soup		
10	1	Fried chicken			2	Rice	Soup				1	Doughnut				
11	2	Cereals	milk		2	Cereals	milk				2	Fish	Fruits			
12	2	Rice	Chicken		1	Nugget					1	KFC				
13	3	Fried noodle	nuggets	Strawberry	5	Rice	Vegetables	Fish	Fried chicken	Plain water	2	Fried rice	Grape juice			
14	3	Biscuit	Bread	Dates	4	Rice	Vegetables	Fish	Egg		5	Rice	Meat	Potatoes	Dates	Nugget
15	1	Rice			1	Kway teow					1	Durian				
16	1	Rice			1	Spaghetti					2	Rice	Fish			
17	1	Bread			2	Fish	Vegetables				2	Chicken	Soup			
18	1	Meat			1	Bread					1	Kway teow				
19	1	Bread			1	Maggi mee					1	Kway teow				
20	1	Rice			1	Vegetables					1	Mee hoon				
21	2	Koko Krunch	milk		2	Rice	Fish				2	Fried rice	Squid			
22	3	Rice	fried chicken	milo	4	Fried rice	Cereals	milk	Plain water		3	Fried rice	Squid	Lychee drink		
23	1	Rice			1	Bread					1	Vegetables				
24	1	Fish			1	Chicken					1	Rice				
25	1	Rice			1	Fried chicken					1	Fried rice				
26	2	Rice	egg		1	Mee hoon soup					1	Bread				
27	1	Watermelon			1	Vegetable					1	Durian				
28	1	Cereal			1	Curry					2	Noodle	Soup			
29	1	Toast			1	Jam bread					2	Rice	Fried chicken			
30	1	Fish			1	Rice					1	Fish				

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APPENDIX P Continued

ID	BREAKFAST					LUNCH						DINNER			
	Sum	Food choice				Sum	Food choice					Sum	Food choice		
31	1	Rice				1	Noodles					1	Rice		
32	2	Chocolate cake	Iced milo			4	Rice	Fish	Apple	Fresh orange		3	Rice	Fish	Milk
33	1	Nasi lemak				1	Biscuit					1	Laksa		
34	1	Bread				1	Doughnut					1	Fruits		
35	1	Rice				1	Maggi mee					1	Noodle		
36	2	Koko Krunch	Milk			2	Rice	Assorted side dish				2	Rice	Assorted side dish	
37	4	Soy sauce Rice	Fried egg	Iced milo	Fruits	3	Soy sauce rice	Fried chicken	Orange juice			2	Biscuit	Hot Milo	
38	1	Nasi lemak				2	Rice	Assorted side dish				1	Roti canai		
39	2	Rice	Assorted side dish			2	Rice	Assorted side dish				2	Rice	Assorted side dish	
40	1	Rice				1	Bread					1	Kway teow		
41	1	Bread				1	Fried chicken					1	Rice		
42	1	Rice				1	Bread					1	Rice		
43	0	-				1	Pizza					1	Pizza		
44	1	Vegetables				1	Fruits					1	Rice		
45	1	Apple				1	Rice					1	Kuih		
46	1	Bread				3	Rice	Fried chicken	Plain water			3	Fried noodle	Fried egg	Plain water
47	2	Koco Krunch	Milk			2	Honey Star	Milk				2	Rice	Assorted side dish	
48	1	Kway teow				1	Rice					1	Soy sauce rice		
49	1	Spaghetti				1	Rice					1	Spaghetti		
50	2	Rice	Egg			1	Doughnut					2	Rice	Egg	
51	1	Roti canai				1	Fried noodle					1	Fried rice		
52	3	Honey Star, Koco Krunch	Milk	Plain water		3	Soy sauce rice	Egg	Plain water			3	Rice	Chicken	Chocolate drink
53	1	Bread				1	Mee hoon					1	Kuih		
54	1	Noodle				1	Mee hoon					1	Rice		
55	2	Rice	Vegetables			2	Rice	Chicken				2	Spicy rice	Spicy fish	
56	1	Plain water				1	Plain water					1	Rice		
57	1	Rice				2	Rice	Assorted side dish				2	Rice	Assorted side dish	
58	4	Fried rice	Macaroni	Cheese	Syrup	3	Bread	Noodles	Milk			3	USA fried rice	Kg fried rice	Fruits
59	1	Rice				1	Banana					1	Rice		
60	2	Rice	Fish			2	Rice	Assorted side dish				1	Bread		

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APPENDIX P: Food Choice Stated by the Children in the Post-test

ID	BREAKFAST					LUNCH						DINNER					
	Sum	Food choice				Sum	Food choice					Sum	Food choice				
1	2	Rice	Fish			1	Vegetables					1	Noodle				
2	2	Fried rice	Watermelon juice			2	Pizza	Soft drink				3	Rice	Tom yam	Juice		
3	3	Noodles	Bread	Syrup		5	Cucur	Vegetables	Fish	Soup	Plain water	2	Fried rice	Plain water			
4	1	Cereal				1	Rice					1	Mee hoon				
5	1	Milk				1	Rice					1	Pizza				
6	1	Cereal				1	Noodle					1	Orange				
7	1	Chocolate bread				1	Chicken					1	Fried rice				
8	1	Biscuits				1	Fried chicken					1	Rice				
9	2	Corn flakes	Milk			3	Rice	Vegetables	Plain water			3	Rice	Fish	Plain water		
10	1	Doughnut				2	Rice	Chicken				2	Rice	Vegetables			
11	1	Sugar bread				1	Sugar bread					1	chocolate				
12	2	Rice				1	Burger					1	Ice cream				
13	3	Nasi lemak	Fried chicken	Milo	Tea	2	Nasi lemak	Plain water				3	Crab	Squid	Orange juice		
14	1	Bread				1	Roti canai					2	Rice	Chicken			
15	1	Rice				1	Rice					2	Rice	Chicken			
16	1	Koko Krunch				1	Maggi					1	Noodle				
17	1	Bread				2	Rice	Vegetables				2	Rice	Fish			
18	4	Rice	Noodle	Papaya	Pineapple	1	Apple pie					3	Rice	Muffins	Strawberry		
19	1	Vegetables				2	Rice	Vegetables				1	Carrot				
20	1	Vegetables				2	Rice	Vegetables				1	Mee hoon				
21	2	Cereal	Milk			5	Rice	Fish	Egg	Squid	Orange juice	5	Rice	Vegetables	Fish	Squid	Plain water
22	2	Rice	Vegetables			2	Rice	Eggs				2	Koko Krunch	Milk			
23	1	Cereal				3	Rice	Fish	Plain water			3	Rice	Fish	Orange juice		
24	2	Rice	Noodle			2	Rice	Chicken				2	Rice	Noodle			
25	1	Bread				1	Fish					1	Chicken				
26	2	Chocolate bread	Milk			3	Rice	Fish	Iced Milo			4	Rice	Fish	Fruits	Plain water	
27	1	Rice				1	Vegetable					1	Rice				
28	3	Rice	Eggs	Plain water		3	Chicken	Soup	Plain water			2	Fried noodle	Plain water			
29	1	Vegetables				2	Nasi lemak	Kuih				1	Rice				
30	1	Vegetables				1	Fish					1	Rice				

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APPENDIX P Continued

ID	BREAKFAST					LUNCH					DINNER					
	Sum	Food choice				Sum	Food choice				Sum	Food choice				
31	1	Vegetables				1	Carrot				1	Water				
32	1	Bread				2	Rice	Bread			2	Rice	Egg			
33	1	Cereal				1	Biscuit				1	Rice				
34	1	Biscuit				2	Rice	Vegetables			1	Fruits				
35	1	Rice				1	Mee hoon				1	Maggi				
36	3	Sausage	Bun	Plain water		3	Rice	Fried chicken	Plain water		5	Rice	Fish	Egg	Fried chicken	Plain water
37	1	Rice				1	Rice				1	Milo				
38	1	Rice with sambal				1	Fruits				1	Fried rice				
39	1	Nasi lemak				1	Fried rice				1	Guli-guli				
40	2	KFC	Orange juice			0	-----				2	Maggi	Plain water			
41	1	Curry puff				1	Bread				1	Milo				
42	1	Rice				1	Bread				1	Rice				
43	2	Noodles	Plain water			2	Kway teow	Orange juice			2	Satay	Plain water			
44	1	Rice				1	Bread				1	Vegetables				
45	2	Fruits	Tea			4	Rice	Mee hoon	Soup	Apple juice	5	Rice	Fried chicken	Fish	Sweet potatoes	Plain water
46	1	Biscuit				1	Burger				1	Milk				
47	1	Biscuit				1	Rice				1	Rice				
48	1	Bread				1	Hotdog				1	Burger				
49	3	Spaghetti	Macaroni	Orange juice		2	Spicy fried rice	Iced Milo			2	Spicy fried rice	Iced Milo			
50	2	Koko Krunch	Milo			2	Rice	Egg			2	Rice	Egg			
51	1	Vegetables				1	Vegetable				1	Noodle				
52	3	KFC	Iced Milo	Mineral water		2	Soy sauce rice	Mineral water			3	Rice	Fried chicken	Mineral water		
53	1	Bread				1	Rice				1	Biscuit				
54	1	Vegetables				1	Cereal				1	Rice				
55	2	Rice	Vegetables			2	Rice	Vegetables			2	Rice	Vegetables			
56	0	Nothing				1	Bread				2	Rice	Fish			
57	1	Rice				1	Rice				1	Fish				
58	4	Rice	Vegetables	Fruits	Tea	2	Nuggets	Iced Milo			3	Mee hoon	Spaghetti	Orange juice		
59	2	Koko Krunch	Milk			2	Rice	Fish			1	Soy sauce rice				
60	1	Bread				1	Fried rice				1	Rice				

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APPENDIX Q: Semi-structured Interview Questions (Kindergarten Supervisor)

Food Preferences and Physical Activities Questions

Name:	**Job Title:**

Q1	How many meals do the 5 and 6 years old children usually have in NCDRC?
Q2	What are the names of food in each meal?
Q3	Do the children usually finish all the food? If no, what would normally left by them?
Q4	Do the children like to eat fried food? Such as fried chicken and fried banana.
Q5	Do the children like to drink sweet drinks?
Q6	Do the children like to eat fruits?
Q7	Do the children like to eat vegetables?
Q8	Do the children like to eat fast food? Such as KFC and McDonald's?
Q9	Do the children like to watch animations and movies?
Q10	Do the children like to do exercise outside the classroom? Examples: running, war climbing, swimming or playing games with classmates on the playground.
Q11	How many activity classes are conducted outside the classroom? Do the children have outdoor activities every week?
Q12	How long is the activity session?
Q13	Can obesity cause heart problems?
Q14	Can obesity cause diabetes?
Q15	What would you do if you become very fat in the future?

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APPENDIX R: Information Sheet for Interview with Pediatricians

Project Title: The Effects of Game-based Childhood Obesity Prevention Framework: A Case of *Fight Obesity 2.0*

Date:

You are invited to take part in a research study which is being conducted as part of a PhD degree at Sultan Idris Education University. Before you decide whether to take part or not, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please feel free to contact me if you would like more information or you have any concerns regarding this research. Take time to decide whether or not you wish to take part.

What is the purpose of this study?

The purpose of this study is to validate a game-based childhood obesity prevention framework for preschool children in the National Child Development Research Centre (NCDRC), Sultan Idris Education University.

Why is the study being done?

Game-based prevention is a form of player-centred treatment and prevention that use games for health purposes, particularly as a lifestyle intervention. This approach is relatively new which could reinforce the conventional childhood obesity treatment and prevention. Hence this study is being done to validate a game-based childhood obesity framework.

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Why have I been invited to participate?

You have been invited to take part in this study because this study intends to collect your views as a pediatrician who has experience in treating patients with childhood obesity. Your views are particularly valuable and crucial in this research.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part, you have to sign a consent form for this study. You will be free to withdraw at any time and without giving a reason. This decision will not affect you or your rights in any way.

What do I have to do?

You will be asked to sign a consent form and participate in an interview session. Prior to the interview, you will be directed to visit the *Fight Obesity 2.0* website to download, install and play *Fight Obesity 2.0*. You may also guide children to play the game to understand all game levels and the features offered by the game. After playing the game yourself or observing children playing *Fight Obesity 2.0*, you will be directed to answer six questions related to the game and the game-based childhood obesity prevention framework.

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What are the possible benefits of taking part?

There are no direct benefits to you from taking part in this study. I am hoping that the data collected will validate or improve the provisional game-based childhood obesity prevention framework and *Fight Obesity 2.0*. However, at the end of your participation, you might observe how content knowledge on obesity prevention could be gamified into serious games.

What are the possible disadvantages of taking part?

Participating in the study will take some of your time. Every effort has been made to keep any inconvenience to a minimum.

Will my taking part in the study be kept confidential?

The use of any information that identifies you during the course of the research will be kept strictly confidential. This information will be kept in a secure place and only people involved in the study or authorised individuals will have access to it.

What happens when the research stops?

The data obtained will be used for internal publication for a PhD thesis and submitted for assessment with a view to being published in academic journals/ conferences. I can also send you a summary of the study results on request.

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Contact details

If you would like any further information please contact:

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Web: http://fightobesityv2.wixsite.com/fightobesity2

Thank you for taking the time to read this information.

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