PSYCHOTHERAPY BASED GAME DESIGN FOR HEALING BRAIN TUMOR IN CHILDREN

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UNIVERSITI TEKNOLOGI MALAYSIA
PSYCHOTHERAPY BASED GAME DESIGN FOR HEALING BRAIN TUMOR IN CHILDREN

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A thesis submitted in fulfilment of the requirements for the award of the degree of Doctor of Philosophy (Computer Science)

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This dissertation is dedicated to my Father Syed Shahid Abbas, Mother Dr. Shaheen Shahid, Husband Dr. Sajjad Mohsin and my Children Ali and Anusha.

I love you all.
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ABSTRACT

Brain tumor is the second largest deadly disease in children. Diagnosis of brain tumor in children may lead to other problems including psychological distress. Recent research has proven that health games have been effective for the management of psychological problems. There is still lack of psychotherapeutic game design that would help patients to alleviate psychological distress. Therefore this research proposes automation of psychotherapy using game design. The proposed game design integrates psychotherapy into it. The psychotherapy design consists of play therapy and guided imagery therapy to make a play guided imagery therapy (PGIT). The existing Mechanics, Dynamics and Aesthetics (MDA) game design framework has been enhanced into Mechanics, Dynamics, Aesthetics and Therapy (MDA-T) framework to facilitates the development of game that includes psychotherapy aspect in the design. The therapeutic game is developed and experimented on children with brain tumor. Two groups were formed with one group played the game and other group acts as a control group. Both the groups have undergone established psychological testing before and after playing the game. The results prove that the group that played the game had shown remarkable improvement as compared to their results before game playing. On the other hand, the control group has shown no significant improvement. The four psychological symptoms that represent the main indicators of brain tumor patients are measured. They are anxiety, depression, aggression and disruptive behavior. The results of the experiment shows that, anxiety and depression of the children have been reduced by more than 30%, and, anger and disruptive behavior are reduced by 20% and 5% respectively. In conclusion, the proposed therapeutic game has contributed toward producing positive behavioral changes in children with brain tumor.
ABSTRAK

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## LIST OF ABBREVIATIONS

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<tr>
<td>AGE</td>
<td>Action, Gameplay, Experience</td>
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<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
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<tr>
<td>BAI</td>
<td>Beck Anxiety Inventory</td>
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<td>BANI</td>
<td>Beck Anger Inventory</td>
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<tr>
<td>BDBI</td>
<td>Beck Disruptive behavior Inventory</td>
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<td>BDI</td>
<td>Beck Depression Inventory</td>
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<td>BSCI</td>
<td>Beck Self Concept Inventory</td>
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<tr>
<td>CBT</td>
<td>Cognitive Behavior Therapy</td>
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<tr>
<td>CKD</td>
<td>Chronic Kidney Disease</td>
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<tr>
<td>DPE</td>
<td>Design, Play, Experience</td>
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<tr>
<td>GEQ</td>
<td>Game Experience Questionnaire</td>
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<tr>
<td>HBTS</td>
<td>Holistic, Boundary, Temporal, Structural</td>
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<tr>
<td>HCI</td>
<td>Human Computer Interaction</td>
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<tr>
<td>IBD</td>
<td>Irritating Bowel Disease</td>
</tr>
<tr>
<td>iGEQ</td>
<td>in-Game Experience Questionnaire</td>
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<td>IT</td>
<td>Information Technology</td>
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<tr>
<td>MDA</td>
<td>Mechanics, Dynamics, Aesthetics</td>
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<tr>
<td>MDA-T</td>
<td>Mechanics, Dynamics, Aesthetics, Therapy</td>
</tr>
<tr>
<td>MDI</td>
<td>Mechanics, Dynamics, Impression</td>
</tr>
<tr>
<td>MSAT</td>
<td>Mechanics, Story, Aesthetics, Technology</td>
</tr>
<tr>
<td>NPC</td>
<td>Non Player Character</td>
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<tr>
<td>PD</td>
<td>Participatory Design</td>
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<td>PGIT</td>
<td>Play Guided Imagery Therapy</td>
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<tr>
<td>PI</td>
<td>Personal Investigator</td>
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<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
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<tr>
<td>UI</td>
<td>User Interface</td>
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<tr>
<td>UX</td>
<td>User Experience</td>
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<tr>
<td>WBC</td>
<td>White Blood Cell</td>
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<tr>
<td>WDTA</td>
<td>Watch, Discover, Think and Act</td>
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<tr>
<td>WTO</td>
<td>Working Things Out</td>
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CHAPTER 1

INTRODUCTION

1.1 Overview

New computer games are launched on an almost daily basis. These games have applications in various capacities from military trainings to health care and from education to cultural training, information, sports etc. Games made for the purpose of training, education or improving health is usually referred to as serious games. One of the most important aspects in developing serious game is “Game Design”. Game design documents the creative, conceptual, technical and functional aspects of game. Every game has to be custom design depending on its intended usage. There are no specific set of rules for serious game design but common principles can be applied to these games. Health games are meant for the purpose of targeting the psychological aspect of people and are important for the improvement of health behaviors, positive behavioral modification and self-management of deadly illnesses as well as encouraging and sustaining psychological wellbeing. One of the second largest deadly diseases in children is brain tumor which causes many psychological problems among them and these problems can be dealt with success if some form of psychotherapy is applied on such patients. Health games can be used for such a purpose. The psychological health games need psychological harmony in their design in order to be effective.

1.2 Problem Background

Diagnosis of any kind of cancer may lead to mental health problems and psychological distress thus causing them to have high level of anger, anxiety and may distort their self-concept (Pinkerton et al., 2007). Brain tumor is the second largest deadly disease in children and studies by Wellisch et al. (2002) have shown
that 50% of the patients and perhaps 80% of the brain tumor patients are suffering from depression (Price et al., 1997). Depression is a state of low mood and a symptom which appears after certain trauma or bad experience. It may lead to severe mental and physical conditions. It is believed by researchers that depressive behavior of the people is usually due to the traumas they have faced in the past and one of the ways to recover from it is the use of some form of psychotherapy (McCabe, 2007). Psychotherapy is a treatment based on the relationship between a therapist and patient, to produce change in feelings, thoughts and actions. For treatment, psychotherapist makes systematic use of psychological theories to devise and direct intervention. The level of psychotherapy specifies the level of training regarding the treatment. Current research confirms that psychotherapy is an effectual conduct for psychiatric disorders. Psychotherapy heals patient’s problems, and appreciating psychotherapeutic techniques (Bateman, 1995). Two such psychotherapies are imagery psychotherapy and play therapy.

The idea of utilizing imagery psychotherapy as a therapeutic involvement in health is established on the basis that images could have direct or indirect effect on health. Visuals stimuli communicate and manipulate the perceptions while providing imaginary views. This is considered to be a tool for various perspectives in helping people to cope with mental problems. This technique has a history, in early ages where drawings and colors were used to indicate certain meaning for decision. In the Arnheim theory real life situations are appropriate for viewing of images. Act of seeing is not a simple stimulus-response action but it is actually a cognitive activity which helps the capacity to craft and classify individual meaning (O’Neil, 2011). Visual display of information is the extension of a therapy utilizing the curative properties. This therapy uses activities through the use of imaginative scenes, intended to improve mental problems and skills. Researchers have shown that people who received imagery psychotherapy has shown marked improvement in their behaviors over the people who did not receive psychotherapy and also more positive attitude towards life was observed (Astin et al., 2003). Similarly play therapy is a form of psychotherapy used for children in which play is used to communicate to resolve some psychosocial tasks. This is thought to help them towards better social and emotional growth and researches has shown improvement in mental health of children after utilizing this therapy with problematic children (Moustakas, 1955). This therapy helps children in many ways. The concept behind it is that children may play out traumatic or difficult life experiences in order to make sense of present problems and may cope with the future problems. Bratton et al. (2005) have explained that the outcomes of the play therapy may be general e.g. a reduction in anxiety and raised self-concept, or more specific such as a change in behavior and improved social relations. Play therapy may have different forms as per the requirement of a problem. However a psychotherapist
is a must requirement for conducting such a therapy.

Targeting brain tumor in children to solve their problematic behaviors related with the diagnosis of their disease through the use of psychotherapy video game can be one use of the technology. Radiation therapies like stereotactic radio surgery, immunotherapy, and vaccine therapy are given to the brain tumor patients as a primary treatment and it is a must but during these treatments the psychological state of body should not be ignored because psychological treatments have also contributed for better prognosis reports for such patients (McCabe, 2007).

Imagery psychotherapy and play therapy for children has been doing well in advancing relaxation, soothing anxieties and facilitating children in numerous way, (Garrett and Norris, 1985). In order to examine the effect of imagery therapy a study was conducted on depressed white blood cell (WBC) counts, over a 90-day period. All the patients showed significant increases in their WBC count, even though they possess diseases/illnesses that could cause the decrease in WBC count. The experiment conducted by Troesch et al. (1993) found that individuals who took part in guided imagery sessions not only scored better on both mood scores and quality of life scores than those who did not. Rather, even after sessions were complete, the scores continued to improve in the experimental group, giving clear indication that guided imagery is effective in improving mood and quality of life in cancer patients.

Psychological therapies can reduce the mental health problem focusing on the symptoms highlighted. Therapy can make patients handle the behaviors and mental stress stages. Regarding brain tumor some therapies act as a healing tool. The problem is that many psychotherapists know little about video games such as World of Warcraft and Second Life. They may let go gaming as insignificant. When people come to treatment with problems, it is important to remember that they are trying to cope with them in the best way they can. With that in mind, therapists can offer a reflective and engaging partnership with their clients, working toward the goal of helping them to be authentic and compassionate in a world that can be extremely stressful. Meeting the needs of the competing goals of psychological therapy through conventional techniques of psychotherapy is extremely challenging due to the shortage of psychotherapists and the need to create an appropriate therapy environment. Technology nowadays is providing many human like solutions in different aspects of life from education to treatments.
The role of serious gaming in managing health is one of the examples for the use of management of difficult or problematic behaviors. Health games can help patients develop specific skills needed to manage illnesses in a cost-effective, easily distributed way (Kato, 2010). Several games, have been developed on the treatment of health through games. Elementary principles for a game design generally include basic idea, problems to solve, game rules and mechanisms of feedback for health purposes. But one more thing that has to be considered while designing a health game is the message of the game and the interest in the game.

A popular health game, Re-mission has been developed by Hope Lab for cancer patients in which the player manages realistic and life threatening side effects related to cancer with the purpose of better understanding and handling physical disease (Tate and Haritatos, 2009). Re-mission was the first game made for cancer patients and proved effective with regard to decrease in anxiety and depression level of the patients but it was meant for teenagers. There is no such therapeutic game made for children. Re-mission game was a third person shooter game, hence does not provide the explanation of self-empowerment which is essential to fight any enemy and hence cannot fulfill the therapeutic requirements. They have introduced their own design principles by following some medical mechanism of disease identification and then full testing of disease and symptoms but the game is meant for teenagers only and the design does not contain any form of known psychotherapy into it.

Another health related serious game is Personal Investigator (PI) (Coyle et al., 2005b). It is designed to engage adolescents in psychotherapy through a computer aided model. This game is developed to cope with the mental health problems like anxiety, social skill problems and depression. In this game the Solution Focus Therapy (SFT) is used as a therapeutic model because it focuses on the goal oriented approach as computer games do.

‘Treasure Hunt’ is the very first psychotherapeutic computer game made based on the rules of behavior enhancement (Brezinka, 2008). It targets children high quality attraction for video games in order to maintain psychotherapy. This collective adventure game which is for eight to twelve year old children is not developed for replacing the therapist but to advise engaging electronic homework assignments and practice the main educational concepts that have been adopted during therapy.

Many frameworks for making game designs has been explained for the health as well as entertainment games, for example, Hunicke et al. (2004) has proposed
a MDA Framework for game design. MDA stands for Mechanics, Dynamics and Aesthetics. Mechanics illustrates the game at algorithms level. Dynamics shows the run-time behavior of the game as system and Aesthetics demonstrates the emotional reactions induced in the player. This game developed an approach that is flexible enough to make changes in the aesthetic part. It is difficult to propose a game design that is safe for multiple targets because several designs are technically very sound but are not close to heart of players. A game must have psychological synchronization if it is to have psychotherapeutic impact on its audience.

It was found that the existing solutions for targeting the therapeutic aspect are not addressing the psychological problems of the brain tumor children in time and especially children are not aware of what is going inside their body. The reality for them is too hard to understand. However they are really good in imagination and play. The physical aspects of these children are dealt as a priority but the fact that mental state can affect the physical state is ignored. There is also a lack of game design which can work as a therapist itself when the psychotherapist is not available.

Therefore, to design an appropriate therapy game for brain tumor cancer children a design is desired to be proposed in which psychotherapy is embedded and can be provided without the physical presence of the psychotherapist. Computer technology is utilized in every area of life and hence can be utilized to generate psychotherapeutic game for children with brain tumor. Psychotherapy for use with the illness-related psychological problems is a very important aspect as explained in the background and thus it should not be ignored.

1.3 Problem Statement

Embedding psychotherapy into a game design can clearly be the important line of research into serious health video game designs which has not yet used in previous designs. The previous games such as Re-mission, Personal Inventory and Treasure Hunt showed that there are reactive approaches in terms of game designs of health game as several designs are technically very sound but may not be closer to heart of player due to lack of involvement of the players cognitive interests themselves. Menestrina (2007) have proved the involvement of the end-users in the development of a health game that is truly user oriented. Participatory design or in general terms involving the users must be taken into account for the design of health games. Games
such as Re-mission though meant for cancer patients have not involved the end users in its design. Therefore there is a need to use proactive approach in designing a game so that the adaptation becomes natural and support for those having behavior problems associated with physical illnesses such as brain tumor may be targeted. Lastly designing a computer game for brain tumour children with psychotherapy into it will minimize the role of psychotherapist in the oncology ward who is rarely available in every hospital. Hence, the issue of unavailability of a therapist to solve psychological problems related with diagnosis of brain tumour in children are the main problem to solve in this research by proposing an effective game design for a psychotherapeutic purpose.

In this thesis an attempt has been made to propose psychotherapeutic game design, which can work as a psychotherapist in the unavailability of therapist for the children suffering from brain tumor, through involving the children in developing the therapeutic game. Hocine and Gouaïch (2011) emphasized the importance of embedding psychotherapy into a game design and this work has addressed the involvement of psychotherapy into a game design for health games, targeting brain tumor in children.

1.4 Research Questions

The open issues discussed above lead to some research questions. The following research questions are addressed in this research:

i Which psychotherapy or combination of psychotherapy can be embedded into a computer game design?

ii How can health game design be enhanced to make it a therapy design for brain tumor in children?

iii How can the computer game be served as therapist for children problematic behaviours with brain tumor?
1.5 Research Aim

The aim of this research is to propose psychotherapy game design for children suffering from brain tumor, by introducing the psychotherapy into the game design, thereby making it possible to provide psychotherapy through a computer game for the related psychological problems of this disease.

1.6 Research Objectives

The following research objectives are to be achieved during the research work. These objectives are in the perspective of the research questions mentioned in section 1.4.

i To propose a suitable existing psychotherapy or combination of therapies that can be embedded into a game design.

ii To enhance existing computer game design and propose a new game design for the children with brain tumor.

iii To integrate the proposed game design into a computer game that can serve as a therapist for psychological symptoms of brain tumor children.

1.7 Research Scope

The scope of this research covers the following points:

i The study focuses on finding and embedding a suitable combination of psychotherapy in design of computer health games.

ii The research is restricted to the use of imagery psychotherapy and play psychotherapy for embedding into a computer game design and other form of therapies are out of scope for this research.

iii The proposed psychotherapy game design is implemented using Adobe Photoshop, 3D Max and Unity.

iv The proactive involvement of the children is ensured by involving them in the creation of game environment for the proposed design.
v The proposed design is tested on the children suffering from brain tumor and is particularly designed for children with age range 10 to 14 years.

vi The change in behaviour such as anger, disruptive behaviour, self-concept, aggression, anger and anxiety of brain tumor children before and after playing the game is verified through a standardized psychological inventory testing module.

vii The MDA framework has been chosen to design the game with psychotherapy.

viii The scope of this study is limited to the effects of psychotherapy based game design only on children suffering from malignant brain tumor and it does not apply on other cancers.

ix The Beck Psychological Inventory Tool is utilized in this study due to its variability in measuring five most accurate psychological problems which are originated after the diagnosis. The test is specially designed for the purpose. The scope does only cover the testing from Beck Inventory.

1.8 Thesis Organization

The rest of the thesis is organized as follows.

Chapter 2 describes an exhaustive literature review of the area of study, background, problems, solutions and evaluations. A comprehensive exploration on the existing literature in the available approaches for game design, serious health games and the available game designs of health games, effect of playing computer games for dealing with anxiety and pain control, psychotherapy and effect of imagery therapy and play therapy on problematic behaviors of brain tumor children are presented in chapter 2.

Chapter 3 highlights the flow of research methodology, which is used in this research. This is followed by survey steps of the proposed game environment. Research design procedures of the game design are explained such as MDA design and justification for choosing MDA design. The two chosen therapies are described in detail. Evaluation methods are elaborated.

Chapter 4 outlines the design detail of introducing the suggested therapy part using the MDA framework and it presents the proposed psychotherapy play and
imagery model in which game design with therapy is evolved. The proposed steps to design the game and proposed enhanced game design are evaluated through the standardized methods used in HCI.

Chapter 5 explains the proposed design validation with the brain tumor children. Expert evaluation, user evaluation, user interface evaluation and user acceptance evaluation has been performed.

Chapter 6 presents the conclusion, describes the contributions made by this study, and suggests directions for future research.
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