INSTRUCTIONAL ANIMATION DESIGN: THE INFLUENCE OF RENDER STYLES AT THE COGNITIVE STAGE OF PSYCHOMOTOR LEARNING

TERRY BIN LUKAS @ LUCAS

PhD

June 2018
INSTRUCTIONAL ANIMATION DESIGN: 
THE INFLUENCE OF RENDER STYLES 
AT THE COGNITIVE STAGE OF 
PSYCHOMOTOR LEARNING 

TERRY BIN LUKAS @ LUCAS 

Thesis submitted in fulfilment 
of the requirement for the degree of 
Doctor of Philosophy 

Faculty of Art and Design 

June 2018
CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 16th January 2018 to conduct the final examination of Terry Bin Lukas @ Lucas on his Doctor of Philosophy thesis entitled “Instructional Animation Design: The Influence of Render Styles at the Cognitive Stage of Psychomotor Learning” in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiners recommends that the student is awarded the relevant degree. The panel of examiners was as follows:

Darusalam Abu Bakar, PhD
Professor
Faculty of Communication & Media Study
Universiti Teknologi MARA
(Chairman)

Azahar Bin Harun, PhD
Senior Lecturer
Faculty of Art & Design
Universiti Teknologi MARA, Melaka
(Internal Examiner)

Neo Tse Kian, PhD
Professor
Faculty of Creative Multimedia
Multimedia University, Cyberjaya
(External Examiner)

Katherine T. Frith, PhD
Professor
School of Journalism
Southern Illinois University Carbondale, USA
(External Examiner)

PROF SR DR HIJ ABDUL HADI
HJ NAWAWI
Dean
Institute of Graduates Studies
Universiti Teknologi MARA
Date: 30th May, 2018
AUTHOR’S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student : Terry Bin Lukas @ Lucas
Student I.D. No. : 2013132637
Programme : Doctor of Philosophy (Arts & Design) – AD950
Faculty : Art & Design
Thesis Title : Instructional Animation Design: The Influence of Render Styles at the Cognitive Stage of Psychomotor Learning
Signature of Student :

.........................................................

Date : June 2018
ABSTRACT

There have been several studies investigating the effectiveness of two-dimensional visual representation and three-dimensional visual representation. Areas that are similar to this study are in information visualisation, simulation, user interface and virtual navigation. However, the findings from these studies are relatively inconsistent. The research specifically focused on psychomotor learning as this area of study is still relatively under-researched. Moreover, recent studies show that animation is effective in learning procedural tasks. Nevertheless, based on the recommendations of these studies, more research is needed to narrow the gap on the underlying visual characteristics of the digital human representations and its techniques. Hence, this research aims to investigate the effectiveness and the efficiency of various virtual human representations such as two-dimensional visual and three-dimensional visual in motor skills acquisition. The first phase is to investigate the underlying characteristics and applications of animated digital human representations in instructional animations. Explorative studies via a hybrid of directed and interpretive content analysis grounded on Cognitive Theory of Multimedia Learning on the specific design features and visual representations were analysed. This study found common characteristics and unique approaches to creating instructional animation. The second phase is to propose a theoretically based instructional animation design framework for psychomotor learning. The study lays out a conceptual design framework based on selected learning theories, instructional video design, and digital human representations. The third phase is to test the render styles variable of the proposed instructional animation design framework through a series of hypothesis testing which includes cognitive efficacy, temporal efficacy and preference. The hypothesis testing for validation will be done through post-intervention method to measure the difference in efficiency and effectiveness performance. In the context of visual design, this experimental phase explores possible influences of realism (levels of visual details) in the cognitive aspect of motor skill acquisition. Sixty-four students with low-prior knowledge on the subject of tennis were randomly assigned into three groups to view either 2D schematic, 3D stylised, or live-action instructional tennis video. Their performance on the knowledge test (based on the revised Bloom’s Taxonomy), learning time, efficiency score, confidence levels, preference, and open-ended responses were analysed. Key findings showed that despite most participants preferred to watch the live-action video; there was no statistically significant difference regarding cognitive learning performance among learners from different treatment groups. Hence, animated digital characters can still be incorporated into motor skill acquisition especially in instructional animations, videos, simulations, video games, and virtual reality. It is crucial to know the efficacy of different graphical renderings to design a simultaneously cost-efficient and engaging learning experience. Overall, this study contributed in identifying design characteristics of instructional animations, proposing instructional animation design framework for motor learning, and observing the efficiency and effectiveness of realism (levels of visual details) that can be applied in various fields such as arts, sports, and multimedia content design. Furthermore, this study has provided empirical evidence, framework and methodological reference for future research.
ACKNOWLEDGEMENTS

Firstly, I wish to thank God the Almighty for giving me the opportunity, strength and patience to embark on my PhD endeavour and endure unforeseen obstacles in this long and challenging journey. My gratitude goes to my supervisors Assoc. Prof. Dr Ruslan Abd Rahim and Dr Nazrul Azha Mohamed Shaari. Also, I would like to thank Dr Rosita Mohd Tajuddin, Dr Mumtaz Mokhtar, Mrs Noradlin Mohd Ali, Mrs Suzarah Sajuri, Mrs Erni Mustafa Bakri, and Mrs Salwani Sapidi for providing postgraduate administrative support. I would like to thank Assoc. Prof. Dr Puzziawati Ab. Ghani, Prof. Dr Hajibah Osman, and Dr Mohd Zuli Jaafar for providing advice on statistical analyses, thesis writing, and thesis formatting respectively. I would like to thank the Ministry of Higher Education (SLAI) and UNIMAS for providing some financial support and opportunity for me to pursue my PhD study.

Secondly, my sincere appreciation goes to the INTEC Academic Director, Dr Ruzela Tapsir and Mr Mohammad Shurabil Suib who provided the permission, facilities and assistance during sampling and experimental study. I would also like to thank students of INTEC ATCP Cohort 14 who participated in the study. Many thanks also go to Mr Rahizam Abdul Rahim for guiding and finding support, and providing suggestions in designing the tennis videos. I would like to thank Sri Aakash Reddiyar and Talhah Mohamad Rahizam for the willingness to become tennis demonstrators for my study. My appreciation also goes to Alvin Siaw for assisting with the PLAto development. I thank my UNIMAS colleagues who provided helpful comments in the development of my research instruments: Prof. Dr Chen Chwen Jen, Assoc. Prof. Dr Soubakeavathi Rethinasamy, Dr Faridah Safari, Dr Mohd Khairul Hisyam Hassan, Dr Philip Nuli Anding, Dr Nurashikin Suhaili, Agatha Lamentan ak Muda, Candida Jau Emang, Chuah Kee Man, Hafzah Nahrawi, Jayapragas Gnaniah, Mogeret Binti Sidi, Noorhaslina Binti Senin, Rahah Haji Hasan, and Sheilla Lim Omar Lim. Special and wonderful thanks go to my parents, siblings, relatives, friends, and multi-talented pet, Drogon, for providing moral support throughout my PhD journey.

Last but not least, this thesis is especially dedicated to my late grandparents. May their beautiful souls rest in peace.
# Table of Contents

**Confirmation by Panel of Examiners**  \(\text{Page} \ ii\)

**Author's Declaration**  \(\text{Page} \ iii\)

**Abstract**  \(\text{Page} \ iv\)

**Acknowledgements**  \(\text{Page} \ v\)

**Table of Content**  \(\text{Page} \ vi\)

**List of Tables**  \(\text{Page} \ xiv\)

**List of Figures**  \(\text{Page} \ xvi\)

**List of Plates**  \(\text{Page} \ xxi\)

**List of Symbols**  \(\text{Page} \ xxv\)

**List of Abbreviations**  \(\text{Page} \ xxvii\)

**Chapter One: Introduction**  \(\text{Page} \ 1\)

1.1 Background of the Study  \(\text{Page} \ 1\)

1.1.1 Preliminary Studies  \(\text{Page} \ 6\)

1.2 Problem Statements  \(\text{Page} \ 11\)

1.2.1 Lack of Research Focusing on Design Attributes of the Instructional Animation in Video Format  \(\text{Page} \ 11\)

1.2.2 Lack of Conclusive Empirical Results in Investigating Different Animated Visual Representations  \(\text{Page} \ 12\)

1.2.3 Lack of Research Comparing the Effectiveness and Efficiency of Using Instructional Animation for Motor Skill Acquisition  \(\text{Page} \ 18\)
1.2.4 Studies on Visual Effectiveness in Complex Motor Learning are Lacking 20

1.2.5 A Majority of the Instructional Videos Involving Psychomotor Analyzed Did Not Fully Apply the Scientifically Proven Visual Design Principles, Information Design and Learning Theories 21

1.3 Research Objectives 22

1.3.1 To Determine Underlying Characteristics of Two-Dimensional and Three-Dimensional Visual Elements related to Animated Digital Human Representations 23

1.3.2 To Construct a Conceptual Instructional Animation Design Framework that Integrates Theories of Visual Perception, Visual Design, Instructional Design and Learning 23

1.3.3 To Explore the Effect of Different Animated Render Styles on the Cognitive Efficacy, Temporal Efficacy and Preference at the Cognitive Stage of Psychomotor Learning 23

1.4 Research Questions 24

1.5 Scope of the Study 24

1.6 Significance of the Study 27

1.7 Definition of Terms 28

1.8 Upcoming Chapters 33

CHAPTER TWO: LITERATURE REVIEW 36

2.1 The Neural Vision 36

2.1.1 Sensation 37

2.1.2 Visual Perception 41

2.1.3 Object Recognition 44

2.1.4 Summary 49

2.2 The Triadic Dimensions 50

2.2.1 The Illusion of Three-Dimensions 50