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Pan, Zhengxiang

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**Goal Oriented Model for Persuasive Storytelling in
Improved Game Experience for Elderly**

PAN ZHENGXIANG

Interdisciplinary Graduate School

2021

**Goal Oriented Model for Persuasive Storytelling in
Improved Game Experience for Elderly**

PAN ZHENGXIANG

Interdisciplinary Graduate School

A thesis submitted to the Nanyang Technological University
in partial fulfilment of the requirement for the degree of
Doctor of Philosophy

2021

Statement of Originality

I hereby certify that the work embodied in this thesis is the result of original research, is free of plagiarised materials, and has not been submitted for a higher degree to any other University or Institution.

30 November 2020

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Date

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Pan Zhengxiang

Supervisor Declaration Statement

I have reviewed the content and presentation style of this thesis and declare it is free of plagiarism and of sufficient grammatical clarity to be examined. To the best of my knowledge, the research and writing are those of the candidate except as acknowledged in the Author Attribution Statement. I confirm that the investigations were conducted in accord with the ethics policies and integrity standards of Nanyang Technological University and that the research data are presented honestly and without prejudice.

30 Nov 2020

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Date

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Miao Chunyan

Authorship Attribution Statement

This thesis contains material from 5 papers accepted at conferences, 1 paper accepted in a peer-reviewed journal and 1 paper under review in a peer-reviewed journal in which I am listed as an author.

Chapter 3 is published as Z. Pan, Y. Zhang, H. Zhang and C. Miao, "Encouraging Health Games Adoption among Elderly: A Depiction of the Elderly Health Game Experience," *International Journal of Information Technology*, vol. 27, no. 1, 2021.

The contributions of the co-authors are as follows:

- I designed and conducted the research experiment. I analysed the data and wrote the manuscript.
- Ms. Zhang Yaming assisted in formulating and carrying out the study.
- Mr. Zhang Hao helped organize the collected data for analysis.
- Prof. Miao Chunyan provided detailed supervision to the research and assisted in the revision of the manuscript.

Chapters 5 and 6 are submitted as Z. Pan, Y. Zhang, C. Miao, "Developing an Assessment Tool for the Elderly Health Game Experience," *International Journal of Human Computer Interaction*, 2021. (under review)

The contributions of the co-authors are as follows:

- I designed and conducted the research experiment. I analysed the data and wrote the manuscript.
- Ms. Zhang Yaming assisted in conducting the on-site study and assisted in preparing the data for analysis after the on-site study.
- Prof. Miao Chunyan provided detailed supervision to the research.

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- I proposed the model, conducted the study and wrote the manuscript.

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The contributions of the co-authors are as follows:

- I designed and conducted the research experiment. I analysed the data and wrote the manuscript.
- Prof. Miao Chunyan provided detailed supervision to the research.
- Dr. Yu Han provided advice in quantitative methods.
- Prof. Cyril Leung assisted with the revision of the manuscript.
- Prof. Chin Jing Jih provided medical knowledge related to wellness games.

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The contributions of the co-authors are as follows:

- I designed and conducted the research experiment. I analysed the data and wrote the manuscript.
- Mr. Zhang Hao assisted in the data analysis.
- Ms. Zhang Yaming assisted in the study design and on-site experiment.
- Prof. Cyril Leung assisted with the revision of the manuscript.
- Prof. Miao Chunyan provided detailed supervision to the research.

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The contributions of the co-authors are as follows:

- I designed and conducted the research experiment. I analysed the data and wrote the manuscript.
- Ms. Zhang Yaming assisted in design and execution of the on-site study.
- Mr. Zhang Hao helped organize the collected data for analysis.
- Dr. Shen Zhiqi provided guidance on the model formulation and assisted in the revision of the manuscript.

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The contributions of the co-authors are as follows:

- I studied the relevant literature and wrote the manuscript.
- Dr. Yu Han assisted in the search for related works.
- Prof. Miao Chunyan provided direction and supervision to the research.
- Prof. Cyril Leung assisted with the revision of the manuscript.

20 November 2020

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Date

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Pan Zhengxiang

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Table of Contents

Statement of Originality.....	3
Supervisor Declaration Statement.....	4
Authorship Attribution Statement	5
Acknowledgments	8
Table of Contents	9
List of Tables.....	14
List of Figures.....	16
Abstract	19
Abbreviations	21
1. Introduction.....	22
1.1 Background and Research Motivation	22
1.2 Research Problem: Low Adoption of Health Games among Elderly	25
1.3 Research Questions	28
1.4 Thesis Contributions	31
1.4.1 Elements of the Elderly Health Game Experience (EHGE).....	31
1.4.2 Health Game Experience Questionnaire (HGEQ).....	31
1.4.3 Goal-Oriented Storytelling Model (GSM)	32
1.5 Thesis Outline.....	33
2. Background of Serious Health Games and the Elderly Health Game Experience (EHGE).....	35
2.1 Introduction	35
2.2 Types and Benefits of Serious Health Games	36
2.3 Game Experience between Health Games and Elderly Players	39
2.3.1 Health Games' Perspective: A Combination of Entertainment and Health Benefits	40
2.3.2 Elderlies' Perspective: Age-Related Factors Forming Digital Barriers.....	44
2.4 Summary	46
3. Pre-Study to Discover Elements of the EHGE	47
3.1 Introduction	47
3.2 Health Game used in Study: Pumpkin Garden.....	47

3.3	Study Methodology.....	51
3.3.1	Evaluation Method: Phenomenology.....	51
3.3.1.1	Introduction to Phenomenology	52
3.3.1.2	Types of Phenomenology.....	52
3.3.1.3	Analysis with Van Manen’s Hermeneutic-Phenomenological Approach.....	54
3.3.1.4	Implication to Our Study.....	57
3.3.2	Interview Methodology.....	59
3.3.3	Study Flow and Selection of Participants	62
3.4	Phenomenological Text Describing the Lived Experience	65
3.4.1	Participant 1: 64, Female, 8 Years Since Diagnosed	66
3.4.2	Participant 2: 69, Male, 20 Years Since Diagnosed	68
3.4.3	Participant 3: 69, Male, 6 Years Since Diagnosed	72
3.4.4	Participant 4: 73, Female, 30 Years Since Diagnosed	75
3.4.5	Participant 5: 78, Female, 10 Years Since Diagnosed	78
3.4.6	Summary of Phenomenological Text.....	80
3.5	Findings: Elements that Make a Good Health Game Experience	81
3.6	Discussion: A Fuller Picture of the Health Game Experience	87
3.7	Summary	90
4.	Review of Existing Game Experience Questionnaires	91
4.1	Introduction	91
4.2	Common Practices: Self-Report Measurement using Likert Scales.....	92
4.3	Various Existing Game Experience Questionnaires	94
4.3.1	Game User Experience Satisfaction Scale (GUESS).....	94
4.3.2	Core Elements of the Gaming Experience Questionnaire (CEGEQ)	95
4.3.3	Player Experience of Need Satisfaction Questionnaires (PENSQ).....	95
4.3.4	User Engagement Scales (UES)	95
4.3.5	Immersive Tendencies Questionnaire (ITQ).....	96
4.3.6	Game Experience Questionnaire (GEQ).....	96
4.4	Discussion.....	98
4.5	Summary	99
5.	Health Game Experience Questionnaire (HGEQ): A Health Game Experience Assessment Tool	101
5.1	Introduction	101
5.2	Development of Health Game Experience Questionnaire	102
5.2.1	Additional Constructs to GEQ.....	102
5.2.1.1	Health Values	103

5.2.1.2	Familiarity	105
5.2.1.3	Identification of Human-Like Properties	106
5.2.2	HGEQ Item Generation.....	108
5.2.2.1	Health Values	108
5.2.2.2	Familiarity	111
5.2.2.3	Identification of Human-Like Properties	111
5.2.3	The Big Picture	113
5.3	Methods to Evaluate HGEQ.....	114
5.4	Summary	114
6.	Study 1: Evaluation of Health Game Experience Questionnaire (HGEQ).....	116
6.1	Introduction	116
6.2	Study Methodology.....	116
6.2.1	Evaluation Criteria and Tools Used.....	116
6.2.2	Confirmatory Factor Analysis	119
6.2.3	Study Flow and Selection of Participants	122
6.3	Results, Findings and Observations	123
6.3.1	Participants' Demographics	123
6.3.2	Internal Consistency Reliability	124
6.3.3	Predictive Validity	127
6.3.4	Convergent Validity.....	128
6.3.5	Discriminant Validity.....	133
6.3.6	Sensitivity	137
6.4	Findings from Open-Ended Questions.....	139
6.5	Summary	140
7.	Review of Approaches and Theories for the Coaching Model.....	142
7.1	Introduction	142
7.1.1	Game Literacy as an Approach to Improving Game Experience	142
7.1.2	Coaching to Improve Game Literacy and Game Experience	144
7.2	Storytelling	148
7.2.1	Practical Applications of Storytelling	148
7.2.2	Storytelling, Positive Experience, and Behaviour Change	149
7.2.3	Various Narrative Theories	151
7.2.3.1	Freytag's Pyramid.....	151
7.2.3.2	The Hero's Journey.....	152
7.2.3.3	Propp's Narrative Theory	153
7.3	Persuasion Methods and Theories	161
7.3.1	Overview of Persuasion Theories	162

7.3.2	Literature Review of Elaboration Likelihood Model (ELM)	164
7.3.3	Literature Review of Familiarity	170
7.4	Goal-Oriented Theories.....	173
7.4.1	Literature Review of Goal Setting Theory	174
7.4.2	Literature Review of Goal Net	177
7.5	Putting the Approaches Together	181
7.5.1	Novel Approach: Reconstructing the Gameplay Learning Journey as a Narrative 181	
7.5.2	Persuasion and Familiarity as Augments	185
7.5.3	Infusing Storytelling with Persuasion, Familiarity and Goal Setting	185
7.6	Summary	186
8.	Goal-Oriented Storytelling Model as a Health Game Coaching Methodology	187
8.1	Introduction	187
8.2	Mechanisms in the Goal-Oriented Storytelling Model (GSM)	188
8.2.1	Storytelling Mechanism: Recontextualized Propp's 31 Functions.....	189
8.2.2	Goal Setting Mechanism: Facilitating Progression	195
8.2.3	Familiarity Mechanism: Cultural, Symbolic, Actionable	197
8.2.4	Persuasion Mechanism: Elaboration Likelihood Model	199
8.3	Modelling GSM Using Goal Net.....	201
8.3.1	Coaching Scenario 1: Introducing the Game	202
8.3.2	Coaching Scenario 2: Completing a Game Goal.....	203
8.3.2.1	Coaching Scenario 2-1: Overcoming a Challenge During Goal Completion.....	204
8.3.3	Coaching Scenario 3: The Final Challenge.....	205
8.3.4	Coaching Scenario 4: Persuading the Elderly to Continue the Game	206
8.3.5	Assembling GSM sub-goal-nets into a Gameplay Session	207
8.4	Implementation Guide.....	208
8.5	Summary	210
9.	Study 2: Gameplay Session with GSM-Driven Coaching	212
9.1	Introduction	212
9.2	Study Methodology.....	212
9.2.1	Evaluation Criteria and Tools Used.....	212
9.2.2	Selection of Participants.....	216
9.2.3	Study Flow: GSM Implementation.....	217
9.3	Results, Findings and Observations	219
9.3.1	Participants' Demographics	219
9.3.2	Quantifiable Metrics: Game Performance, Literacy and Experience	221

9.3.2.1	Time Taken to Finish Each Round	221
9.3.2.2	Comparing Responses of The Game Literacy Questionnaire.....	231
9.3.2.3	Comparing Responses of The Health Game Experience Questionnaire	234
9.3.3	Qualitative Observations: The Coached Game Experience	236
9.3.3.1	Storytelling Mechanism: Four Key Segments of Propp’s Functions.....	237
9.3.3.2	Goal Setting, Familiarity, Persuasion Mechanisms	244
9.4	Summary	246
10.	Conclusion	248
10.1	Depiction of the Health Game Experience among the Elderly	248
10.2	Design of the Health Game Experience Questionnaire	249
10.3	Design of Goal-Oriented Storytelling Model	249
10.4	Future Research Direction	251
10.4.1	Improvements to HGEQ	251
10.4.2	Improvements to GSM.....	251
10.4.3	Utilization of Crowdsourcing	253
10.4.4	Potential Benefits of the EHGE Approach towards Health Game Design	253
10.4.4.1	Affective Design for Health Games.....	253
10.4.4.2	Maximizing Health Outcomes.....	253
10.4.4.3	Health Game Rating System for Elderlies	254
10.4.5	Further Research on Coaching’s Effects on Positive Game Experience	254
	Appendix A: Pre-Game Questionnaires Used in Study 1	256
	Appendix B: Game Literacy Questionnaire Used in Study 2	258
	Appendix C: HGEQ Used in Both Study 1 and Study 2.....	261
	References.....	266

List of Tables

Table 1. Categories of Health Games and Examples	37
Table 2. The Types of Data Collected for the Study	58
Table 3. Demographics of the 5 Elderly PD Participants	62
Table 4. Sample Format of Likert Scale Questionnaire	93
Table 5. Examples of Previous Game Questionnaires from the Literature.....	99
Table 6. HGEQ's Evaluation Criterion and Associated Metrics Used to Support the Criterion	118
Table 7. Demographics of the 51 Participants for Study 1	123
Table 8. Cronbach's Alpha of HGEQ Post-Game Module	124
Table 9. Cronbach's Alpha of HGEQ Core Module.....	125
Table 10. List of Selected Fit Indices.....	127
Table 11. Fit Indices of HGEQ Core Module	128
Table 12. Fit Indices of HGEQ Post-Game Module.....	128
Table 13. Bivariate Correlations of HGEQ Post-Game Module	129
Table 14. Bivariate Correlations of HGEQ Core Module.....	130
Table 15. Bivariate Correlations between Core and Post-Game Module Constructs.....	132
Table 16. AVE of HGEQ Core Module	134
Table 17. Squared Correlations between Different Constructs of HGEQ Core Module	134
Table 18. AVE of HGEQ Post-Game Module	136
Table 19. Squared Correlations between Different Constructs of HGEQ Core Module	136
Table 20. Correlations Between Familiarity, Positive Affect, and Negative Affect among Different Age Groups	137
Table 21. Correlations Between Identification of Human-Like Properties and Positive Affect among Different Age Groups	138

Table 22. Correlations between Health Values and Post-Game Positive Experience among Different Health Groups	139
Table 23. Categorised Persuasion Models and Theories.....	163
Table 24. GSM Design Implementation for the Study	190
Table 25. List of Coaching Scenarios	193
Table 26. Goal Setting Methods	196
Table 27. Short Survey for Study 2 Participant Selection.....	216
Table 28. Demographics of the 51 Participants for Study 2.....	220
Table 29. Independent Samples t-test of Mean Rounds Taken to Learn for Each Minigame	223
Table 30. Independent Samples t-test of Mean Time Between Participant Groups	223
Table 31. Independent Samples t-test of Average Time Difference Between Each Minigame	225
Table 32. Study 2 Results: Game Literacy Questionnaire ISM Construct.....	232
Table 33. Study 2 Results: Health Game Experience Questionnaire Results	234
Table 34. Summary of the Coached Game Experience as a Proppian Story	244

List of Figures

Figure 1. Learning from Commercial Games: Assessing and Enhancing the Elderly Health Game Experience (EHGE)	27
Figure 2. Visualization of Thesis Outline	34
Figure 3. The Starting Screen of Pumpkin Garden Game.....	48
Figure 4. Task Selection Screen Showing Minigames Used for Study	49
Figure 5. The Weed Clearing Minigame.....	50
Figure 6. An Example of Weeds Clearing Minigame Result	50
Figure 7. The Water Wheel Minigame.....	51
Figure 8. Phenomenological Approach of Pre-Study	59
Figure 9. Pumpkin Garden Gameplay Sequence Designed for Pre-Study.....	64
Figure 10. P1's Character Development Throughout the Game Session	68
Figure 11. P2's Character Development Throughout the Game Session.	72
Figure 12. P3's Character Development Throughout the Game Session	75
Figure 13. P4's Character Development Throughout the Game Session	78
Figure 14. P5's Character Development Throughout the Game Session	79
Figure 15. Understanding of Relationships between the Elderly, Health Game and Game Companion.....	87
Figure 16. Elderlies' Diminished Interaction with the Health Game Lowers Game Experience	88
Figure 17. The Researcher.....	88
Figure 18. Health Values.....	88
Figure 19. Familiarity.....	89
Figure 20. Human Companionships.....	89
Figure 21. Holistic View of the EHGE when Accompanied by the Researcher	90

Figure 22. Summary of Constructs in Proposed HGEQ	113
Figure 23. The Hypothesized 10-Construct Model for HGEQ Core Module	120
Figure 24. The Hypothesized 4-Construct Model for HGEQ Post-Game Module	121
Figure 25. Factor Loadings of HGEQ Post-Game Module	125
Figure 26. Factor Loadings of HGEQ Core Module	126
Figure 27. Freytag's Pyramid of Narrative Technique	151
Figure 28. The Hero's Journey.....	153
Figure 29. The Goal Setting Theory and Task Performance.....	176
Figure 30. The Basic Elements of the Goal Net	178
Figure 31. Three types of Goal Interactions	181
Figure 32. Visualization of ELM Persuasion Strategy.....	200
Figure 33. Coaching Scenario 1: Introducing the Game	202
Figure 34. Coaching Scenario 2: Completing a Game Goal	203
Figure 35. Coaching Scenario 2-1: Overcoming a Challenge	204
Figure 36. Coaching Scenario 3: The Final Challenge	205
Figure 37. Coaching Scenario 4: Persuading the Elderly to Continue.....	206
Figure 38. General Model of GSM-Driven Coached Gameplay Session	207
Figure 39. Computer Agent Implementing GSM to Facilitate the Wizard of Oz Testing....	215
Figure 40. Dashboard to Control the Computer Agent	216
Figure 41. GSM Implementation for Study 2.....	218
Figure 42. Participants Demographics Age Group Comparison with Singapore Population	220
Figure 43. Time Taken to Finish Each Round in Water Wheel Gameplay Using Hand	222
Figure 44. Time Taken to Finish Each Round in Water Wheel Gameplay Using Mouse	224
Figure 45. Time Taken to Finish Each Round in Water Wheel Gameplay Using Apple Pencil	226

Figure 46. Time Taken to Finish Each Round in Weed-Clearing Minigame	227
Figure 47. Visualized Difficulty Curve of Different Minigames Based on Average Time Taken to Complete	229
Figure 48. Study 2 Coaching Scenario: Introduction.....	238
Figure 49. Study 2 Coaching Scenario: Overcoming a Challenge	239
Figure 50. Study 2 Coaching Scenario: Overcoming a Challenge (Help Required)	240
Figure 51. The Struggle to Victory Signifying the Completion of the Game Session	241
Figure 52. Violation to Counteraction Requires Persuading Participants to Accept the Game	243

Abstract

Serious games for health are beneficial in fostering a healthy aging population. However, health games are not as popular among elderly when compared to commercial games. From the inherent differences between health games and commercial games, and between elderly and the average player, the term “elderly health game experience” was identified and explained. This thesis delves into assessing aspects that are unique to the elderly health game experiences (EHGE), and subsequently, methods to enhance the EHGE. The efforts aim to promote adoption of health games among elderly which can help them age healthily down the road.

In this thesis, a pre-study is first conducted to discover elements of the EHGE. Through phenomenological study of elderly players’ gameplay and sharing, health values, familiarity and human interactions are highlighted as important aspects of the EHGE.

Health Game Experience Questionnaire (HGEQ) is subsequently designed to establish understanding of EHGE via creating an assessment tool. Constructs and question items are added into the pre-existing Game Experience Questionnaire, thereby extending its measurement capabilities into important aspects of the EHGE. The constructs are modelled and the HGEQ is validated as a whole through Confirmatory Factor Analysis and statistical tests in a subsequent quantitative study with 51 participants. The HGEQ is deemed to appropriately capture the additional aspects of the EHGE, and bears potential to serve as a good measurement tool to provide feedback of health game experiences among the elderly.

The third part of this thesis presents our attempt to craft a positive health game experience for the elderly. The Goal-Oriented Storytelling Model (GSM) is proposed to provide a methodological, step-by-step approach to coach the elderly when they play a health game. The storytelling mechanism in GSM uses Propp’s theory to structure a gameplay session into

discrete states, much like different points in a story. On the other hand, other GSM mechanisms (persuasion, goal setting and familiarity) suggest coaching techniques that can help the elderly overcome barriers and complete the game with good experience. Four coaching scenarios are proposed by referencing these different mechanisms. The coaching scenarios are modelled using the Goal Net, enabling it for future implementations using intelligent agents. A GSM implementation is proposed and applied to coach 20 elderlies who had little to no prior exposure to video games through a health game session. Through quantitative and phenomenological analysis of the gameplay process, GSM is demonstrated as an effective practice that improves elderlies' game performance, game literacy and game experience. Phenomenological findings also highlight the essence of the coached game experiences as a “storified” learning journey complete with various character archetypes, made possible by coaching practices derived from GSM mechanisms.

Through the combination of quantitative and qualitative methods, the HGEQ and GSM contribute towards the assessment and creation of positive health game experiences for the elderly, thus encouraging them to adopt health games and in extension, a healthy lifestyle. Finally, the contributions in this thesis can eventually help serious game designers or researchers alike find new ways to improve health games from new coaching perspectives.

Abbreviations

AVE	Average Variance Extracted
ELM	Elaboration likelihood model
EHGE	Elderly Health Game Experience
GSM	Goal-Oriented Storytelling Model
HGEQ	Health Game Experience Questionnaire
GEQ	Game Experience Questionnaire
PD	Parkinson's Disease

1. Introduction

1.1 Background and Research Motivation

Elderly Health

People worldwide are enjoying a prolonged life, which creates opportunities for not only the elderly and their families, but also for the whole society. Leading longer lives provides people with a chance to pursue new activities such as life-long learning, fulfilling lifelong dreams and contribute in many ways to their families and communities. However, the extent of those opportunities heavily depends on the health of the elderlies. If they can experience late years of life in good health, they will bring a positive impact to their surroundings through their ability to do the things they value. Conversely, if the extra years are dominated by a declined state of physical function and mental capacity, the implication for both the elderly and society will be negative.

Singapore is facing the challenge of a rapidly aging population. The Singapore Department of Statistics [1] has shown the proportion of the elderly (aged 65 and above) among the whole population has risen rapidly from 9% to 14.4% in the period 2010 to 2019. At the same time, elderlies' life expectancy has increased from 19.8 years to 21.3 years in the same period, which is one of the highest in the world.

An aging population comes with a set of challenges such as declined economic growth, social issues and increased healthcare and social services. Singapore is well aware of its aging population and is actively addressing issues with its aging population, exemplified by its increasing health expenditures [2, pp. 4, 5] and number of senior activity centres [3]. The road to creating a healthy aging population is still long and challenging.

Rise of Video Games

Apart from an aging population, the world has also seen a rise in the gaming industry. The growth rate of global games market is forecasted to increase from 2018 up until 2023 [4]. Commercial video games which provide rich experiences are continuously being released to provide entertainment to the masses, even among the elderly population. A study by AARP [5] showed a significant rise in gaming among older adults. The number of gamers older than 50 years old has risen by approximately 10 million from 2016 to 2019 (from 38% to 44% of the population). Games' popularity among seniors is also reflected in the money spent on games, from \$523 million to \$3.5 billion within the same timeframe.

Games' popularity has created an avenue for practical applications such as serious games. Serious games are games that go beyond entertainment, designed to achieve a meaningful purpose that is significant in the real world. While they typically do entertain, the more valued 'serious' purposes are typically related to transmitting knowledge, developing skills, or inducing behaviour change [6].

Serious Health Games' State-of-the-Art

Serious game applications have gained significant popularity in the field of healthcare; such games are also known as *health games*. According to the taxonomy of serious health games [7], health games can specialize in different forms such as prevention, therapy, assessment, education, informatics and production. They also cater to individuals, professionals, researchers and governments in charge of public health. One way or another, the ultimate goal of these health games is to provide health benefits to the masses.

There has been increasing evidence that supports the use of health games on digital platforms for health improvement. Several review studies have presented significant positive effects of playing serious health games [8, 9, 10]; one of which suggests that games should be better

tailored for the elderly to maximize the health benefits [9]. More specific examples of health games like exergames [11, 12, 13] and cognitive training games [14, 15] are actively being developed for elderlies. At the same time, their benefits are constantly being monitored to provide feedback for future development of more effective health games [16]. The potential of health games remains promising in the backdrop of an aging population.

The health benefits brought by health games has received significant backing from prior research. Thus, increasing adoption of health games is an important next step to reap the health benefits offered by health games. However, a systematic review on the state-of-the-art of health games reveals a less promising landscape. Lu and Kharrazi [17] conducted a systematic review on the content of health games being released from 2018 back to 1983. Noteworthy observations are highlighted:

- More than 84% of health games are designed for the healthy general public.
- Purpose-wise, most health games stopped at “raising awareness” and “transmitting knowledge” (58%), when compared to games that actually require active gaming (33%).
- The quality of health games is lacklustre when compared with commercial games. More than 50% of the games are mere “simple interactive applications” and around 75% of games can be completed in less than an hour, which demonstrates less engagement than typical commercial games (games less than 2 hours are considered very short for commercial games [18]).
- Games for health have slowed in production since 2014; developing more health games is likely not the proper way to increase adoption.

Other researchers agree that although health games’ benefits are well proven, health games market are still at an early stage (i.e. health games receive relatively low investments) [19]. Health games are generally still limited to offering short-term engagement through extrinsic

rewards [20], in contrast to the rich, vast and variety of experiences the commercial game industry can offer. From the observations above, we see room for improvement for health games' design quality and uptake among the population. There is much to learn from the commercial games industry [21] to achieve a comparable success in the field of health games, which can in turn help encourage the need for a healthy aging population.

1.2 Research Problem: Low Adoption of Health Games among Elderly

The low adoption of health games is prevalent among the elderly population, where health games are perceived to have great benefit potential. Although health games do encourage the elderly to have fun while providing health benefits at the same time, the adoption of health games among the elderly is still far from commercial games. While elderlies are receptive towards commercial games, the uptake of health games are still relatively confined to research applications (from [17, p. 6], half of developed health games in history are funded by research).

A noteworthy trait to highlight here is that health games, as “benefit delivery systems [22]”, have more stringent requirements. The research applications for health games requires the games to be designed with rigorous empirical backing, which diverted resources and effort away from making the game attractive. As a result, the low adoption of health games for general wellbeing manifests as a relatively small health game market [19]. It is harder to be on par with commercial games in terms of attractiveness and entertainment value when these traits are not the sole priority in serious game design. Serious health games' design constraints [21], compounded with age-related factors that inhibits elderlies' ability to use digital applications, can result in underwhelming game experiences. There is a need for health games to generate more positive experiences¹ for the elderly, in order to encourage them to accept and adopt health games as part of their lifestyle. For example, a rehabilitation health game which

¹ The word choice “game experiences” is intentional; here it refers to “experience from playing games” and not “prior experience with games” which is not as distinguished in prior literature.

generates better game experience also helps improve elderly's adherence to their rehabilitation programs.

Researchers have suggested learning from the commercial games industry to improve health game adoption, stating that *“if the user is sufficiently entertained to regard the process as a game rather than a rehabilitative program, then the chances of continued engagement are increased”* [21, p. 7]. After all, commercial video games are valued in terms of the positive experience they create for the player [23], and industries will seek to design the optimal game experience for their players. Games which provide good game experience tend to be more popular than games which do not. As such, the industry focuses on designing the optimal game experience for their players, with entire books being published and updated on this matter. Aside from design, having effective ways to assess the crafted game experiences is also important to provide feedback for designers. The game industry utilizes playtesting [24] and questionnaires [25] for assessing the game experience. This concept of assessing and perfecting the game experience is very useful in health games' context; investing effort to investigating the components of the health game experience can be worthwhile to promote health game adoption among the elderly population.

Thus, the concept of the “elderly health game experience” is central to this thesis. It can be understood as a more specific form of game experience: the experience felt by elderly players when they play health games. Figure 1 visualizes a promising avenue to increase health game adoption among elderly, which is to enhance the elderly health game experience (EHGE).

Figure 1. Learning from Commercial Games: Assessing and Enhancing the Elderly Health Game Experience (EHGE)

Referencing the success of commercial games, we are confident that in the long run, having a positive game experience can drive higher motivation to play health games. Increased use of health games brought by positive game experiences helps promote general wellbeing among active elderlies or improve elderlies' medical adherence in rehabilitation programs that utilize health games. However, there is a general lack of literature that attempts to increase “health game adoption” or “game adoption among elderly” by directly addressing the potential positive experience health games can produce for the elderly player. The more pressing gap in literature lies in the very definition of the elderly health game experience (EHGE). The gaps are visualized as dotted circles in Figure 1 above.

Research Gap

Existing literature that aims to improve the health game experience among the elderly are briefly reviewed here. IJsselsteijn et al. [26] emphasizes that the elderly needed to understand the perceived benefits well in order to accept the game. His work focused on generic advice such as “*we need to design for rich and rewarding experiences, combining low-threshold*

interaction styles with content that will directly speak to and engage elderly users.” Brox et al. [27, 28] has made recommendations solely on the game design itself, with plenty more studies following suit [29, 30, 31, 32].

It is apparent that plenty of research focus has been directed at improving the gameplay design in terms of content and interaction [33] to better cater them for the elderly. However, the goal of game design is to create better game experiences, and the above design recommendations can be made more actionable and directed if they focus directly on various dimensions of the health game experience as perceived by elderly players. Hence in this thesis, the research focus is keyed onto the subject of the EHGE:

“In effort to promote use of health games among the elderly, how can we better define, assess and enhance the health game experiences among the elderly?”

1.3 Research Questions

The contributions presented in this thesis attempt to address the following specific challenges.

Question 1: What is the the elderly health game experience?

Before we attempt to assess or craft a health game experience for the elderly, we need to first understand what dimensions exist in such a game experience. By inspecting the term “elderly health game experience” itself, we gather that it is an extension of “game experience”, with “health” and “elderly” being elements in the extended definition.

- The *health* element: Prior research has attempted to define [34] and measure [35, 36] the “serious game experience” as an aspect of unique game experiences that serious games can provide. The “serious experience” is often understood as perceived benefits, a long-term motivator for frequent use. However, the “health game experience” as a sub-type of the “serious game experience” is never explicitly coined nor measured in

prior literature. As such, constructs specific to the “health game experience” are never explicitly explored.

- The *elderly* element: Plenty of research has been conducted on the age-related needs of elderly and how it affects their gaming preferences. Topics in this area are diverse, but can be roughly categorised into exploring elderly’s perceptions [36, 37, 38], reporting successful projects [32, 39, 40] and providing design recommendations for elderly games [9, 26, 33]. However, little research to-date explores elderly gaming from an elderly game experience perspective. We found a study that described the elderly’s experiences with the words “keeping the mind active”, “challenge”, “accomplishment” and “enjoyment” [41], but these findings are yet to be reconciled with grounded theory in elderly research to become useful.

Hence, in this thesis we will first focus on identifying significant elements of the “health game experience” and the “elderly game experience” before developing solutions on quantifying and creating the “elderly health game experience”.

Question 2: As part of promoting adoption of health games among the elderly, how might we develop an assessment tool for the elderly health game experience?

Researchers have developed several assessment tools when assessing game experiences which typically comes in the form of questionnaires. Many such questionnaires exist currently [42, 43, 44, 45, 46, 47] to evaluate generic video games meant for entertainment. However, no formalised method to assess game experience in health games’ context have been developed. Current research has attempted to directly plug-and-play existing game questionnaires² into health games [40, 48, 49], which may result in an inadequate representation of reality since it does not shed light on dimensions that are only present in the “serious game experience” [34]

² The author uses “game questionnaire” as an umbrella term to refer to questionnaires that attempt to measure the game experience.

or the “elderly game experience”. When the goal is to build a Health Game Experience assessment tool for the elderly, it is logical that health-game-specific and elderly-specific constructs should be explored and then added to an existing game questionnaire. As such, current methods to improve health games are being constrained to in-game design aspects, possibly due to receiving inadequate feedback from players of health games.

Question 3: As part of promoting adoption of health games among the elderly, how do we enhance the health game experience for the elderly?

When the elderly attempts to play health games, they often encounter difficulties due to the lack of confidence and direction when experiencing an unfamiliar virtual game world. Unlike the younger generation who grew up with video games, the older generation has to rely on their understanding towards the real world to obtain basic game literacy. Their low game literacy prevents them from making meaningful interpretations from the game’s feedback. Using the understanding towards the EHGE obtained earlier, we aim to develop a methodology that can improve their health game experience. Although prior studies attempted to accomplish this through gameplay design, they typically offer generic advice that are not actionable [9, 26], or specific recommendations (i.e. project-specific advice) that are not generalizable [32, 39, 40].

Game design is not the only way to enhance the elderly gameplay process. Playing a game is, after all, a process of interactions between the elderly player and the health game. To date, few studies have focused on the elderly’s interaction with the researcher who functions as a mediator. Little is known on the actual process of guiding the elderly and helping them navigate the complexities of interfaces presented in video games, except for a direct question-and-answer approach [50]. When probing deeper into finer aspects of how we can coach an elderly through a health game, we found no research to-date that attempts to explore the full process of the elderly’s health game experience outside the game world. The elderly-game interaction

appears to be an alternate avenue to elevate elderlies' health game experiences. The practice of coaching is a promising way to facilitate smoother interactions between the elderly and the health game, thereby improving their health game experience.

1.4 Thesis Contributions

The thesis records the search for game experience elements specific to the elderly and to health games, the development and validation process of a questionnaire that aims to assess elderlies' health game experiences, and the formulation process of a coaching model designed for health games and the elderly. The contributions are summarized below.

1.4.1 Elements of the Elderly Health Game Experience (EHGE)

A phenomenological pre-study is conducted to explore what does game experience mean in health games' context with elderly players. Specifically, *what are the elements that form the health game experience for the elderly?* Five Parkinson's Disease patients played through a health game and were interviewed about their experiences through a half-day session each. Subsequent phenomenological analysis revealed the theme of health values representing the health game experience, while familiarity and human interactions represent the elderly game experience. These 3 themes are the first steps in formulating a definition for the elderly game experience or health game experience in literature. They are then used to build the 2 remaining thesis contributions that are detailed below.

1.4.2 Health Game Experience Questionnaire (HGEQ)

The Health Game Experience Questionnaire (HGEQ) is developed as an extension to the Game Experience Questionnaire (GEQ) to capture game experience when elderlies play health games. Through the pre-study and literature review of elderly-specific and health-specific topics, three additional constructs are proposed: Health Values, Familiarity, and Identification of Human-Like Properties. For each construct, question items are listed and appended to the GEQ core

module to form the Health Game Experience Questionnaire. In study 1, fifty-one elderly participants fill in the HGEQ after playing the Pumpkin Garden health game. Quantitative analysis (such as Confirmatory Factor Analysis (CFA) and mean testing) are performed to evaluate the quality of our proposed questionnaire model. Results show that HGEQ can aptly assess elderlies' experiences playing health games. With HGEQ as an assessment tool, health game designers can hopefully be able to pinpoint more holistic areas of improvement based on elderlies' health game experience.

1.4.3 Goal-Oriented Storytelling Model (GSM)

Aside from validating HGEQ as a well-developed questionnaire, study 1 also shows that coaching is required to generate positive game experiences among the elderly on top of existing HCI and game design efforts. Inspired by the fact that the storytelling approach is oftentimes applied in serious health games, we propose using the same approach to instead formulate a methodological, narrative-based *coaching model* for serious health. The coaching model named as the Goal-Oriented Storytelling Model (GSM) proposes 4 coaching scenarios that enables the game coach (which could be healthcare workers or virtual game companions) to effectively utilize health game technology to benefit the elderly players. The formal definition of coaching scenarios using Goal Net modelling methodology may also serve as a basis for future computer agent implementations. In study 2, we provide a comprehensive implementation of the GSM which lays out detailed steps to guide the elderly through the eventual process of accepting and enjoying health games. Metrics on game performance, game literacy and game experience are gathered to show the positive impacts that health game coaching can generate. Additional qualitative results also show how different coaching scenarios play out in real life and how it relates back to the GSM.

1.5 Thesis Outline

This thesis has been organized into four main parts. Part I contains the introduction (Chapter 1) as well as background information on serious health games and the EHGE (Chapter 2).

Part II details a pre-study that utilizes phenomenology to extract the qualities of the game experience between health games and the elderly players (Chapter 3). Three significant themes were identified as unique aspects of the EHGE: Health Values, Familiarity and Human Interactions.

Part III highlights the construction process of the Health Game Experience Questionnaire (HGEQ), an assessment tool for EHGE. We reviewed existing game questionnaires (Chapter 4) and used the three new constructs from pre-study findings to extend the GEQ (Chapter 5). HGEQ as a self-reporting questionnaire is administered to a group of 51 participants after their gameplay for our quantitative study 1, and the results are discussed (Chapter 6).

Part IV introduces the Goal-Oriented Storytelling Model (GSM) as a design methodology that aims to provide positive health game experiences through the practice of coaching. We first explicate the process and selected theories in the development of GSM during the literature review (Chapter 7). We then describe GSM in terms of storytelling, familiarity, goal setting and persuasion mechanisms, before proposing an integrated general model under Goal Net (Chapter 8). GSM is then used to design the coached gameplay session for the Pumpkin Garden game in study 2 (Chapter 9).

Part V concludes the thesis findings and provides recommendations for future research (Chapter 10).

Figure 2. Visualization of Thesis Outline

Figure 2 provides a visualization of the 3 contributions in this thesis along with their relationship. By centring the research focus around the EHGE, the contributions of this thesis can be utilized to enhance health games to make them more attractive to the elderly, thus increasing health game adoption along with the health benefits they bring.

2. Background of Serious Health Games and the Elderly Health Game Experience (EHGE)

2.1 Introduction

The “Serious” in Serious Health Games

There has been debate about whether games that are made for entertainment could truly bring extrinsic real-world benefits. Practically, games could (and should) be both fun and useful; the fun in games should be utilized to accomplish serious purposes. Abt [51] coins the term “serious” as a matter of great interest and importance, something that raises questions that are not easily solved and bearing possibly significant consequences. Games allow us to delve into these serious issues without its usual heavy baggage, described aptly in the author’s own words, *“significant without being solemn, interesting without being hilarious, earnest and purposeful without being humourless, and difficult without being frustrating”* [51, p. 10]. In essence, serious games are video games with additional utilitarian functions [52].

The term *serious game* is the use of a video game to introduce a lasting, tangible benefit in people’s lives, other than pure entertainment. The term was popularized around the beginning of the year 2002, aimed at separating the image of games with a serious intent from games for pure entertainment [53]. The term’s exact meaning has evolved as it challenged video games’ traditional hedonic branding, despite having already existed before the commercialization of the first entertainment games. Zayda [54] penned a definition of serious games as a physical or mental contest that utilizes entertainment to achieve education, health, public policy, and strategic communication objectives.

Hence, serious games tend to incorporate one or more utility functions through delivering an educational or persuasive message, providing training and transmitting knowledge.

The Prevalence and Potential Benefits of Serious Health Games

In its early days, serious games were designed to illustrate scientific studies, train professionals or to broadcast a message. As time went on, serious games caught on in the mainstream and became prominent in fields of education, healthcare, defence, art and culture, religion and corporate training / advertising [53]. Serious games manifest in the form of digital game-based learning platforms, immersive simulations for professional training, and persuasive games.

Serious games may not have caught on in the mainstream video games industry, but its perceived benefits remain promising. The benefits of serious game can be educational, psychological and medical [55], which can be brought forth by the game's engaging tasks that stimulate logical thinking, problem solving, strategic planning and precise control. An analysis of recent usages of serious game for education revealed a large number of supportive findings towards game-based learning practices [56], increasing confidence in their utility. To sum up, the long-term real-world benefits of serious games are becoming more evident as research towards serious games achieve maturity.

Among its many uses, we focus on the use of serious game to tackle health-related issues especially for the elderly, which is an emerging need in Singapore. We have outlined our understanding of elderly health in its current state and the importance of game experience in our introductory chapter. In this chapter, we will outline an overview of serious health games in its status quo, discuss the benefits of serious games for elderly healthcare, and what constitutes a health game experience.

2.2 Types and Benefits of Serious Health Games

Overview of Serious Health Games

Serious health games are games with a focus on health care, mental and physical fitness, also known as health games. In recent years, there has been much research interest towards serious

health games. In particular, a systematic review [57] has studied 149 health game related publications from 1984-2010, highlighting a surge of publications in the 2008-2009 period. 59.7% of studies used a commercial game while 42.3% of them developed their own non-commercial game for the study. The same systematic review has coded health games used by the studies under six categories.

Table 1. Categories of Health Games and Examples

Health game category	Examples
Educational games	informing users about a disease
Behavioural games	improving adherence to medication [58]
Cognitive games	memory training
Exercise games	improving physical exercise
Rehab games	rehabilitation of upper extremity
Hybrid games	a mix of others

These applications in the healthcare industry are gaining profile as serious games' new potentials are constantly being unveiled via research and experiments.

Health Benefits in Serious Health Games

Serious games can bring health benefits in three areas: physical, cognitive, and social or emotional health. The physical benefits of health games are prominent in various subcategories such as exergames and rehabilitation games.

Exergames are games that involve physical exercise, typically meant for maintaining general health through a fun and non-intrusive way. Exergames have great potential for health improvement as shown by Larsen et al. [59], which concluded that 6 out of 7 exergame studies with healthy elderly participants managed to have a positive effect on them. Both program-specific studies [11, 13] and systematic reviews [9, 59] can agree that exergames help improve elderly health in some ways.

Rehabilitation games are another subcategory of serious health games, typically developed as an engaging therapy to encourage rehabilitative physical movement. A good example of this is Fun-Knee, a serious game for post-surgical rehabilitation of the Total Knee Replacement (TKR) treatment [60]. The patients' action of raising their knee is gamified into a fishing activity, in which the game experience is designed to distract patients from pain typically caused by the rehabilitation exercise. Through transforming clinically required exercises into fun game elements, Fun-Knee improves patients' compliance to carry out rehabilitation exercises that in turn, leads to improved recovery.

Health games also address social or emotional health. In the past, video games have been criticized as anti-social activities [61]. This attitude has changed due to an increase of social elements in recent games. Today many games actively encourage players to collaborate with friends and achieve their goals together. These games provide a friendly platform to share experiences and discuss opportunities that enable the occurrence of a sense of community. Serious games are quick to adopt social elements; a systematic review of serious games for the treatment or prevention of depression has shown promising results with positive impact on depression through interaction and storyline [62]. These types of serious games have successfully been used to counter depression and social isolation among the elderly.

On the other hand, serious health games that aims to bring cognitive benefits can be designed to simulate general cognitive activities, or to deal with specific neurodegenerative diseases. Health games can be designed to task the player to practice their memory, focus their attention as well as coordinate their actions. While mentally stimulating, their long-term benefits include improvement of cognitive abilities, and mitigating brain-related disorders. Elderlies with cognitive impairments may also benefit from playing serious game that are designed to keep them active and stimulated, thereby potentially slowing down cognitive decline.

Generic cognitive functions aside, health games also aim to provide early detection of cognitive diseases. The app *Sea Hero Quest* by *Deutsche Telekom* (in partnership with many Alzheimer’s research centres) aims to better understand dementia by observing how the brain works in spatial navigation [63]. As a diagnostic tool, the game managed to capture enough data to conclude that people who fall under high risk of developing Alzheimer’s disease tends to perform badly on spatial navigation tasks. In short, serious health games can be developed to stimulate physical and cognitive activities.

The examples above illustrates how serious games can be designed to serve as a health stimulation, assessment or rehabilitation tool that tends to be perceived as less intrusive and more enjoyable than traditional clinical methods.

Discussion

Although findings have shown that health games can be an effective solution to promote elderly health, those benefits will only surface if we find ways to instil acceptance and enjoyment of health games among elderly players. Our readings on present literature identify positive game experience as a key predictor to acceptance and prolonged use of games in general. However, health games are built with a significantly different purpose compared to general, entertainment-focused games, hampering their “fun” aspect. Hence, this thesis emphasizes understanding the EHGE in order to explore methods to elicit positive EHGE.

2.3 Game Experience between Health Games and Elderly Players

There are unique elements in the EHGE compared to commercial game experience (simply referred to as “game experience” below). Below we briefly look at two unique aspects: age-related constraints versus the general population, and special characteristics of health games versus commercial games.

2.3.1 Health Games' Perspective: A Combination of Entertainment and Health Benefits

Health games can be understood to possess a dual-purpose [64], which is to provide entertainment and health values at the same time. In contrary, commercial games only deliver the former and not the latter. Similarly, the health game experience should possess a similar duality when compared to normal game experiences. Prior studies has attempted to define and measure serious game experience, stating that serious game experience contains extra elements like interest towards in-game topics [34] on top of the existing “fun and enjoyment” found in traditional game experiences [65]. The same study differentiates these experiences by calling it the “fun experience” and the “serious experience” [34]. Thus, health games can be classified as a dual-purposed information system where both fun and serious aspects are important in generating intrinsic and extrinsic motivation respectively [66].

Entertainment and Utilitarian Values in Serious Games Experience

Serious games are essentially video games with utilitarian functions [52]. On one hand, video games are expected to provide hedonic functionality that aims to entertain players in the form of pleasure, while design of serious games that aims to provide instrumental value place more emphasis on utilitarian functionality. On the other hand, the “serious” element in a game refer to utility values, upholding product efficiency and real-world impact. Utility values in serious games pose an interesting contrast to video games’ traditional focus on hedonic values, with the former providing additional extrinsic motivation (productive use) on top of the intrinsic motivation (prolonged use) given by the latter [64].

Since serious games pose such an interesting duality in their values, it is fair to imply that the resulting game experience, termed as the serious game experience, to share the same duality. The hedonic aspects of a serious game experience is described in literature with the term *enjoyment* [67, 68], while the utilitarian aspects of a serious game experience could be

interpreted as perceived benefits [69]. Both facets can motivate future use of the health game, and we understand *enjoyment* and *perceived benefits* as the *serious game experience* when combined.

The strategy of a good serious game design appears to be in maximizing both hedonic and utility values. The combined presence of utilitarian and hedonic values forms a dual-purposed game system, which combines both utilitarian and hedonic values to provide both functional benefits and pleasure for players [64]. Such dual-purposed game systems can significantly influence the player's intention to continue playing the game without compromising the benefits in each play session.

Entertainment: Game Enjoyment as Primary Factor of Game Experience

The core of positive game experience is a state full of pleasant sensations; this state is more commonly termed as enjoyment [65]. From the user's point of view, entertainment has been understood not so much as a feature of such game but rather as an emotional response of it. For example, playing a game can be challenging and rewarding but may also be irritating and tiresome.

Researchers have modelled the complexity of the entertainment experience [65] to explain factors that elicit enjoyment in entertainment, leading to potentially beneficial effects.

- User Prerequisites and Motives

When examining the cause behind the occurrence of positive experience, there are several user-related prerequisites which upon fulfilment, generates an enjoyable sensation:

- Suspension: Willingness and ability to suspend disbelief, i.e. perceive the fictious events in the media as though they are real

- Empathy: Ability and readiness to empathize/feel an affinity with the character in the media
- Parasocial interaction/relationship: Capability and desire to relate and attempt to interact/form relation with the character in the media
- Presence: Sense of being transported to the site of action in the media. Various conceptualizations of the process range from involvement, immersion, flow, transportation, adsorption, to presence, that has become the most comprehensive term for the sensation of non-mediation [74]
- Interest: Whether a specific topic, problem, or knowledge domain of user's interest is present in the media

Aside from the player, we next focus on another entity in the gameplay process which is the serious game itself.

- Game Design Prerequisites

Serious game design elements are important in the creation of successful health games. A well-designed serious game introduces a great diversity of task types and levels of difficulty to keep the player engaged. Games also commonly feature a unifying theme, with consistent problems in the theme's context to challenge the player. There are different approaches to focus players' attention and coordinate their actions. Feedback mechanisms on behaviour, coupled with health-related achievements create enjoyment for players via an intuitive gameplay flow. Ability to resolve in-game tasks and mastering in-game challenges also closely relate to game enjoyment [65, 70]. Thus, good game design that induces smooth play could improve game experience.

Entertainment might be able to persuade users to adopt health games, but entertainment itself should be seen as a means to an end, which is the nontrivial task of serious health games [29] bringing health benefits to the players.

- Emotional Response, Concept of Meta-Emotion, and Enjoyment

When the two prerequisites previously mentioned are achieved, the user may experience enjoyment which may manifest in different emotional responses such as serenity, laughter, or suspense.

However, the initial emotional response elicited from engaging in an activity is not the complete picture of the experience. There are also post-activity emotional responses which presents itself as the reaction to the initial responses. These responses can be explained by the notion of “meta-emotions”, which means the way people feel about feelings. The meta-emotions are produced by one’s emotion goals and evaluations about feelings. The concept of meta-emotions helps to understand more complex human emotional responses, such as how people can be entertained by horror films or sad films even without happy endings. Even though the initial emotional reactions are negative, their appraisal of those emotions, which is affected by factors such as ‘need for affection’ (the motivation to engage in activities which evokes emotional response) in horror films [71], or ‘cognitive switch’ (questioning the morale value behind the story) in sad films [72], eventually leads to positive emotional response. In serious game context, the concept of meta-emotion is important to help us understand how seemingly non-positive emotional responses like the feeling of being challenged or exhausted can lead to positive overall experience. This form of experience is also known as the ‘positive-negative’ experience [73].

All in all, a good game experience requires enjoyment from the player, which in turn requires the player to be aware of their feelings throughout the process. These nuanced experiences that

may generate enjoyment (including enjoyment from reflection of “horror” or “empathic sadness” etc.) are not as easily captured in simple terms like “happy” or “feel good”. In order to effectively foster game enjoyment, we need to be conscious of the game prerequisites and user prerequisites presented above. Out of the two, user prerequisites will be the focus of our research.

Utilitarian: Health Values as Alternative Path to Positive Game Experience

Elderlies, given the natural deterioration of their health, are possibly more sensitive to health values as health-related issues tend to be more personally relevant. With proper presentation, health values that co-exist with entertainment values in a health game might be another route to persuade the elderly to accept games and get to enjoy them regularly, after which health benefits would follow. This is a defining theme for health games, which provides a unique advantage that commercial games do not possess.

The *attitudes* construct of the Theory of Reasoned Action by Ajzen and Fishbein [74] illustrates how people’s values guide their behaviour. People are generally willing to act in ways that will promote the achievement of the things in life they value. When facing a choice between two conflicting goals under equal conditions, they are more inclined to go for the goal that is perceived to be more valuable. The connection from game goals to personal health values plays a heavy influence on a person’s attitude towards a health game.

With this knowledge, health-related themes inside a game’s storyline, quests and game activities can possibly appeal to elderlies’ desire to maintain their health.

2.3.2 Elderlies’ Perspective: Age-Related Factors Forming Digital Barriers

Although games were gaining popularity among the elderly [5], they still tend to prefer a certain subset of games. The report titled “2019 Essential Facts About the Computer and Video Game

Industry” reported that *boomer gamers* aged between 55-64 prefer card games, puzzle games and virtual board games [75]. This significantly differs from other age groups’ favourite genres like racing, sports and first-person shooters, which tend to be more action-packed.

Hence, we see the player’s age to be a major influencer in this distinct gaming preference. Aged-related attributes and characteristics that cause the shift in preference include physical degeneration, cognitive impairment and extra psychological needs (e.g. loneliness, inferiority, menopause) [76]. Elderlies who suffer from degradation of eyesight and movement dexterity also make more mistakes than younger users [77]. Sensory degeneration causes difficulty when reading at close distances, while weakened motor functions results in loss of flexibility and coordination [78] which games may sometimes require. Cognitive impairments also result in longer response time to stimuli, increased distraction and reduced working memory [79]. The higher rate of error, compounded with difficulty understanding what they did wrong from the ensuing error messages, causes frustration and inability to perform well when using technology products [80, 81]. As described by a field study, “*for some, initial enthusiasm soon faded away and was replaced by tardiness, discomfort and trepidation*” [82, p. 543].

Therefore, the occurrence of errors to some degree is to be expected as elderlies learn to play health games. The feeling of helplessness or being overwhelmed as the result of these errors leads to frustration during learning process. The unpleasant learning process, being part of their experience [83], culminates into a negative health game experience. As a result, elderlies refrain from participating in technology-related activities [84, 85] due to difficulty, confusion, and consequently frustration in learning to use technology as they age.

These “digital barriers” cause the elderly to have an entirely different set of preferences and constraints from other age groups. Despite elderlies’ willingness to engage with easier games [86], it is important to take measures to help the elderly to overcome the digital barriers they

may face due to their age. This makes it possible for health games to be widely accepted by the elderly, with comparable success to commercial games.

2.4 Summary

Significant research has proved that health games can be beneficial for the elderly. Health games which combine utility and hedonic values also produce a game experience with similar duality. The hedonic side of a health game experience would be enjoyment, while the utilitarian side can be represented as perceived health benefits. The duality of health game experiences, combined with age-related factors that lead to special needs or digital barriers, form the *elderly health game experience (EHGE)*. With this preliminary construction of the term, a fair hypothesis is drawn:

The EHGE contains specific elements that directly encourages them to play health games regularly.

The next chapter presents our pre-study that identifies such elements that make EHGE positive and enjoyable.

3. Pre-Study to Discover Elements of the EHGE

3.1 Introduction

In this chapter, we aim to explore the elements of the EHGE which is rarely explicitly studied in prior research. Literature review has deemed health games to be beneficial and the game experience to be an important motivator for increased use of health games. Hence, it is important to find out what are the important elements that contribute to an elderly's positive game experience when playing health games.

For the pre-study, five elderly participants are visited in their homes to conduct a gameplay session. The gameplay session is then followed by a one-on-one interview session, where participants are encouraged to share with us their game experience and opinions on health games in general. This pre-study utilizes phenomenology to uncover what elderlies (especially those weakened by age or disease) value when they go through a game that they know is healthy for them. The phenomenon under study is *“What elements makes up the elderly's experience when going through a health game session?”* Interpretative phenomenology is used to capture the most prominent representations of the elderly's experience through their interaction, expression and sharing.

3.2 Health Game used in Study: Pumpkin Garden

The Pumpkin Garden iPad Game is developed by NTU-UBC Research Centre of Excellence in Active Living for the Elderly (LILY) to detect Parkinson's Disease (PD) symptoms through interactive gameplay [87]. The game also serves as a means of rehabilitation for patients diagnosed with PD [88].

The game is created using the evidence-based design (EBD) approach in the four steps listed below:

1. Review the existing research literature to select the relevant findings and recommendations.
2. Match the selected findings based on the data collected from the field visits, questionnaires and domain experts.
3. Make a prediction on the design outcome.
4. Implement the design with positive outcome.

Based on the EBD approach, research findings related to PD are integrated into the design of Pumpkin Garden game.

The game elements are designed to assess a player's risk of developing PD through gathering data on motor functions of the user. This includes finger movement, synchronization and symptoms of micrographia (progressively smaller handwriting). The game also helps to analyse the player's cognitive functions by testing their memory as well as impulsive or compulsive behaviours. This health game will assist to collect data unobtrusively about a user's exhibition of PD symptoms in a fun, game-like environment. The game combines Unified Parkinson's Disease Rating Scale (UPDRS) and Montreal Cognitive Assessment (MoCA). Both tools are used for early detection that helps doctors plan for early treatments.

Figure 3. The Starting Screen of Pumpkin Garden Game

(a) is the login screen; (b) and (c) are the short game introductions before choosing a game task.

In the game, the player is told to look after the pumpkin garden by completing tasks. The Pumpkin Garden game consists of 4 tasks (later referred to as *minigames*). Among all the tasks, only Task 1 (Weeding) and Task 2 (Irrigating) were selected in this study.

Figure 4. Task Selection Screen Showing Minigames Used for Study

The Weed Clearing Minigame

Task 1: weeding (later referred to as the *weed clearing minigame*) is shown in Figure 5. The player's goal is to clear the weeds by moving two fingers upwards synchronously. There are total of 6 rounds in this Task 1. In rounds 1 to 5, players are only required to clear a fixed number of weeds. The bar on the left side of the screen indicates the number of the weeds to be cleared. In round 6, the level of difficulty increases the player is required to clear weeds that continuously grow as the player clears them, challenging them to clear the weeds faster than they grow. Round 6 will be only completed if the weeds are cleared faster than they grow.

The design of the tasks in-game stimulates players' movement from their freezing situation, a disability among PD patients where they are unable to move. This is done through the rhythmic sound effects in the game [88, p. 9].

Figure 5. The Weed Clearing Minigame

(a) shows the minigame's instruction screen; (b) is the in-game screenshot showing 2 cursors (representing the player's fingers) clearing the weeds

Once the player has completed the entire weed clearing minigame, a summary of results will be shown (Figure 6). The results screen displays the kilograms of weeds that has been cleared, as well as the seconds taken to complete the task.

Figure 6. An Example of Weeds Clearing Minigame Result

The Water Wheel Minigame

In Task 2: irrigating (referred to as the *water wheel minigame*) the player waters the pumpkin garden. They are required to hold down a finger on a red button in the corner and use the other hand to spin the water wheel. They need to fill up the water bar in 6 different rounds to complete 1 iteration of the minigame.

Figure 7. The Water Wheel Minigame

(a) shows the minigame's instruction screen; (b) is the screenshot of gameplay feature a big and small waterwheel

Similar to the weed clearing minigame, both the audio rhythm and visual hints cue the players when they encounter the freezing situation. In Figure 7 (b), the bright yellow spark cues the player to move the big waterwheel. In this case, the player holds their right finger on the red button in the bottom right corner, while the left hand turns circles following the shape of the big waterwheel. The player is allowed move waterwheel either clockwise or anti-clockwise. The minigame requires participants to switch hands between rounds; participants alternate between turning the big waterwheel and small waterwheel, at the same time switching the hand that holds the red button with the hand that moves the waterwheel between different rounds. The blue bar on the left side of the game screen indicates the litres of water that the participant has drawn from the wheel to water the pumpkin garden for this round.

3.3 Study Methodology

This section elaborates on the selection of methods to carry out the study and analyse the results.

3.3.1 Evaluation Method: Phenomenology

Among other methodologies, phenomenology will be used in this study. Phenomenology is a branch of qualitative study methods, which do not require manipulation of an independent variable, control groups, and random assignment of participants as they rely on observations only [89, 90]. Phenomenology broadens our understanding of the complex phenomena that

takes place in learning, behaviour change, and communication processes in the field of healthcare [91]. More specifically, a phenomenological approach offers a way for healthcare providers to understand the range of factors that can affect research participants' subjective experiences which have significant impact on their physical, emotional and social well-being.

Hence, phenomenology is deemed a suitable method to observe and interpret what are the constructs that contribute to positive game experience for the elderly. This section presents our understanding towards phenomenology from literature, and specific approaches used in the pre-study.

3.3.1.1 Introduction to Phenomenology

Phenomenology is type of qualitative research methodology that assists in gaining a deeper understanding of the meaning of everyday experience. Phenomenological research asks questions like “*what does this experience mean*”, “*what is this experience like*” or “*what contexts or situations have influenced the experiences*”, which is concerned with the study of experience from the individual's perspective. The purpose of the phenomenological approach is to identify phenomena through how the phenomena is perceived by the individual given a situation. Phenomenology enables researchers to look at change processes over time, adjust theories to new issues and ideas as they emerge, contribute to the development of new theories and gather data which is seen as natural rather than artificial. It is a powerful paradigm for gaining insights into people's motivation and actions and eliminating the clutter of taken-for-granted assumptions and conventional wisdom [92].

3.3.1.2 Types of Phenomenology

Phenomenology is about different approaches of understanding. There are two types of phenomenology: descriptive (*transcendental*) and interpretative (*hermeneutical*). They are introduced separately below.

Descriptive Phenomenology

The primary differences between the descriptive and interpretive approaches are in how the findings are generated and used to support the new knowledge. Descriptive phenomenology applies the technique of “bracketing off” unrelated, external influences that usually accompanies phenomenon, in order to get to the essences. With such clarity, the focus can be trained on the correlation of the *noema* (“what”) and the *noesis* (“how”) of experience. The “what” aspect tells what is in the subject’s focus, while “how” aspect shows how meaning is created. Descriptive approach has been demonstrated to be better choice in uncovering essences of phenomena that have not been conceptualized by prior studies. Descriptivist thinks that there is more than one reality, that leaves doubt and a lack of clarity [93].

Interpretative Phenomenology

Interpretivists believe there are endless number of realities, and the act of writing descriptions is an interpretive process. When compared to descriptive phenomenology, interpretive phenomenology holds in higher regards the participants’ existence and relation to the world around them. Interpretative phenomenology recommends interpreting the meanings found in relation to phenomena. Understanding towards the meaning of experience is obtained by engaging with data interpretively and less on finding out the essences. The approach allows and even encourages room for interpretation when performing the analysis of, for example, text. This type of phenomenology does not formalise an analytical method so that the context of a phenomenon can determine how the data is analysed [94]. Smith articulated an optimal approach to be “rigorous and systematic” and at the same time “exploratory and creative” [95].

3.3.1.3 Analysis with Van Manen's Hermeneutic-Phenomenological Approach

In our study, we use a more specific form of Interpretative Phenomenology, which is the theoretical-practical view of Max van Manen's Phenomenology of Practice [96]. It provides us with a detailed guide and directive on conducting hermeneutic phenomenological research.

Van Manen suggested three methods to be used in hermeneutic phenomenological study: empirical social sciences method for data gathering; philosophical and reflective social sciences method for reflection; and philological method for report writing [97].

Data Gathering Methods

To portray the phenomenon (i.e. the *lived experience*) in the best way possible, phenomenology employs empirical methods typically used in social science studies, such as interview and observation. The primary purpose of the interview/observation is to collect pre-reflexive, experiential material to be represented in an alternative manner from the phenomenological perspective afterwards. A variety of these methods include structured or semi-structured interviews, questionnaires, conversations, participant observation, focus group discussion, action research and analysis of texts.

Reflection Methods

Reduction is considered to be the principal "method" in phenomenology. The fundamental goal of reduction is to create direct, primitive contact with the world as we experience it, leaving aside the way we conceptualize it. Reduction consists of two methodological movements, epoché ("bracketing" or suspension of beliefs) and reduction (reflexivity).

Van Manen differentiates certain methodological moments of epoché:

- Heuristic (*wonder*): bracketing what is taken for granted to awaken a deep sense of awe caused by the phenomenon we are focussing on.

- Hermeneutic (*openness*): bracketing all prior interpretation and expectation to achieve a genuine, radical opening into the phenomenon.
- Experiential (*concreteness*): bracketing all theory and previous beliefs with the goal of explaining the concrete nature or meaning of the phenomenon.
- Methodological (*approach*): bracketing all the usual conventional research techniques to find the most appropriate way of focusing with the phenomenon being studied.

Moreover, van Manen focuses on two (out of five) reductions, eidetic (*eidōs* or ‘*whatness*’, i.e. what makes something unique) reduction and ontological (*ways of being*) reduction.

In addition to epoché-reduction, van Manen suggests that reflective methods from social sciences, such as thematic analysis, can be used in conjunction with said philosophical method. In practical terms, where massive data is fairly disorganised, the first step is to read through what is being said, then identifying key themes and issues in each document. The key things are what the focus of the texts and how the texts describe the experience to look for non-dominant ways of understanding. All the data can be combined into a database according to the analysis heading for easier extraction and comparison. It is particularly useful to identify relationships between themes and factors.

Report Writing Methods

The vocative dimension is essential of phenomenological writing since we try to express the meaning of a phenomenon in ineffable and pathic, rather than cognitive, manner. According to van Manen, the more vocative a text is, the stronger the meaning is implanted in the text.

There are several vocative methods (based on philology) by which phenomenological language may be expressed:

- Revocative method (*lived thoroughness*)
 - Describe the vocative aspects of language vividly
- Evocative method (*nearness*)
 - E.g.: Anecdote as phenomenological example; metaphors, etc.
- Invocative method (*intensification*)
 - Keywords with invocative value, so that layers of phenomenological meaning become strongly embedded in the text
 - E.g.: Poetic language; Textual tone and aspect seeing
- Convocative method (*pathic*)
 - The tone of the text has to do with its convocative pathic quality
- Provocative method (*epiphany*)
 - Articulates the kind of ethical predicament suggested in the phenomenon that is being studied and what are the active normative response, such as advice, tactful practices, policies etc.

Phenomenological studies make details about individual's situations. Therefore, the development of the general findings needs to be done transparently with validity, so that the reader is able to see how the research has arrived at the results. Different details are important at different points of the report. Three sections can be used to report and discuss the findings: summary of the results; discussion; and issues and implications. The summary of the results arranges the findings according to the topics and key issues being discussed by participants. The aim is to be true without any ethical issue including misrepresenting or distorting the original findings. The main role of the summary is to describe rather than explain. In the discussion section, there are interpretations and linkages to relate the findings to previous research, personal experience or common-sense opinions and developing tentative theories or

models. The final section on issues and implications provides an opportunity to further clear the ideas developed through the discussion.

3.3.1.4 Implication to Our Study

While believing that there should be a pathway of methodological aspects of phenomenology for researchers to follow, van Manen nevertheless acknowledges the claim that “there is no method” in hermeneutics and phenomenology. Thus, he leaves it to the individual researchers to determine the best way of conducting phenomenological study in a pertinent, plausible manner [97].

For our study, based on methodological framework provided by van Manen detailed above, we can categorize our phenomenological study into 3 broad steps:

1. Data Gathering – Gather factual observations from the phenomena intended to be observed.
2. Reflection - Grasp the essential meaning of the phenomenon through thematic analysis, interpretation through conversation with the elderly, and epoché-reduction, seeking oriented and strong interpretation as a resource to produce knowledge.
3. Report Writing - write an oriented, vocative and rich phenomenological text where the voice of the professional is heard (e.g. evoking implicit meaning or “felt sensations”).

The steps above are explored in detail in the following paragraphs.

For step 1: data gathering, we define the phenomena being observed as *experience of our elderly PD patients when they play a health game*. Table 2 shows the types of data collected for our study.

Table 2. The Types of Data Collected for the Study

Type of Data Collected	Medium
1 Recording of the interview responses, discussion flow, actual questions asked during semi-structured interview	<ul style="list-style-type: none"> • Audio • Field notes
2 Recording of expressions and reactions during interview	<ul style="list-style-type: none"> • Video footage
3 Recording of interactions with the elderly during Pumpkin Garden game session	<ul style="list-style-type: none"> • Video footage • Audio

The data gathered is used to carry out step 2: reflection. Reflection consists of two main steps: thematic analysis and epoché-reduction. In thematic analytics, we try to identify common patterns occurring in the data gathered throughout the experiment and consolidate them into common themes. From these discovered themes, we perform the second part of reflection: epoché-reduction. In this step, we seek for the essence in the phenomena under study [97] by trying to construct from the themes a concrete and concise meaning of what the phenomena is, and what makes it unique.

Finally, we produce a phenomenological report based on our reflection. The report should express aspects of the meaning of phenomena being observed in expressive rather than cognitive way (i.e. the text can “speak” to us of the implicit meanings, of “felt sensations”, of the phenomena).

The moment-to-moment interactions per participant are noted down in the form of a phenomenological text log. From there, we conduct deeper analysis on specific instances of those similar experiences in order to compile a holistic picture of the EHGE.

Figure 8 below summarizes our understanding of phenomenology and how it translates into techniques to conduct analysis on our qualitative data.

Figure 8. Phenomenological Approach of Pre-Study

3.3.2 Interview Methodology

The research interview is one of the most essential qualitative data collection methods. Interviews serve as a useful tool for interviewers to learn about the world of interviewees. Thus, a well-planned interview approach can produce a rich set of data for better understanding and analysis.

Overview

Interviews are broadly used as a data collection tool for qualitative investigation [98]. Since qualitative research is concerned with the understanding and explanation of phenomena, the gathered data should not be measured in terms of quantity. Instead, the data should be gathered in a way that allows in-depth studies to uncover deeper meaning or processes beyond what numbers can show. The one-on-one interview methodology is particularly useful as a qualitative research tool to assess interviewees' attitudes and values, which cannot necessarily

be accommodated in questionnaires aimed for quantitative studies. Open-ended questions allow interviewees to speak in their own voices and with their own language that would have otherwise been misrepresented or missed entirely. As a result, researchers are more likely to receive more detailed and elaborate responses than closed-ended questions. Strong evidences support that qualitative interviews provide better access to interviewees' experiences, interpretations of activity, understanding, as well as personal feedback. Interview methods are typically implemented based on an ontological stance that respect game players' values and experience as a meaningful and worthy subject of exploration; these are part of the process to uncover elements that our elderlies deem to be important as part of their health game experiences.

Choice of Interview Methodologies

Babbie [99] has identified three major categories of interviews that can be carried out through question-and-answer: standardized interview, semi-standardized interview and unstandardized interview. Standardized interviews are structured and pre-planned questions are asked in a rigid setting. In a standardized interview, the interviewer asks the same set of questions in the same order and manner to all groups of participants without variation. Multiple instances of such interviews can be conducted in parallel, hence achieving greater throughput. The unstandardized interview more closely resembles a casual conversation with focused themes. The interviewer creates spontaneous follow-up questions in response to interviewees' replies during the interview. As a result, the questions may differ across different sessions as interviewee's replies may be different. In order to avoid any unfairness, it is best practice to have the same interviewer conduct all sessions. Unstandardized interviews are typically used to explore new fields of research when there is very little pre-existing information. Among different interview forms, the one-on-one unstandardized interview is the most commonly used

for data collection in qualitative research when the aim is to find out about interviewees' experiences towards a subject and the deeper values they hold [100, 101].

Between the two types of the interviews, we have the semi-structured interview. This form of interview has gained popularity as it is flexible, accessible and most significantly, capable of disclosing importance and often hidden facets of human behaviour. A semi-structured interview starts with a fairly consistent set of questions with a fixed order for each interviewee and the interviewer will ask follow-up questions for clarification and encourage deeper thinking when appropriate [102]. For a semi-standardized interview to produce consistent data, the same person should conduct the interview for the entire study.

One-on-one semi-structured interview is chosen for our study #1 to enable interviewees to freely and spontaneously respond while ensuring the topic of game experience is conversed properly by starting with a set of questions [95]. As the interviewer, we did our best to be good listener so that the interviewee can be a good storyteller rather than a respondent. We also look out for opportunities to poke for similarities and differences when different participants share their game experience after playing the Pumpkin Garden game. We selected one-on-one interviews over focus group discussions to prevent an inhibitive atmosphere created by the presence of others. With the replies not being influenced by coping behaviour, leader effect or peer pressure, one-on-one conversation ensures personalised responses can be generated to undergo thematic analysis at a later stage, adding dimensions to the various themes available.

The main goal of this one-on-one interview study is to learn about PD patients' game experience when playing the Pumpkin Garden game from the interviewee's perspective. The interview will work in tandem with the gameplay session as a data gathering tool in study 2.

3.3.3 Study Flow and Selection of Participants

Demographics of Participants

We visited 5 willing participants to conduct the study in their homes (prior literature suggests at least five [103, 104] or six [105] participants to conduct phenomenological studies). The participants were Parkinson's Disease (PD) patients aged above 60 selected through homogeneous purposive sampling, a suitable sampling method for interpretative phenomenology [95]. Since the Pumpkin Garden game is developed for early detection and rehabilitation of PD (see 3.1), this allows us to conduct the study on more personally relevant grounds and generate a richer set of experiences to be studied.

Table 3. Demographics of the 5 Elderly PD Participants

S/N	Age	Gender	Years Since Diagnosed with PD
P1	64	F	8
P2	69	M	20
P3	69	M	6
P4	73	F	30
P5	78	F	10

Reason on Purposive Sampling of Participants with PD

Purposive sampling is common among interpretative phenomenological studies to select participants that are most relevant for the studied phenomena [95, 106]. In this study, the Pumpkin Garden game is introduced to our PD patients as a health game aimed for the early diagnosis of PD [87]. They were informed to simply attempt to finish the required rounds and it will capture their play behaviour data. We explained that the data is valuable to help improve the game's diagnostic ability, thus helping with early PD detection in other patients. They were

also told that the game helps them exercise and improve their hand-eye coordination. This explicates the game's *health values* to the participants. With the health values of the game made known, we try to determine what are the added effects through their response throughout the gameplay. Since Pumpkin Garden was developed for PD patients' screening and rehabilitation (explained in 3.1 above), we selected participants that are diagnosed with PD. The increased personal relevance invoked more discussion, and through the process we were able to gather more personally relevant experiences. These "lived experiences" provide valuable insights for phenomenology studies.

Study Flow

The study was conducted through a physical face-to-face session in accordance to one-on-one interview guidelines. Each session consists of 2 main activities: A Pumpkin Garden gameplay session followed by a one-on-one semi-structured interview session. The time spent with each participant lasted around half a day, as we needed to slowly guide the elderly through the relatively long game session (considering they have PD) and chat extensively to obtain their game experiences.

Before the gameplay session, we asked for permission to conduct the study and made sure they understand the consent form before they signed. We also asked for permission to take a video recording of the whole gameplay and interview sessions, stating they are strictly for internal use only and will not be circulated.

For the gameplay session, a gameplay sequence based on the Pumpkin Garden game is designed for the participants. The gameplay sequence is illustrated in Figure 9 below.

Figure 9. Pumpkin Garden Gameplay Sequence Designed for Pre-Study

Participants are first required to play 3 iterations of the water wheel minigame using 3 different tools in the listed order: their fingers, the Microsoft Arc Mouse, and the Apple Pencil. Each iteration consists of 6 rounds, and participants are required to switch hands between rounds. Then, participants will be required to play 1 iteration of the weed-clearing minigame with their fingers, which consists of 5 rounds of static gameplay (participants clear weeds spanning 1 screen) and 1 final round of real-time challenge gameplay (participants are challenged to clear weeds as they grow in real-time).

For the post-game one-on-one semi-structured interview, questions were designed to explore overall processes of health game experience and shed light on what might be desired from the health game to support the elderly's needs. The questions revolved around two themes: their health game experience from the gameplay session and their opinion towards health games in general. We used the following few questions as a starting point for each participant:

- How do you feel after playing the Pumpkin Garden game? Would you like to share your game experience?
- What do you think about this Pumpkin Garden game? Have you heard of other health games?
- Do you recall encountering challenges when you played just now? What do you think enabled you to finish the game?

After the interview, players are given a more comprehensive explanation towards the questions asked, and assurance towards data confidentiality and the research value they have provided.

3.4 Phenomenological Text Describing the Lived Experience

We start our phenomenological analysis by building the case from ground up observations. Here we present the phenomenological text that describes the gameplay process and interview of each PD patient. The phenomena under study is the *elderlies' game experiences when playing a health game*. It is important for the writer to capture the phenomena in the way it is experienced so that the reader can understand what actually happened. This includes subtext, expressions and the more intricate silence on top of the usual conversation content. Quoting van Manen himself, "*there are various categories of silence operating... in hermeneutic phenomenology particularly*" [107, p. 112]. From these observations, the important themes that comprise the EHGE can then surface.

As we are studying the lived experience (LE) of participants using hermeneutic phenomenology, it is necessary to write the LE exactly as observed with the researcher's interpretation towards the LE, using descriptions and anecdotes where needed. This is known as the *revocative* writing method, aimed at allowing the reader to realize, through their own way, that such an experience do possibly exist. The LE is also written using *evocative* methods (e.g. establish perspective direction towards the meaning of what has been lived, creating the

feeling that the text is directly speaking to them) to immerse the reader and bring them closer to the LE. Being liberal with probing the phenomena and writing *experiential stories* from the researcher's point of view also helps readers experience the phenomena like how it is lived as close as possible. This is described as the *convocative method* of writing. The above techniques are recommended practices for phenomenological writing [97, p. 1730].

3.4.1 Participant 1: 64, Female, 8 Years Since Diagnosed

“Could you give me a moment...” We stood at the doorstep for 10 minutes, wondering what could be so urgent as to deny entry to a visitor whom she has never seen before. Eventually she opened the door for us after settling “something else”, which we found strange because normally you would not have a visitor wait that long at the doorstep.

She responded little, and with a soft voice when we introduced our research purpose. Her movements were also relatively reserved. When filling our pre-survey form, she opted to read the question by herself without requiring much explanation from us, and it appears she would scrutinize the contents of the questions. When asked casually about how long she has had Parkinson's Disease, she surprisingly shared a few extra sentences on her diagnosis, which seemed contrary to the first impression of a person with little words.

She looked around for the start button. We helped her start the water wheel minigame. During the gameplay session, she presented a calm and composed attitude. Seemingly having a keen eye for detail, she voiced out (albeit softly) on whether the wheel in the water wheel minigame should be turned clockwise or counterclockwise, after noticing the animation seemed not to match her gesture. Additionally, when she was done using the pen for gameplay, she knew exactly the original place to put it back.

In a harder minigame (using the mouse to play the water wheel), our participant is sharp to notice the difficulty spike immediately, and subsequently, to think of ways to counter the

disadvantages presented to her by her PD condition. The increase in difficulty is evident in hand and computer mouse movement, however the only queries she expressed verbally was aimed towards gathering the information she needed to play well. To illustrate, first she tried to verify with us whether an up-and-down motion will suffice instead of a circular motion sticking to the wheel's shape, which is hard to do with a trembling mouse. Second, she was quick to suggest trying the mouse without the mousepad to open up the area to move. In courtesy of her observations, we obliged and provided her with what she needed. Only then, she said that she was a bit slow, which is probably due to the up-kept efforts to attempt to follow the wheel's circular shape, despite knowing an up-and-down motion will suffice. This act of diligence is deduced from the circular shape she managed to draw using her right hand with the mouse (Note: PD affected her left body more severely). She smiled and said "good exercise"; perhaps from the satisfaction of getting to see what she wanted to achieve.

Later in the interview, she described the process as challenging and interesting, reflecting a positive attitude towards challenges. She noted the challenges: weaker left hand, presentation of micrographia symptoms and as a result, inability to keep to a circular motion when drawing or moving. In her own words, "Sometimes it's not a circle, it's an oval. It is actually quite frustrating" and "I try to, but the fingers are not moving the way I want to go. The brain can think of wanting, but this hand is like, stuck. I think it is due to my degenerative Parkinson, and I think if I practice more, draw more circles and try harder, I think I'll still be able to do it." When asked how she managed to overcome these challenges and finish the game, the reply was straightforward: "stay positive, be patient and keep trying, don't give up. I feel that I have completed a task, and (I) feel good." The attention to detail is made clearer when she shared her background as a nurse, being used in taking care of patients and noticing the smallest of anomalies. A finishing quote from her after the gameplay is "my skills got better, and improved my hand (performance)".

Her attitude seemed to have grown warmer after the gameplay and interview sessions, speaking more, expressing care by asking whether we had our lunch. When talking about her days as a nurse, she revealed that although retired, she still looks after her ailing, bedridden mother with dementia, and explained that she was lifting her back into the bed when we came to her doorstep. She sounded surprisingly calm and factual when showing us the bedroom where the 90+ years-old mother lay. Perhaps, upon learnt of our research on the Pumpkin Garden game to help PD patients, the personal relevance might have rung a bell somewhere deep. A deep round of reflections must have taken its course in the disease-ridden years leading up to our meeting, and it felt like a privilege to have received the level of trust from a person that up until a few hours ago, was a stranger. That day, we witnessed a positive attitude and a will to excel against odds presented by life, be it from PD or an ailing parent.

We kept in contact throughout the days that followed. She went the extra mile and actively helped us recruit more PD patients that she got in touch from her days as a nurse. We are extremely grateful for that.

Figure 10. P1's Character Development Throughout the Game Session

3.4.2 Participant 2: 69, Male, 20 Years Since Diagnosed

He was already sitting in his chair when we greeted his spouse, who was the one who welcomed us. When she introduced us to him, he did not react much except acknowledging he had to “play a game”. Answering with simplest words he could find (yes/no), the pre-game form was

filled in relative silence. He is an English speaker; it could not have been due to language barriers.

He placed his right hand on the button and left hand on the wheel as instructed. “Control my hand ah?” It sounded like something a normal person would not question twice, but perhaps, the ability we took for granted everyday could have been leaving him for the last 16 years. We sat up; how much is still left?

The water sounds started to come from the iPad, but not for long. His left hand slowed down to a halt. We leaned forward; is the game too hard for him?

“Turn the wheel, as you are turning, the blue bar will increase.” His pace picked up a little, and it was received with a compliment. His wife laughed when we said that he played very well. He faltered again seconds later. “What’d I do?” We explained again, including the goal with filling up the blue bar, and this time the circular motion persisted. He played with his left index finger firmly on the screen, his thumb and remaining 3 fingers were in the air. Only afterwards by trying the gesture ourselves that we realized it is not the most natural way we would drag something on-screen. It must be pretty tense for him. The tremor is clearly visible in his fingers.

The gesture was normal when he used his right hand to turn circles; all fingers were tucked in with only the index finger in contact with the screen. Although he stayed silent throughout, he looked more relaxed when using his right hand to play.

With the mouse, even his right hand started to tremble on the button as he concentrated to move the mouse with his left hand. He stopped once after switching to the right; his palm is shaking while the mouse is stationary, and we encouraged him by stating the good progress he made. Nevertheless, progress was slow, his eyes were constantly concentrated on the screen. He stated so in the last round when he lifted his hand, still shaking: “need lots of concentration...”, and

we convinced him to carry on with the last round. After what seemed like forever, he managed to complete filling up the water bar.

Once introduced to play with the pen, his motion becomes more liberal; drawing circles really fast compared to before. It was like comparing seconds to minutes. Even though the circles are wobbly; they resembled a flower shape more than a circle, but he drew the circles with speed and vigour. He seemed to be relieved that the toughest part is over. It would not be explainable otherwise, considering he had a really slow start.

Once we started the weed cutting game for him, he took off his spectacles and rubbed his face a little. From the time he focused at the screen, it must have taken significant amounts of concentration for him to play the game. We encouraged him again with “good job”, and he pressed on.

He did not take too much time to learn the game, but the speed this time is comparable to the water wheel game with the pen, despite only getting to know the weed clearing game seconds ago. The performance was a huge difference from when he started. Half an hour ago he was disoriented and slow, sluggish and finding the ropes; now he is focused and coordinated, rarely faltering in his motion. We were worried of the final round as the weeds will grow in real-time and outpace the player, but he surprised us by catching up right away and finished the game, overall using less than 1.5 minutes. “You cleared it so fast!”, after which we saw a faint smile; the first one from him since we stepped in.

In the interview, the first thing he shared is that he found the game is very challenging. “I find the beginning to be quite tough. It is extremely difficult to handle. But after you manage to do it, then you feel better.” Consistent with what we saw, he reported the toughest part to be turning circles with the mouse, stating difficulty in figuring out the direction. He has more control when using the pen and his own finger. When asked to reflect how he overcame his

difficulties, he was able to articulate about how he focused to avoid “split second resets” of the mind, and that once he managed to get a routine up in his mind, he could overcome with more ease. He also stressed on the spirit of trying again when it still felt difficult. “In the beginning, I thought of stopping it, I can’t focus anymore, very difficult. I say, I will try it, try it one more time until I finish.”

He stressed the vigilance to practice every day: “If you missed a day, you said one day never mind, then two days... days become weeks, weeks become months, and you would have forgotten. It is difficult, especially with this disease, so I must tell myself to practice every day without fail, because fail once, you will fail twice, and three times.” When asked to compare it with the game experience from just now, he keyed into the element of immersive and focus. In his own words, “I feel that (when playing) the computer game, you have to be very focused. Because it is a new game, (because I) never seen the game before that (is) where the difficulty comes in. The game keeps you occupied and keeps you going.”

He shared at length on the poverty, family dispute and hardship he faced in his youth, and the fighting spirit that ensued. His last response sums it up well.

“What is your mind set for the new game?”

“This game is new to me. My mind set is, (if I) find it is too difficult, I just walk away. but I (in real life) find it so difficult, I nearly want to walk away. But I try, I try, try until I really can’t, then give it up. Because I tried to do many things in the life. Because you have to keep on try it and trying. And I just learned successful people have to try many times. Yes, you have to try, you have nothing to lose in fact. Once you give it up, that’s the end. So your mind must be very very focus(ed). And then, you think it is good for your health. You don’t mind taking on the challenge. Keep trying until you succeed.”

We found it apt to describe this essence of his attitude, shaped by his life experience, as a hero's journey, on a quest to discover the self, encountering pressing challenges, fought hard to survive and enjoyed a happy ending. That is why when we asked, "What was your greatest satisfaction?" and received the reply "When I managed to finish!" with a big grin, we have reasons to let out a laugh of relief ourselves too.

He personally sent us to the doorstep with help of his walking stick with an unusually fast gait. We almost could not tell he had Parkinson's disease. In retrospect, the experience helped him recall his unusual past and we were glad he shared it with us willingly.

Figure 11. P2's Character Development Throughout the Game Session.

3.4.3 Participant 3: 69, Male, 6 Years Since Diagnosed

His voice might be soft, but that does not make him sound less amicable. In fact, when we introduced the game to him, he leaned forward, seemingly anticipating exploring something new. On top of that, he wears a slight smile as we interview him before the game.

The smile is not as prominent when he is playing though. Peering at the screen from the top of his glasses, a focused expression took shape. His hand controlling the wheel is always open, fingers spread, as he slides a single finger on the screen carefully to draw the required circle. With the constant speed, it felt like a trance. Sometimes his finger would lose contact with the screen and it would respond by going dark. He did not flinch but merely continued with the

circle until the movement is detected again. In the last round using the hand though, he glanced up nervously and hastened up after we said, “last round”. After that, we assured him not to be stressed with the gameplay speed, and it turns out his concern was on the slight breaks in his motion. He really is careful about circles being proper circles, which probably explains his slow, smooth playstyle. We again assured him it is not a big deal.

It did not take him too long to find out that maintaining the same smooth circular motion while using the mouse is significantly tougher. Still focused, he leans to his right to get a better look at the feedback, checking if it matches with his mouse movements. He is cautious, slowing down even more to stick to the wheel’s outer rim until we tried to make it easier for him by asking him to stick to the inner rim instead, shrinking the circle size and lowering the goal difficulty. He adjusted quickly and found his pace, but he still tries really hard to stick to the exact shape of the inner rim, which we found to be rather diligent.

When changing to pen, some relief returned to his expression; now he is smiling a little again. The lift of difficulty did not tempt him to go too fast though. Remaining patient, he draws the pen exactly following the rim again, this time commenting that it felt way easier from just now. We praised him for the patience, and his smile broadened momentarily. As he nears the last round, his actions became quicker, possibly from eagerness to finish.

The weed clearing minigame did pose some problems for him though. He had difficulty getting his initial touch registered by the game and fumbled around a little to obtain his bearings. It turns out his gesture has resulted in another part of his hand touching the screen unknowingly, and when we pointed it out, he figured out that he needs to tuck in the rest of his fingers to be able to play properly. It was a good discovery; he understood immediately in the last challenge in the weed clearing minigame that he had to catch up with the new weeds constantly appearing on-screen. He focused more than usual rounds, and as a result, the motion of both his hands

did not go out of sync and he was able to catch up to the growing weeds in seconds. We applauded him for the great performance, and he broke into a big grin.

We were rather interested in how he kept himself composed throughout the game process. He mentioned that he has played other types of tablet games before, so he was neither nervous nor intimidated when first playing the Pumpkin Garden. When asked about how he managed to finish smoothly, he seemed to have trouble coming up with words, making a few gestures he just practiced in-game. We asked if that means he feels immersed, he affirmed and stated that he is able to get immersed quickly. While he stutters to find the right words when speaking, he is liberal with using hand gestures to illustrate what he is trying to express and maintains eye contact throughout.

However, he does find turning circles challenging. He highlighted the need to keep telling himself to maintain the size of the circles he draws, and make conscious efforts to motivate himself to control the drawing well, never thinking of giving up. When asked about the gaming process as a whole, he mentioned enjoying the game experience, as he is able to apply his beliefs that “we should be determined and focus on completing every task at hand” into the gameplay. Then when he has completed the game, he could feel relaxed and satisfied.

Despite being less vocal, he left a deep impression in our hearts. Reflecting on his gameplay, he looked like a calligraphy master patiently creating a masterpiece that he knows he will be satisfied with.

Figure 12. P3's Character Development Throughout the Game Session

3.4.4 Participant 4: 73, Female, 30 Years Since Diagnosed

“I can’t read English oh...” She said when she saw the survey form. “It’s ok, we will guide you.”

“I have to play this thing?”

“Yup.”

She glanced at the iPad. “Is this ‘Pumpkin Garden’?”

“Yeah! You can read English!”

“I saw these words before!”

She might look aged, but she is warm, chatty and moves around a lot.

It was fun interviewing her with a light-hearted mood hanging in the air. When we started the game and told her not to worry, she exclaimed “Not worried at all!”. At the same time, she was shifting around a little. By now we have gotten a little more used to the lively movements that she kept making in her seat.

“Hold your right hand here,” “this is the right hand!” She said as she placed her right hand on the button. “Use your left hand to turn circles.” “Turn circles!” She did exactly that; drawing a single circle and then stopping, waiting for our next instruction. “Keep turning.” “Oh, keep

turning!” Her finger looked like it is mopping the screen; the fingertip was dragged across the screen indicating how hard she pressed down. She stopped halfway and leaned back. “Finish it,” we prompted. “Oh, there’s more? I still need to play?” “You need to fill the blue bar.” “Oh, it hasn’t filled.” It was interesting to watch her learning the game.

“You look troubled, do you need help?” We prompted. She complained, “I pressed very hard. Can I not press as hard?” “Yes, it will work too,” we answered. “But you said I have to press hard!” She continued the game with the new knowledge and said, “now it is easier.” Her finger slipped and she stopped before leaning back again. “Try again!” “I told you I’m not great at games! I feel slow.” “You’re doing ok!” The agent seemed to have accomplished its job for now; she carried on. “Is this game testing my brain? My brain has degenerated you know, I think it is due to lack of a certain vitamin.” We tried to probe: “oh? What vitamin is it?” “That’s why I have Parkinson! I don’t know how to say actually.” She sounded casual, even playful.

“Now we use the mouse to play the game.” “Use mouse I *‘jialat lor’*³...” “Don’t worry, do your best!” She tried it out and said, “but it kept running away!” “You did well.” She continued, but she could not seem to turn circles with the mouse. “But I have no ‘mood’ (interest) if I use the mouse. Let me try again.” A few more seconds passed before she let go of the mouse. “Nope, (with) mouse I couldn’t do it. My performance was very bad. I don’t have the patience to play.” She laughed, a little nervous. We decided to let her play another game instead. “Okay no problem, can you...” “don’t play with the mouse?” She tried to finish our sentence. “Yes, now you will use the pen.”

“Now it is easier!” She exclaimed. “It’s fun, unlike that mouse. I’m having a lot of fun.” “You are playing very smoothly.” “Yeah, I use the pen every day!” We laughed. “But with the other hand, I am less used to it. It will be slower, but I exercise my hands every day, so they are not

³ *‘jialat’* refers to a dire situation in Singlish

so stiff.” As she played, she carried on sharing how her grandmother got her to write with the right hand instead of the left. She completed the water wheel minigame with the pen in no time.

“Was I fast?” “Very.”

“In this game you have to clear the weeds with both your hands by pushing upwards.” “Do I have to use a lot of strength?” “Take it easy.” She got stuck briefly once or twice, but only for a few seconds at most. “I did not play very well. *Paiseh*⁴.” “No, it’s the opposite; you played very well!” The last round was meant to be a challenge, but this time it was hardly one, and the game was completed in no time. “Wow, you completed in 90 seconds!” “Ah, I used that long?” “Not at all, you are faster than most people!”

After the game, she shared that she has been diagnosed with PD for 30 years, and although her actions can be stiff sometimes, the game still helped her become more confident in herself. She felt happy when she is able to play the game well, and she said this game, along with all the other tasks in life that she is able to complete, gives her a sense of satisfaction. When asked why she liked playing the water wheel with the pen, she shared at length how she still writes on a daily basis, and how it helped her play better and have more fun during that part.

She shared that although she may not have wholeheartedly enjoyed all parts of the game, she still felt happy to be able to contribute to research that can benefit fellow Parkinson patients, even to the extent of cheering for them. “Thank you for giving me this opportunity to help out my fellow Parkinson patients! Although not as interested in the game itself, I still think that helping others is the least I could do. I help myself indirectly in the process too, so thank you!” We thanked her back for the kind gesture that reminds us of our research mission and compassion amidst the technical details and empirical findings.

⁴ *‘paiseh’* means sorry in this context, also describes an embarrassing situation

Figure 13. P4's Character Development Throughout the Game Session

3.4.5 Participant 5: 78, Female, 10 Years Since Diagnosed

She sits on a medical chair. On first sight, it is easy to associate her to a bedridden patient. “Do you own a handphone?” We asked, expecting the usual answer, as most elderlies nowadays do own phones. “No... san ba lao⁵.” She revealed a toothy grin as she referred to herself as an outdated and tacky. Our previous conception was turned on its head. Despite immobile, she could crack jokes and was apparently very caring too. “Are you comfortable?” She asked with the usual smile. “I’m good, let us start?” It was a little awkward; we should be the one asking the question.

Her gameplay with the water wheel is neither slow nor trembly, almost like a normal person. “Your play is as good as a normal person,” we noted. She thought for a while. “My disease is ‘Parkinson unlike Parkinson’” and we both laughed. Despite having a slightly pouty look when in concentration, she always had a way to lighten up the mood. “Could you tell I have Parkinson? People with PD seems to have trembly hands.” “Your play is as normal as it could be. Does your hand usually tremble?” “When I am hungry...” we laughed again.

Switching to the mouse, she asked for a few tips right when she started to play. She was able to cope with the difficulty spike by making a key discovery: the mouse registers motion only

⁵ 三八老 in Chinese

at its optical sensor. By only focusing on moving the tip of the Microsoft arc mouse against the mouse pad, she was able to gain better control despite never having used a mouse before.

“Do you write often?” We asked as we handed her the pen. “A little,” she answered. She didn’t say much else when playing with the pen except asking, “big wheel or small wheel?” We provided the relevant information and the pen gameplay finished without much issue.

She needed much help for the weed clearing minigame though. “You look troubled, do you need help?” asked the computer agent. She nodded. We came in for the rescue. “Move your fingers up... you missed the weeds, come back down, and try again...” she obediently followed our guide. Despite missing the target plenty of times, under numerous “try again” prompts from us, she slowly cleared the weeds bit by bit and learned to deal with instances where she missed the target and had to come back by herself. We had to manually quit the last round for her, since she got stuck in an unintended game mechanic and was starting to look more and more troubled. We still applauded her for her efforts and taking the challenges positively.

She was not great with words but managed to express that although she had more than a decade of Parkinson’s disease, she still put in a lot of effort and enjoyed the game process very much with a human presence helping her out whenever needed. Her cheerful attitude despite immobile showed us to never judge a book by its cover when interacting with patients who may appear frail from the outside.

Figure 14. P5's Character Development Throughout the Game Session

3.4.6 Summary of Phenomenological Text

When participants are informed to play the game, we observed some uneasiness as they had to interact with something that they are unfamiliar with. The uneasiness is not very pronounced; rather, participants chose to play the game because they trust that we will guide them well. As P4 put it, *“I’ll just follow your instruction to play.”*

The first hurdle for the hero comes when they are required to play the water wheel minigame using the mouse. P1 felt the lack of strength and control in her left hand when using the mouse, and the weaker left hand caused by her Parkinson’s disease also affected her gameplay on the weed clearing minigame, with the weaker hand falling out of sync. In round 6, she only managed to clear the weeds slower than the growth rate, which eventually leads to the game timing out. However, she was determined to continue up until the end. Her post-game interview is well summarized by a quote from none other than herself: “I find it interesting and challenging. Despite my weak left hand, I enjoyed the game a lot.” She also attributed her willingness to play and positive game experience to the support and good encouragement received from the researcher. That could explain why she was willing to share with us something as private as her mother’s illness condition after the study has ended.

P2 experienced arguably the most amount of challenge in the gameplay with the mouse. In addition to intense tremor in both his hands, he found it hard to focus especially when coordinating the mouse direction into circles. Relief came when we switched in the pen for him, and he was able to perform well until the end of the weed clearing minigame. His experience and attitude towards the challenge, in his own words, are as follows: “If you can’t overcome it, I guess you have to try it, try it and try it. Once you overcome it, then you feel it better.” In the same interview, he shared with us at length how the farming theme in the game reminded him of his hardship in the past (planting crops for a living) and how he persisted with the same “try again” attitude.

P3 reported finding it difficult to maintain a circular shape when he was playing the water wheel minigame, taking exceptionally more time when using the mouse. The weed clearing game posed a slight challenge for him as well, but he was able to master the gameplay techniques quickly, beating round 6 in no time. When asked about his “secret”, he said, “stay focused and be immersed in the gameplay”, which is a sign of steadiness.

P4 was very unhappy and unconfident with her performance when playing with the mouse, eventually giving up. Despite the setback, we asked her to play with the pen instead, and she actually had a far better game experience. “It is easier and more fun with the pen compared with the mouse” was her remark the moment she switched tools. Like P2 and P3, she was able to clear all rounds of weed clearing minigame without problems. She later stated that she felt the fun when playing with the pen because she uses the pen every day, and it reminds her of the other things she can do well in life. “Anything that I can achieve well in life always makes me feel happy,” she noted.

P5 is not as troubled with the water wheel mouse gameplay, due to the ingenuity of discovering the exact way the mouse works and using it to her advantage. The subsequent challenge in the weed clearing minigame proved slightly too hard for her though; she took a long time just to get every inch cleared in rounds 1 to 5. From what she shared; she enjoyed the game because she put in a lot of effort with a positive attitude.

The gameplay sequence presented in Figure 9 above has produced a set of common experiences that our participants reportedly went through. In the following section, we present the experiences in themes to better understand what makes them unique yet similar.

3.5 Findings: Elements that Make a Good Health Game Experience

This section answers the question presented in 3.1 “*What elements makes up the elderly’s experience when going through a health game session?*”.

We offer our interpretation of what made participants enjoy the game, through close inspection of their sharing. Participants were prompted to share with us their game experience after the Pumpkin Garden gameplay session. Through combining the interview responses with participants' reactions during the gameplay, we gained a better understanding towards elements that shape positive experiences in health games. Several themes were identified and presented.

Familiarity

In our study, the pumpkin garden gameplay resonated well with our participants in terms of familiarity, and observations were categorized based on the 3 familiarity dimensions described by the author's previous study [108].

For P2, the in-game tasks of tending to a farm has encouraged him to share about his past doing farming activities for a living.

*“My early life was in ‘kampung’. I did farming. Life was difficult, I tried very hard to survive. (There was) like no food, not even rice.”
(P2, Male, 69 years old)*

The visuals of a farmland and the farming activities he performed in-game invoked a symbolic familiarity of him in his youth days, which reminded him of the accompanying hardship as well as the coping attitude described as a “try again spirit”.

*“In the beginning, I thought of stopping it, I can't focus anymore, very difficult. I say, I will try it, try it one more round until I finish.”
“You not only finished it, you did well, very well!”
“Very good game to stimulate the mind. I tried very hard.”
(P2, Male, 69 years old)*

With that he was able to have a memorable game experience when he was able to re-apply it into the challenging gameplay.

When P4 tried to give up after encountering difficulties with the mouse gameplay, we introduced the pen as a play tool and she subsequently regained interest in the gameplay. She mentioned about her experience with writing.

“Until today I still write with the pen. I write to record or remember things, and sometimes I even write to learn something better.”
“Do you think being familiar with the pen helped you play the game?”
“Yes, I think so. My past experience with the pen helped me play better.”
 (P4, Female, 73 years old)

We concluded that the action of moving a pen along a surface has allowed her to enjoy the game segment and recover from the setback she experienced when playing with the mouse. Interestingly, actionable familiarity could also be the reason why she dislikes using a mouse, as she recounted bad prior experience with it (i.e. environmental spoiling [109, p. 356]).

“I had a computer mouse before, but I found out that I can’t really use it, so I gave it away. I have no interest towards the mouse, I played very badly when I use it. That is why I don’t want to play with the mouse.”
 (P4, Female, 73 years old)

P1 experienced the game in a much more rational way, playing on when she learnt that the empirical data generated from the study can potentially help develop better healthcare tools. She was able to key into these medical facts and details due to her work culture in the past as a nurse. In her interview when asked about opinions towards health games, she highlighted their usefulness in capturing various metrics of the body or movement, giving detailed descriptions of the problems she faced and how she might overcome it.

“You must know which part of body is lacking, is it brain, fingers, or hand? Got to see what you are trying to measure. When this game measures finger movement, from there you can study where a person needs to develop... for me I try to (coordinate), but the fingers are not moving the way I want to go. The brain can think of wanting, but this hand is like, stuck. I think it is due to my degenerative Parkinson, and I think if I practice more, draw more circles and try harder, I think I’ll still be able to do it.”
 (P1, Female, 64 years old)

As a retired nurse familiar to the culture in the field of healthcare, she was able to strongly associate the purpose of the gameplay process to a culturally familiar context, hence providing her with a meaningful and unique game experience in her own way.

Although the 3 familiarity dimensions are observable in our participants' gameplay, it is still hard to put familiarity-oriented constructs into action due to very personalized requirements that vary greatly between individuals. The personalized requirements also take a lot of effort to understand and replicate. While familiarity is still a good measure of good health game experience, other personalization techniques that we explored are alternative avenues that are more actionable and less dependent on the nuanced details of the individual's past.

Human Interactions

One of the defining features of this study is the presence of a human guide to accompany and assist the elderly when they play. With proper guidance, players were able to quickly engage with the in-game tasks.

*“Do you feel nervous when you play the game?”
“Not at all. I just follow your instructions. No need to think... I felt confident to tackle the game since I know you will help me if I face any difficulties.”
(P4, Female, 73 years old)*

P1 encountered difficulties when synchronizing her fingers in the weed clearing minigame. For more than half a minute, she not making any progress; in their perspective the screen seemingly did not react to their inputs which is a source of frustration. We then explained the step-by-step process to her on how to synchronize the fingers and move upwards together, at the same time providing real-time feedback by asking her to go back when her fingers have slid too far ahead without registering progress. With specific instructions to break a problem down into understandable goals, her performance improved, and she is able to complete the weed clearing minigame. P1 later expressed appreciation the coaching provided throughout the game session.

When asked what helped her complete the challenges, she referred to our coaching as very helpful and encouraging.

“You are very encouraging... I never thought of giving up.”
(P1, Female, 64 years old)

The step-by-step coaching is also well-received by P3 and P5.

“I like the step-by-step guide, the goals are clear.”
(P5, Female, 78 years old)

“Does the whole process motivate you to play?”
“Yes. It helps me stay focused to complete the game. I enjoy the game play experience.”
(P3, Male, 49 years old)

On the other hand, P5 was very comfortable to voice out any doubts to us while playing, and was able to enjoy the game session despite not having owned any smart devices.

“Am I playing ok? Did I mess up anything?”
(P5, Female, 78 years old)

She also displayed much friendliness towards the researcher, and felt happy to accommodate us.

“Have you eaten? Do you need food? Coffee?”
(P5, Female, 78 years old)

In our study, the researcher interacts with the elderly at key moments (especially when they are having trouble with the game). The elderly attributed the researchers to be “helpful”. These moments reflected that human presence is an essential element that keeps the elderly players going when facing doubts.

Health Values

We informed participants about the Pumpkin Garden game’s health values towards PD detection and rehabilitation after they play. When participants were asked how much they

weigh the health values present in a game compared to the fun, the replies they gave generally reflected the cherish they had towards leading a healthy life.

For P1 and P3, both health values and fun elements are equally important. P1 was able to better articulate:

“Both (values) are important. Have to get people to be interested to play in the first place. Health values are important too, you must know which part of the body the person is lacking. From there, you can study where a person needs to develop.”
(P1, Female, 64 years old)

The insight here is that health values and fun elements in a health game go hand in hand; while we ultimately depend on health values to provide players with the benefits, even PD patients who felt the need for good health every day would like to have fun too when playing a game to stay engaged. P1 to explained more of her opinions towards how she found the game relevant to her health:

It’s interesting, enjoyable and somewhat challenging. Because I have to coordinate my brain and my hands. Having Parkinson’s Disease has weakened my left hand. It did not listen to my brain, I felt like I have to keep practicing, be patient in order to complete the game. As I play, my skills get better and my coordination improved. And I feel very satisfied when I complete the game.
(P1, Female, 64 years old)

In contrast, P2 and P4 indicated that health should come before fun. In P2’s own words:

“Even if the game is not fun to play, I will still choose the health game. You know it is good for your health, so you play the game rather than for money or prizes. If you play it for health, you take it as a challenge... improving your mind and your wellness. Health value is the most important because without health, you go nowhere.”
(P2, Male, 69 years old)

From his sharing, we gained a new perspective that the challenge provided by a game can stimulate continued usage of the game that ultimately encourages players to perform healthy activities. P4 expressed awe as it was her first time experiencing a game that helps people obtain better health, stating that better health is very important to her. If games can really bring

about the good health she desired, she is willing to change her attitude towards digital games and would try more of them in the future. In their view, fun elements support the main cause by encouraging players to utilize the health game to cultivate good healthy habits.

Regardless being more important or on par with fun elements, health values is a defining element of health games and therefore should be considered as part of one's health game experience.

3.6 Discussion: A Fuller Picture of the Health Game Experience

The themes presented above (familiarity, human interaction, health values) can be understood as 3 sets of the relationships between 3 entities: the elderly player, the health game and the researcher as their game companion. The sets of relationships are presented in the diagram below. The arrows in the diagram represents the flow of information, and each pair of arrows represent a relationship between a pair of entities.

Figure 15. Understanding of Relationships between the Elderly, Health Game and Game Companion

We will reconstruct the above diagram arrow by arrow using the themes presented above.

In prior literature, game experience is typically described as a subjective relationship between player and game. When the average player plays a generic game, they are usually able to interact with the game without many issues and have fun from it. When put in context of elderly

Figure 16. Elderlies' Diminished Interaction with the Health Game Lowers Game Experience

participants playing health games for improving health as the main benefit (instead of entertainment), the situation is significantly different (see Figure 16). If left to their own devices, the elderly tends to find it difficult to adapt to the technology products and has to spend extra effort to learn to interact with virtual entities which they are not used to.

However, with the presence of the researcher as a *human guide*, this situation could be alleviated. In the case of our pre-study, the elderly player experiences the added company of a coach on top of the Pumpkin Garden game being played, and now we have 3 entities in the gameplay: the player, the health game and the coach (Figure 17).

Figure 17. The Researcher

The elderly participants have provided feedback that *Health Values* are important to them, hence we found it important to highlight the health values of health games to the players as they play. In our case, the coach highlighted game-related health values to the elderly when introducing Pumpkin Garden to our PD patients. As a result, subsequent feedback

Figure 18. Health Values

that the health game provides to the player will be much more relatable now with the coach helping the elderly understand the game's health values (Figure 18). With a better ability to relate to the game tasks' purpose, our elderly participants were able to enjoy the health game.

Familiarity was found to be a great motivator for our elderly participants as they were able to be immersed in the game quickly if they pick up familiar

elements in the game process (e.g. on-screen design, game mechanics). Thus, the coach could utilize this piece of information to assess how much a player is enjoying a game (Figure 19). Through evaluating the match between elements presented by the game and player's preferences,

Figure 19. Familiarity

the coach can obtain an accurate judgement of how much the player is enjoying the game. If the coach can obtain sufficient understanding towards the player, it is possible to nudge the player into recalling some of their prior knowledge and reapplying it into the gameplay.

Human companionship has generated interaction that our elderlies value when navigating an unfamiliar digital realm (Figure 20). With the presence of human interactions that elderlies are warmly receptive to, their anxieties encountered when playing health games can be alleviated. This helps the elderly player to interact properly with the game.

Figure 20. Human Companionships

Figure 21. Holistic View of the EHGE when Accompanied by the Researcher

In summary, the themes are presented as the interaction between the 3 entities: the player, the game and the researcher. Thus, the emergent diagram on the 3-way relationship between the 3 entities represents our holistic view of the health game experience with the 5 elderlies.

3.7 Summary

The phenomenological report presented above aims to answer: “*What elements makes up the elderly’s experience when going through a health game session*”. We presented Health Values (the *health-related* game experience), Familiarity and Human Interactions (the *elderly-related* game experience) to be the key elements that our participants value in the health gaming session. Since these opinions come from Parkinson’s Disease patients, we are confident that they can represent the group of frail elderlies who has, in general, reduced abilities when interacting with digital technology [40]. These 3 elements as an alternate route to enjoyment of health games will be further developed into an assessment tool in Part III of this thesis.

4. Review of Existing Game Experience Questionnaires

4.1 Introduction

Challenges to Improve Game Design with the Rise of Video Games Demand

As the demand for video games continue to rise, game developers and designers are facing the challenge of creating games that are not only gratifying to play, but also marketable in the competitive game industry. In order to improve the success of commercial video games, designers started to use a variety of game evaluation methodologies to improve their games' designs.

Video games are different from traditional software in terms of their design intention. Most traditional software are tools intended to perform tasks in a more efficient, easier, and less error-prone manner, resulting in higher quality outcomes. Games, on the other hand, are intended to be pleasurable yet challenging enough to elicit a positive gaming experience. Therefore, the main challenge of game design is to tackle the obstacles of *fun* rather than obstacles of *accomplishments* [110]. In essence, enjoyment comes above completion.

When evaluating games, one should not simply adopt usability analysis tools meant for productivity software to measure the quality of a game [111]. For example, while consistency is praised for productivity software, it would not necessarily make a game entertaining. Rather, it is more appropriate to include usability as one of the metrics and explore other dimensions that make a game fun and fulfilling, such as the gameplay experience. The concept of game experience is understood as the subjective relationship between player and game. It goes beyond the usability of the game [112], focusing on the personal outcome that player gets from interacting with the game while completing a task. In this case, game experience is more on

charting down how the interaction *feels* to the game players. Self-reporting questionnaire is a common psychometric tool to measure and quantify intangible concepts like game experience.

Game Experience Questionnaires as Means to Evaluate Player's Game Experience

Numerous benefits are inherent to questionnaires as a game experience evaluation tool. Game experience questionnaires are easy to administer *en masse*, and quantitative results may help spot trends that drive big picture decisions. The quality of these results, nonetheless, is dependent on how proper the game experience questionnaire, rating scale, or instrument was developed. Thus, it is essential to have psychometrically validated questionnaires for the purpose of playtesting and game evaluation.

We investigate the common practice of such questionnaires, commonly identified dimensions of game experience, various existing game experience questionnaires, and finally provide a discussion on what can be improved from the *status quo* to develop a health game experience questionnaire for elderlies.

4.2 Common Practices: Self-Report Measurement using Likert Scales

Self-report measurement is type of method for game players to express their attitudes, feeling, beliefs or knowledge about the games. It collects players' perceptions and subjective experiences of their interaction with the game technologies. The self-report questionnaires mentioned above are discrete and multi-dimensional. The advantages of self-report measurement are numerous: they are convenient to administer, they possess high internal consistency for well-developed constructs⁶ with specific definitions, they enable statistical analysis and function well in large scale research studies.

⁶ Constructs are a semantic alternative to dimensions. The term "dimensions" is more commonly used in other academic sources, especially in literature that proposes questionnaires on measuring game experience.

These self-report measurement tools often record participants' responses using a Likert scale, a psychometric rating scale widely used in questionnaires. A Likert scale comes after a statement presented to respondents, who are then asked to rate how much they agree or disagree with the statement. Each response on a Likert scale captures the intensity of each respondent's feeling towards a given statement. An item can be rated either on a scale of 5 or scale of 7, as exemplified in the following table:

Table 4. Sample Format of Likert Scale Questionnaire

7-point Likert Scale	5-point Likert Scale
<ul style="list-style-type: none"> • Strongly disagree • Disagree • Somewhat disagree • Neither agree nor disagree • Somewhat agree • Agree • Strongly Agree 	<ul style="list-style-type: none"> • Strongly disagree • Disagree • Neither agree nor disagree • Agree • Strongly agree

The main benefit of using Likert scale is the ability to collect data easily in an orderly manner. As the collected data is already quantified, it is easier for researchers to perform statistical analysis and draw conclusions with confidence using proven data analysis methods. After the questionnaire is completed, each item can be scored separately or grouped. Questionnaires that implement Likert scale typically feature some highly correlated items that help ensure high internal consistency. As a result, a set of items might appear to be replicas of each other, but in fact such items are justified as parallel instruments.

The 5-point Likert scale is mainly used to increase response rate through ease of use, while 7-point Likert scales can theoretically capture finer details by presenting more options. However, for statistical analysis purposes, the difference between 5-point or 7-point Likert scales does

not appear to be significant [113]. Hence, we do not discriminate between game questionnaires that use different scales.

4.3 Various Existing Game Experience Questionnaires

The following subsections present several sets of validated gaming experience questionnaires that have been designed to comprehensively understand the experience of playing video games, or gaming experience, which in turn helps developers or researchers assess, compare, and improve video games.

4.3.1 Game User Experience Satisfaction Scale (GUESS)

GUESS measures video game satisfaction and consists of 55 items under 9 subscales [42]. *Usability/playability* describes how easily is the game learned and the integration of the game's interface. The *narratives* subscale evaluates the game's story element and characters that are developed in regard to their game storyline. *Play engrossment* describes how well the game induces a state of being immersed, such as a player losing track of time while playing and expressing excitement to play again. *Enjoyment* reflects how fun the game is for the players. *Creative freedom* shows how well the game stimulates curiosity and how much imaginative control it provides. *Audio aesthetics* appeal players to the music and sound effects of the game. *Visual aesthetics* attract the players with the graphics of the game. *Personal gratification* motivates the players to continue to play. *Social connectivity* indicates the connections between the real people playing the game.

GUESS scores uses a 7-point Likert scale; scores of the 9 subscales are averaged to obtain a final score. The final score allows the questionnaire's users to directly compare different games. GUESS can be conducted to evaluate a variety of player satisfaction in different types of video games. Utilizing the newfound understanding of what people enjoy in video games, game designers are able to make informed decisions on where to improve.

4.3.2 Core Elements of the Gaming Experience Questionnaire (CEGEQ)

CEGEQ measures the observable variables in order to understand the behaviour of latent constructs and comprises 38 items with 10 hierarchical scales [43]. On the top of the hierarchy is the *CEGE* scale itself, which comprises *Puppetry* and *Video-Game*. *Puppetry* describes the interaction of the players with the video-game under the conditions of *Control*, *Ownership* and *Facilitators*. *Video-Game* focuses on how the game is being experienced in the terms of *Game-play* and *Environment*. Finally, two scales of *Enjoyment* and *Frustration* is also included to examine the relationship between them and *CEGE*. CEGEQ captures scores using the 7-point Likert scale. It is possible to use CEGEQ to identify what produces the difference between games and provide a hierarchical approach to understand the gaming experience.

4.3.3 Player Experience of Need Satisfaction Questionnaires (PENSQ)

PENSQ investigates the motivation to play the video games by measuring players' intrinsic motivation [44]. The questionnaires are based on Self-Determination Theory (SDT) and other relevant theories to assess the game play experiences in terms of *autonomy* (having control over actions), *competence* (self-efficacy), *relatedness* (meaningful connection with others), *intuitive controls* and *presence/immersion*. *Intuitive controls* determines the degree of control players can exert on their character's actions in the game environment. The value of PENSQ is to bring in greater focus to design of learning curve and provide practical feedback to the game developers. The result of PENSQ is based on a set of 21 items with 7-point Likert-scales.

4.3.4 User Engagement Scales (UES)

UES assesses self-reported user engagement and includes of 31 items experiential questionnaire with 6 dimensions of player's engagement: aesthetic appeal, focused attention, novelty, perceived usability, endurability and felt involvement [45]. Similar to GUESS, *aesthetic appeal* is players' perception of the visual appearance of the user interface.

Endurability is users' overall impression of the experience. The factor of endurability combines concepts linked to player's likelihood to return and evaluation of game success. *Felt involvement* defines players' feelings of having fun during the interaction. *Novelty* counts players' level of interest in the task and curiosity evoked by the game and its contents. *Perceived usability* shows players' affective (e.g., frustration) and cognitive (e.g., effort) responses to the game. *Focused attention* concentrates players' mental activity that contains the elements of flow, specifically focused concentration, absorption and temporal dissociation. UES does not only evaluate engagement in video games, it can also measure engagement in online videos, consumer applications as well as social networking systems. Both 5- and 7-point Likert scales can be employed through UES, which depends on the study design and objectives.

4.3.5 Immersive Tendencies Questionnaire (ITQ)

ITQ is developed to measure the tendency of users to be involved or immersed to experience presence comprising of 18 items. ITQ features both total immersion score and scores that is calculated for subscales of *involvement*, *focus* and *gameplay*. *Involvement* is the tendency of game players to become involved in their activities. *Focus* on the ability to maintain attention on a given game quest. *Gameplay* is the tendency to play the video games. For a game player, a higher ITQ score reflects a greater tendency to be involved or immersed in the game playing, the tendency to maintain focus on the current game and tendency to play the game frequently [46]. ITQ relies exclusively on self-report measurement and uses 7-point Likert scale as well.

4.3.6 Game Experience Questionnaire (GEQ)

Game Experience Questionnaire (GEQ) [47] was developed under the "Fun in Gaming" (FUGA) project funded by the European Community, which strived to measure the experience

of game enjoyment. GEQ⁷ is measured on 5-point Likert-like scales and consists of three different modules:

1. The core module

Obtains the game experience as scores on 7 components: immersion, flow, competence, positive affect, negative affect, tension and challenge. There are approximately 5 questions per component.

2. Social presence module

Acquires psychological and behavioural involvement of the play with other virtual social entities. This module only applies when at least one co-player was involved in the game. The 3 constructs of social presence module are: empathy, negative feelings, and behavioural involvement.

3. The post-game module

Examines how players felt after they stopped playing. It contains 4 constructs: positive experiences, negative experiences, tiredness, and returning to reality.

GEQ constructs emphasize on player-centric feelings without addressing specific game design elements, unlike *Audio/Visual Aesthetics* in GUESS or *intuitive control* in PENSQ. A simple interpretation towards reading GEQ construct scores is that a good game tends to cause users to report higher scores on desirable aspects such as *positive affect* and *immersion*, and lower scores on more “negative” constructs such as *negative affect* and *tension*. However, this simple interpretation is not necessarily true, as constructs that may sound “negative” may be integral in enriching the game experiences [73].

⁷ Game Experience Questionnaire should not be confused with other questionnaires with similar or same abbreviations, namely CEGEQ (reviewed in section 4.3.2) or the Game Engagement Questionnaire.

4.4 Discussion

From review of existing game experience questionnaires and commonly identified constructs of game experience elaborated above, it is not hard to see that existing survey tools can mostly agree on what constitutes a good game experience. Common constructs such as immersion/attention, fun/enjoyment, challenge, social elements, usability and audio-visual appeal are regularly shared among different game questionnaires. These constructs often focus on the gameplay experience themselves and assumes a degree of game literacy to be present among the audience, which makes perfect sense when the goal is to create the best experience (common in commercial games). In other words, a good game is a game that people enjoy and want more of.

Serious games, on the other hand, is a dual-purposed game system combining not just hedonic elements but also utilitarian values to provide both functional benefits and pleasure for players. Serious game experience comprises of both hedonic experience (commonly described as ‘game experience’) and utilitarian experience (i.e. how the player perceives the game as useful or valuable). Therefore, current game experience questionnaires may not holistically measure player’s game experience when playing serious games such as health games, and thus there is a need to develop a game experience questionnaire specially tailored for serious game use.

Table 5 summarizes the questionnaires and reviewed in this section together with their constructs.

Table 5. Examples of Previous Game Questionnaires from the Literature

Game Questionnaire	Dimensions Present
Game User Experience Satisfaction Scale (GUESS) [42]	Usability/Playability, Narratives, Play Engrossment, Enjoyment, Creative Freedom, Audio Aesthetics, Personal Gratification & Social Connectivity
Core Elements of The Gaming Experience Questionnaire (CEGEQ) [43]	Puppetry, Video-game, Control, Ownership, Facilitators, Game-play, Environment, Enjoyment & Frustration
Player Experience of Need Satisfaction Questionnaires (PENSQ) [44]	Autonomy, Competence, Relatedness, Intuitive Controls & Presence/Immersion
User Engagement Scales (UES) [45]	Aesthetic Appeal, Focused Attention, Novelty, Perceived Usability, Endurability & Felt Involvement
Immersive Tendencies Questionnaire (ITQ) [46]	Involvement, Focus & Gameplay
Game Experience Questionnaire (GEQ) [47]	Sensory and Imaginative Immersion, Tension, Competence, Flow, Negative Affect, Positive Affect & Challenge

4.5 Summary

This chapter presents the current status of game experience questionnaires, including benefits of game experience questionnaires, the common practice of using self-report questionnaires in Likert scale format, the commonly identified game experience aspects, as well as brief summary of existing game experience questionnaires.

Based on literature studies, we find that most game experience questionnaires describe the game experience with similar dimensions. This is due to developers of game experience questionnaires focusing solely into the hedonic, enjoyable aspects of game experience. While it poses no problem when dealing with commercial games, which are targeted for entertainment

purposes, these questionnaires do not fully capture the entire facets of gameplay experience of serious games consist of both hedonic and utilitarian aspect, including health games.

With the rise of demand in health games especially for aging population, it follows that there should be an assessment tool to measure player's experience of playing a health game in a holistic manner to help developers or researchers evaluate and improve the health game. So far, little research has been done to develop questionnaire specifically tailored for health game experience, which is the primary motivation for us to come up with Health Game Experience Questionnaire (HGEQ). The following chapters discuss how the novel questionnaire is developed and how we evaluate its appropriateness for general use.

5. Health Game Experience Questionnaire (HGEQ): A Health Game Experience Assessment Tool

5.1 Introduction

Health games belong to a subset of serious games aimed at driving health-related outcomes. As uncovered by previous chapters, health game experience plays an important role in determining player's attitude towards the game, leading to intention to use. However, health game experience is a complex concept, combining the hedonic value such as enjoyment and utilitarian values like perceived usefulness.

Existing game experience questionnaires may not sufficiently portray the unique experiences generated by health games, which is especially important when uncovering ways that can improve the game experience and in extension, cultivate favourable attitudes towards health games. We learn from commercial games industry that often employs questionnaires (typically after playtesting) to gather player experiences that can then serve as constructive feedback to game designers. GEQ is an example of a popular questionnaire used in such cases, however it is developed and validated with teenagers or younger adults (mean age = 20.8) playing commercial games.

Interestingly, there has been no attempt to validate the GEQ in the domain of serious games such as health games [35]. Moreover, there are reasons to argue that there are certain aspects of health game experience which are not reflected in the GEQ. Researchers have agreed that game experience on serious games other than “positive” and/or “fun” doesn't necessarily be “uncomfortable”; there are categories of experience that lies somewhere between positive and uncomfortable/negative experience such as thought-provoking or “positive-negative” experience (i.e. where the user/player takes pleasure from negative experience) [73]. Some researchers even further argue that notions of “fun” are not necessarily applicable to serious

games; instead, the player's interest in the topic being presented in the game would be a better evaluation metric for their experience [34].

This phenomenon can also be observed in practice, where different indicators of game acceptance manifest when games are used for more serious purposes (such as education) instead of fun [114, 115]. In contrast, the GEQ was primarily intended to measure the experience of games which are more hedonic in nature (i.e. entertainment games).

Therefore, when measuring experience of games with more utilitarian purposes such as health games, GEQ requires additional dimensions to measure experiences beyond what is examined by GEQ [35]. This chapter proposes the Health Game Experience Questionnaire (HGEQ), a health game experience assessment tool that extends the GEQ to measure factors that affect the health game experience tailored for the elderly.

5.2 Development of Health Game Experience Questionnaire

The Health Game Experience Questionnaire (HGEQ) is an extension of Game Experience Questionnaire (GEQ), a multi-dimensional game experience measurement tool commonly used to assess gameplay experience of commercial games. Among the many game experience questionnaires available, GEQ is one of the most popular in game experience study [116], which is the reason why we choose GEQ as a starting ground for our new questionnaire. In this section, we will discuss the issues pertaining the use of GEQ in health games, how HGEQ addresses such issues, and the process of HGEQ item generation.

5.2.1 Additional Constructs to GEQ

We briefly review the literature of the 3 constructs uncovered by our pre-study: *health values*, *familiarity* and *human interaction* (formalized as *identification of human-like properties* in HGEQ). Literature generally support health values as a “serious aspect of the game experience” in health games' context [34], while familiarity and human interaction are much valued as

positive experiences among elderlies [117, 118]. The use of these three constructs are supported by previous studies as we review in the following subsections.

5.2.1.1 Health Values

Health games are a combination of entertainment and health benefits. Similarly, the serious game experience consists of *enjoyment* and *perceived health benefits* [64]. Enjoyment is identified as an extrinsic motivator as it involves the gratification of earning some kind of reward from the game. Whereas, health values as the logical *perceived health benefits* to the self after playing a health game is identified as an intrinsic motivator [64]. We focus on the latter in this section as a trait unique to health games when compared to commercial games.

Health values are proposed to be an essential part of the health game experience. This is because there is strong evidence that supports the relationship between intrinsic motivation and activity enjoyment [119, 120]. In fact, players who are intrinsically motivated enjoy activities more than those who are extrinsically motivated [119]. As such, researchers of serious game design suggest intrinsic motivation as an important factor to consider in serious game development [121].

To evaluate participants' intrinsic motivation during activity in an experiment, Intrinsic Motivation Inventory (IMI) [122] is invented as a measurement device. IMI consists of six subscale scores pertaining intrinsic motivation: interest/enjoyment, perceived competence, effort, value/usefulness, felt pressure and tension, and perceived choice. Among these subscales, we are interested in the value/usefulness subscale. When the activity is defined as playing health game, we argue that the other subscales are more related to the hedonic or entertainment side of the game, hence are likely to already be captured by GEQ, while value/usefulness are related to the utilitarian side.

The value/usefulness subscale is used in IMI for internalization studies to verify whether people become self-regulating when they perceive the activity as useful or valuable to themselves. Studies have shown that value/usefulness is a strong predictor of participants' positive gameplay experience, whether it manifests as 'perceived educational value' [123, 124], 'perceived learning' [35], 'perceived benefits' [26, 29], 'perceived usefulness' [114, 125], or 'perceived health value' [126], which leads to higher intention to use.

Many more studies support this type of intrinsic motivation to be more effective in encouraging adoption of serious games. In a study on elementary students, researchers found that students' willingness to use education games is more influenced by expectations of usefulness than enjoyment; they even went so far as stating that the 'fun' effect may distract students' learning engagement [115]. Another study on young students also emphasizes learning opportunities as main determinant of students' preference to use education games [114]. This is also observed from the teachers' perspective, where usefulness is found to be a strong predictor of attitude towards educational video games [127]. As such, they recommend that educational value is taken into account when designing and utilizing games for educational purposes [114, 124, 125].

Perceived value/usefulness is also a major experience factor among elderly participants. A cross-generational study highlights age as an independent variable affecting the amount of perceived benefits from health games [128]. Another study on elderlies playing exercise games using the Nintendo Wii suggested that perceived health value leads to perceived affective response, which leads to perceived satisfaction [126]. This is the reason researchers agree that health game benefits should be properly presented to the elderly [26, 129].

As such, we can argue that perceived health value is an essential metric to be assessed as part of elderlies' health game experience.

5.2.1.2 Familiarity

Familiarity plays an important role in participants' enjoyment when carrying out an activity, especially for older people. Studies on Finnish elderlies' acceptance of novel snack food indicated that their associations to traditional Finnish food (e.g. porridge or hot cereal) may explain the higher acceptance ratings compared to the young [130]. This also holds true in game experiences, namely when elderlies prefer games which resemble activities that they are already familiar with [131, 132, 133]. Therefore, researchers have oftentimes suggested the incorporation of familiarity in digital game design [133, 132] to better appeal to the elderly.

The effect of familiarity on the elderly's game enjoyment can be explained by the P-E fit theory [117]. When not possessing sufficient competence to finish a task (i.e. low ability), a sense of familiarity increases elderlies' functional abilities by evoking their memories. On the other hand, in the case of insufficient environmental pressure (i.e. low motivation), elderlies' prior emotions will be aroused by familiarity and thus their motivation will increase. This increase in motivation and ability when applied into video games can lead to a positive game experience.

Prior research suggests that familiarity is influenced by 5 factors [134]:

- Prior experience: The person's previous experiences related to the current stimulus
- Positive emotion: The person's past positive feelings elicited by a similar stimulus
- Occurrence frequency: The frequency of a stimulus encountered by an individual as stored in his/her memory
- Level of processing: The depth of processing in one's memory
- Retention rate: How much of the memory about a stimulus is retained and is negatively affected by the time interval between two encounters

When one or more of these factors are satisfied, a sense of familiarity will be felt by the subject.

Familiarity can manifest in 3 distinct but related categories [108]:

- **Symbolic familiarity:** Objects, activities or processes commonly occurring in the target users' daily life are infused into the design of a system. This is the category of familiarity that is often being discussed when talking about game UI design.
- **Cultural familiarity:** Concepts, artefacts, patterns, traditions, or rituals commonly appearing in the target users' culture are infused into the design of a system. To distinguish this from symbolic familiarity, we define this as familiarity with non-tangible aspects of the game such as language, expression [135], and behaviour [136].
- **Actionable familiarity:** The acts of interacting with elements in the system are similar to the acts of interacting with these elements in real life. This does not necessarily suggest different human-computer interaction interfaces. For example, familiar gestures that people can associate to in real life [137] also falls under actionable familiarity despite not being an interface.

5.2.1.3 Identification of Human-Like Properties

Researches of video game have attempted to identify sources of game enjoyment beyond performance-induced self-esteem [70]. One of these sources is player's identification with the game, in particular the game character. The notion of identification is conventionally defined as the dyadic relationship between the player and the game character, such as empathy [138] and para-social interaction [139]; however, it can also be defined as a monadic concept of temporary shift in player's self-perception by adopting characteristics of the game character that the player values [140].

Identification is believed to be an important quality of game experience as stronger sense of identification is often associated with higher degree of game enjoyment [141, 142]. This is also

observed in educational games, where a higher degree of identification leads to higher learning effects, which have strong association with enjoyment in educational game context [143].

The intriguing capability of humans to identify with an inanimate object is explained by the concept of imaginative perception [138]; that is, humans imaginatively perceive some human-like characteristics (such as expressions or actions) from the inanimate object which causes them to empathize with said object. The attribution of human-like characteristics to non-human entities is linked with the concept of anthropomorphism: a basic human psychological tendency. Historians suggest anthropomorphism allowed hunters to identify empathetically with hunted animals and better predict their movements. This tendency is exploited by video game developers to create anthropomorphic characters in the game, some of which have become successful media franchises such as *Sonic the Hedgehog* and *Donkey Kong*.

Researchers have identified two ways that perception of anthropomorphism can be manipulated, bottom-up and top-down. Bottom-up manipulation is achieved by making the subject appear more human (i.e. by showing human-like physical appearance, actions, or emotions), while top-down manipulation is achieved by making people ascribe agency, affect, or intentionality to the subject (e.g. by explaining that the subject indeed has human-like traits) [144]. While bottom-up manipulation through physical resemblance is shown to have negative impact on game enjoyment through decreased sense of autonomy [145], top-down manipulation of emotion and agency attribution seems to display some positive impact on the elderly's serious game enjoyment (at least in the short term) [144]. Therefore, we believe that non-physical human-like characteristics have an influential impact on serious game experience, especially for health games which often act as a virtual agent/medium to encourage healthy behaviour.

5.2.2 HGEQ Item Generation

Based on the three additional constructs outlined above, we create a set of questions to be added to the existing questions in GEQ to develop HGEQ. Five questions are added for each construct, with answer to each question being measured using five-point Likert scale consistent with the GEQ. The additional questions will be added to the Core Module of the conventional GEQ, as we believe the three constructs are part of their core in-game experience.

To generate the question items, we take considerations from literature reviews and interviews with participants. Past research efforts on relevant topics of health value, familiarity, and identification of human-like properties help us obtain essential sub-aspects of these constructs to be evaluated. Previously developed questionnaires, such as the Intrinsic Motivation Inventory (IMI) [122], are used as a reference for our question generation.

5.2.2.1 Health Values

Below we presented the concepts to be included in HGEQ as questionnaire constructs. These concepts are supported in prior literatures as well as our pre-study.

Perceived Health Value

This is the core concept of the health value construct, which has been elaborated extensively in section 5.2.1.1 above.

Based on the concept of perceived health value, we formulated two questionnaire items (adapted from IMI [122]):

- *“I believe this game has useful health value to me”*
- *“I would be willing to play this game again because it has some health value to me”*

Relevance of Health Value

The perceived health value per se may not be the factor driving the players' motivation, but the relevance of the health value being presented plays an important role. As an example, a disease management game for serious illness may be more well-received by its target audience (patients with such illness) than game to reduce binge drinking among teenagers and young adults, who are less concerned with health consequences of drinking. The more the game is relevant to the players, they will be more open-minded and willing to try the game, leading to a more enjoyable experience [68]. This is shown in an experiment with depression intervention game, where participants exhibiting more depressive symptoms were shown to have higher motivation to play the game that explicitly claim the health objectives due to personal relevance [146].

Based on the concept of relevance of health value, we formulated one questionnaire item:

- *“The health issue being presented in the game is relevant to me”*

Utilitarian over Hedonic Value

As previously mentioned, some serious games players perceive the utilitarian value (e.g. usefulness) as the more significant driving force of their motivation to play compared to the hedonic value (e.g. fun). Researchers have explored the different pathways perceived hedonic and utilitarian value influence subjects' attitude. In a study on mobile service use, the hedonic value has a more positive effect on user's satisfaction and fun, while the utilitarian value has a more positive effect on customer loyalty and usefulness, both of which leads to intention to use [147, 148].

Moreover, the degree on which perceived hedonic and utilitarian value affects the subject has found to be varied across demographics. For example, in a study on mobile data service usage, effect of hedonic value was found to be stronger in the female group than the male group, while

utilitarian value had stronger effect for the male group than the female group [149]. Differences on perceived hedonic and utilitarian value based on gender is also found on a study of games [150].

Two conclusions can be drawn here:

- People may choose perceived health value, as opposed to fun, as their motivation to play, leading to different pathways to reach intention to use.
- The degree in which people choose health value over fun differs across demographic groups.

The discriminability outlined above provides a foundation for a meaningful measurement tool, thus this concept is used to formulate one of the questionnaire items.

Based on the concept of utilitarian over hedonic value, we formulated one questionnaire item:

- *“I play the game more for the health benefits than for the fun”*

Explicit Address of Health Value

There are two ways to address the health value of the game to the players, implicitly (e.g. through use of metaphors, symbols, or other alternative representations) or explicitly (e.g. through direct mention of the health issues). Results on studies determining which approach works better are inconclusive. One study on diabetes intervention game [58] and one on depression intervention game [146] showed that better game enjoyment are found on explicit version of the game for patients with respective said health problem than the implicit version, possibly due to personal relevance. Another study on cancer treatment game, however, provided different conclusion, that game version with no cancer-related content was better received by children with cancer than the explicit version; nonetheless, parents' interview showed some support towards an explicit health game version, prompting the researchers to

suggest further investigation into this issue [151]. Based on our literature study, more evidence suggest that explicit address of health value is preferable [26] especially for players with more personal relevance with the health issues being addressed [146, 152, 153].

Based on the concept of explicit address of health value, we formulated one questionnaire item:

- *“The health issue is being explicitly addressed in the game”*

5.2.2.2 Familiarity

Deriving from our previous research, we define 3 categories of familiarity: symbolic familiarity, cultural familiarity, and actionable familiarity. Therefore, we formulated three questionnaire items, each corresponding to the different categories of familiarity:

- *“I am familiar with the objects displayed in the game”*
- *“I am familiar with the language, expression, and behaviour being displayed in the game”*
- *“I am familiar with the way to interact with the game”*

5.2.2.3 Identification of Human-Like Properties

Human companionship has proven effective in elevating game experiences for the elderly in the pre-study. The implementation of humanlike entities in-game should create similar effects. Referencing from properties of virtual human [154], there are three essential human-like characteristics that can be introduced without reaching the ‘uncanny valley’ as a consequence [138]: autonomy, interactivity, and personification.

- Autonomy refers to the ability to self-govern and perform actions without receiving explicit instructions. Two key sub-features of autonomy can be identified:
 - Situation Awareness: The ability to understand the situation and context of the environment.

- Proactiveness: The ability to exhibit goal-directed behaviour by taking the initiative.
- Interactivity refers to the ability to interact and communicate with its surroundings, such as human players.
- Personification means giving human-like attributes (such as emotions) to non-human objects.

Studies on elderlies have shown that adapting the game's difficulty to their ability motivates them to keep playing serious games [129], especially for those who have disabilities that reduced their abilities to play well [155, 156]. Serious health games which possess such situation awareness is likely to produce better experience [157].

A health games' proactiveness in guiding the elderly is considered an important dimension of serious game experience [158], despite guidance being less important in commercial games. This is due to the different demographics the games are targeted at. Guidance can come in the form of clear instructions or feedback [159]. Games with clear guidance increase the elderly's confidence in playing, which leads to a more satisfying user experience.

Based on the concepts outlined above, we have formulated 5 question items:

- *"I felt the game difficulty was automatically being adjusted to my ability"*
- *"I felt the game was aware of my situation"*
- *"I felt the game was proactively guiding me throughout the gameplay"*
- *"I felt the game was interactive"*
- *"I felt like interacting with a human"*

5.2.3 The Big Picture

Figure 22 below summarises the proposed Health Game Experience Questionnaire. All in all, the HGEQ consists of ten subscales, with a total of 63 items. The first 7 subscales are extracted from GEQ's core, which are sensory imaginative immersion, tension, competence, flow, negative affect, positive affect and challenges, while the other 3 are the newly added constructs. The three new constructs of HGEQ are *health values*, *familiarity*, and *identification of human-like properties*, all of which are added under the core module GEQ. Health values construct involves perceived health value, relevance of health value, utilitarian over hedonic value, and explicit address of health value. Familiarity consists of symbolic, cultural, and actionable familiarity. Identification of human-like properties comprises autonomy, situational awareness, proactiveness, interactivity, and personification.

Figure 22. Summary of Constructs in Proposed HGEQ

5.3 Methods to Evaluate HGEQ

As with development process of other questionnaires by past researchers, an evaluation process is needed in order to establish the suitability of the questionnaire for general use. Experts have identified various criteria of good measurement tools, such as reliability, validity, sensitivity, robustness, non-intrusiveness, and convenience. Among these, it is generally viewed that reliability, validity, sensitivity are the three most important criteria [47, 160].

Therefore, with reference to GEQ evaluation process, we employ the following criteria to evaluate the quality of our questions:

- **Validity:** The measure should address the intended construct. For this criterion, we focus on face validity (the extent to which a measure appears to evaluate the intended construct), content validity (there is an underlying theory and clear definition of the construct), and criterion-related validity. Face validity is established in pre-study (3.5) while content validity has been established through literature review of health value, familiarity, and identification of human-like properties (5.2.1). Criterion-related validity is established in the subsequent Study 1 (Chapter 6).
- **Reliability:** The measure should be consistent and stable over time. For this criterion, we focus on internal consistency reliability (the extent to which the items of a measure address the same underlying trait or characteristic), which will be established in the experiment section.
- **Sensitivity:** The measure should be able to distinguish between different levels of a construct with a reasonable level of detail. This is established in study 1 (Chapter 6).

5.4 Summary

In this chapter, the Health Game Experience Questionnaire (HGEQ) is proposed to measure health game experience. HGEQ is an extension of GEQ with the intention to address its two

shortcomings: the lack of validation in serious health game use, and the posited lack of measurement of utilitarian aspect of health game experience.

Three constructs were added to the HGEQ, namely Health Value, Familiarity, and Identification of Human-Like Properties. Health Values comprises perceived health value, relevance of health value, utilitarian over hedonic values, and explicit address of health value. Familiarity is categorized into symbolic, cultural, and actionable familiarity. Identification of human-like properties consists of autonomy, situational awareness, proactiveness, interactivity, and personification. Thirteen questions are then generated from the three constructs with reference to the subconstructs summarized in the previous paragraph. These questions are then added to the Core Module of the original GEQ. Evaluation methods are also laid out for Study 1: a quantitative study of HGEQ, which will be elaborated in the next chapter.

6. Study 1: Evaluation of Health Game Experience Questionnaire (HGEQ)

6.1 Introduction

The previous chapter details the Health Game Experience Questionnaire (HGEQ), an extended version of Game Experience Questionnaire (GEQ) tailored for the use of health games. Several criteria were also outlined to prove that HGEQ is a good measure of health game experience, namely *validity*, *reliability*, and *sensitivity* (5.3).

Content validity of the additional constructs (i.e. Health Value, Familiarity, and Identification of Human-Like Properties) has been established with findings from pre-study and literature review. The rest of the criteria can only be verified through quantitative experiment. In this chapter, the Health Game Experience Questionnaire (HGEQ) is validated with elderly players who play through a health game before filling up the HGEQ. We then perform quantitative analysis on the data collected to establish HGEQ as a viable assessment tool, placing emphasis on the 3 new constructs as well as their relationship with existing constructs.

6.2 Study Methodology

6.2.1 Evaluation Criteria and Tools Used

Five remaining criteria are yet to be established for the HGEQ to be considered a well-formed questionnaire: internal consistency reliability, predictive validity, convergent validity, discriminant validity, and sensitivity.

Internal consistency reliability is an assessment of how well a questionnaire is measuring what the question designer wants it to measure. This criterion asks the question “*is your test measuring what it’s supposed to?*”. A group of questions for a construct should express a single clear stance. In contrast, if the answers contradict each other, it is a sign that the questionnaires are not reliably measuring the player’s opinions towards health values [161]. We measure the

internal consistency reliability using two assessment methods: Cronbach's alpha and factor loadings obtained through Confirmatory Factor Analysis (CFA).

Predictive validity displays how well a certain measure can predict future behaviour. For our study, we use fit indices to show how well the CFA model (Figure 23 and Figure 24) fits the observed data collected from the study. A model that achieves good fit indices would be deemed to possess a certain level of predictability, which is an essential trait for measurement tools.

Convergent validity and discriminant validity are subtypes of construct validity. Convergent validity requires constructs that are supposed to measure similar concepts to be correlated. On the other hand, discriminant validity requires that constructs which are not expected to be related have low correlation. Both of these measures ensure that the HGEQ constructs cover distinct aspects and qualities of the health game experience, while at the same time, maintaining a healthy level of redundancy. In order to observe convergent validity of HGEQ, we observe the factor correlations obtained from CFA. Whereas for discriminant validity, the Fornell-Larcker test is employed [162].

Sensitivity of a questionnaire is defined as the ability to discern expected different levels of a construct given manipulation of an independent variable. In our case, we expect the age of the participants to affect a certain set of constructs in the HGEQ; this difference should be significantly reflected in the HGEQ for it to be deemed as a *sensitive* measurement tool. Statistical tests can be utilised to show the sensitivity of HGEQ. We propose 3 qualities of HGEQ that we deem significant to perform statistical test for validation:

1. The proposed *Familiarity* construct in HGEQ has higher correlation to Positive Affect and Negative Affect among older participants.

2. The proposed *Identification of Human-Like Properties* construct in HGEQ has higher correlation to Positive Affect and Negative Affect among older participants.
3. The proposed *Health Values* construct in HGEQ has higher correlation to post-game Positive Experience and Negative Experience among participants with pre-existing health conditions, compared to healthy participants.

To summarize, we have outlined the criteria and our approaches in the following table:

Table 6. HGEQ's Evaluation Criterion and Associated Metrics Used to Support the Criterion

Criterion	Metrics Used
Internal consistency reliability	Cronbach's alpha, CFA (factor loadings)
Predictive validity	Fit indices
Convergent validity	CFA (bivariate correlations)
Discriminant validity	CFA (Fornell-Larcker testing system [162])
Sensitivity	CFA (bivariate Correlations, split by age / health condition)

Several tools will be used to conduct quantitative analysis of the collected data, namely Microsoft Excel, IBM SPSS Statistics, and IBM SPSS AMOS.

- Microsoft Excel is spreadsheet tool used to tabulate the collected data and compute participants' demographical statistics and Cronbach's alpha
- IBM SPSS Statistics is a statistical analysis software package used to conduct means and correlations testing
- IBM SPSS AMOS is a structural equation modelling (SEM) software to conduct Confirmatory Factor Analysis (CFA)

6.2.2 Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) is a multivariate statistical procedure, whose objective is to test the consistency of a construct's hypothesized measurement model with the nature of that construct by fitting it with real data. It focuses on modelling the relationship between variables and factors, indicating which variables load on which factors and which factors are correlated. In our case, CFA is used to assess how well the hypothesized additional constructs to GEQ (as well as the original constructs) fits the results from the study outlined above.

Researchers often use Exploratory Factor Analysis (EFA) to derive the constructs which are then confirmed with CFA. However, scholars have suggested that measurements with adequate empirical and theoretical evidence can be directly confirmed with CFA without using EFA beforehand [163]. For our case in the previous chapter, we laid out the theoretical foundation of the importance of Health Values, Familiarity, and Identification of Human-Like Properties as part of health game experience. These 3 constructs are backed by testimonies from interviews in our phenomenological study (3.5 above): participants expressed how Health Values (e.g. relevance of health values), Familiarity, and Identification of Human-Like Properties (e.g. situation awareness) helped them to enjoy the game. Hence, we deem the three constructs to possess sufficient evidence to be confirmed directly with CFA.

The hypothesized 10-construct model for HGEQ Core module, in which the 3 proposed additional constructs are located is depicted below.

Figure 23. The Hypothesized 10-Construct Model for HGEQ Core Module

On the other hand, the 4-construct model for HGEQ Post-Game module (which is identical to GEQ Post-Game module) is depicted below.

Figure 24. The Hypothesized 4-Construct Model for HGEQ Post-Game Module

The HGEQ core module consists of 33 pre-existing questions in the original GEQ's core module (adhering to the 2013 publication [164]), plus the proposed additional 13 questions. In total, HGEQ core module contains 46 questions, which is modelled as shown in Figure 23 above. The GEQ post-game module is unmodified with 17 questions, which is modelled as shown in Figure 24. Since GEQ has two published versions containing different sets of questions (the full paper in 2008 [47] and the questionnaire-only version in 2013 [164]), we opted to use the questionnaire presented in the 2013 version [164] to derive the HGEQ used for our validation study, as it is more recent.

We convert the tabulated survey results into IBM SPSS Statistics dataset, then use IBM SPSS AMOS to conduct CFA.

6.2.3 Study Flow and Selection of Participants

Fifty-one active elderlies who are in the age range of 50-80 years old were recruited in total from the community. The research participants were recruited randomly from the community. All participants were briefed on the IRB consent agreement and signed the form before taking part in our study.

The participants were required to play the Pumpkin Garden game by themselves. We told them to try and complete the Pumpkin Garden game sequence used in the pre-study (p. 64 Figure 9). We only provided pointers upon their request. Unlike the pre-study, we did not proactively guide them throughout the gameplay process. This helps us observe how elderlies with different levels of prior experience with technology interact with health games.

Before the gameplay, participants were required to complete a pre-game questionnaire to obtain demographic data. They read and signed the IRB consent form to participate in the study. Next, each participant was given an Apple iPad loaded with the Pumpkin Garden game. We introduced the game to them as a generic health game for stimulating fine motor skills before commencing the gameplay session.

The Health Game Experience Questionnaire (HGEQ) was administered at the end of the gameplay session. As Pumpkin Garden is played exclusively in single-player mode, we only administered questions from the Core module and Post-Game module.

Finally, an open-ended question was included at the end of the survey:

- Do you enjoy the game session? What did you encounter that made you say so?

This question, although not considered to be part of HGEQ, allows for any additional comments and feedback on the game session itself.

6.3 Results, Findings and Observations

This chapter presents our CFA results and explain how they establish reliability, validity and sensitivity of HGEQ.

6.3.1 Participants' Demographics

The following table summarizes the demographics of the participants based on pre-survey questionnaire results. The extent these participants represent Singapore's age population is presented separately in Figure 42 below in Study 2.

Table 7. Demographics of the 51 Participants for Study 1

6.3.2 Internal Consistency Reliability

In order to satisfy the criterion of internal consistency reliability, we computed the Cronbach's alpha from the complete questionnaire results (tabulated using Microsoft Excel). Cronbach's alpha (also known as tau-equivalent reliability) is computed for each construct, to measure if the set of questions under the construct agree with one another. The formula to calculate it is as follows:

$$\rho_T = \frac{k}{k-1} \left(1 - \frac{\sum_{i=1}^k \sigma_i^2}{\sigma_X^2} \right) \quad (1)$$

ρ_T = Cronbach's Alpha
 k = number of items
 σ_i^2 = variance of X_i
 σ_X^2 = variance of X

σ_i and σ_X^2 can be both derived from the covariance matrix, which is obtained from responses of all question items under the calculated construct. k is the number of questions under the calculated construct. The calculated Cronbach's Alpha values for each construct in Post-Game and Core modules are presented in the following tables.

Table 8. Cronbach's Alpha of HGEQ Post-Game Module

Construct	Short Name	Cronbach's Alpha
Positive Experience	<i>pe</i>	0.890
Negative Experience	<i>ne</i>	0.874
Tiredness	<i>tire</i>	0.754
Return to Reality	<i>rtr</i>	0.889

Table 9. Cronbach's Alpha of HGEQ Core Module

Construct	Short Name	Cronbach's Alpha
Positive Affect	<i>paff</i>	0.913
Competence	<i>comp</i>	0.882
Sensory and Imaginative Immersion	<i>sii</i>	0.899
Flow	<i>flow</i>	0.879
Negative Affect	<i>naff</i>	0.855
Challenge	<i>chal</i>	0.903
Tension	<i>tens</i>	0.733
Health Values	<i>hv</i>	0.966
Familiarity	<i>fam</i>	0.811
Identification of Human-Like Properties	<i>ihlp</i>	0.904

For constructs that have 4-6 items, it appears that a Cronbach's Alpha value of 0.7 is considered good [165, p. 183]. All constructs from Core and Post-Game Modules show Cronbach's alpha value of above 0.7, thus showing evidence for HGEQ's internal consistency reliability.

Moreover, the following tables shows the factor loadings obtained through CFA (Standardized Regression Weights):

Figure 25. Factor Loadings of HGEQ Post-Game Module

Figure 26. Factor Loadings of HGEQ Core Module

A factor loading with value 0.7 is considered high, while a value of 0.5 is considered medium [166, p. 86]. All question items show a factor loading value of above 0.6 (with the exception

of ne5), indicating that the question items correlate well with the construct they are supposed to measure and providing evidence for internal consistency validity.

6.3.3 Predictive Validity

Predictive Validity is satisfied by inspecting the fit indices reported by the CFA results. Fit indices measure whether the model is sufficiently good to be analysed (i.e. whether we can reliably predict the probability distribution of gathered questionnaire responses). While there are many available fit indices [167, 168], we select the following indices referencing this paper [168] for the good fit indicators:

Table 10. List of Selected Fit Indices

Index	Description	Good Fit Indicator
CMIN (Model Chi-Square value) / DF	Normed Model Chi-Square value (i.e. CMIN divided by Degree of Freedom).	$1 \leq \text{CMIN/DF} \leq 2$ Lower than 1 indicates overfitting, higher than 2 indicates underfitting
CFI (Comparative Fit Index)	A revised form of NFI (Normed-Fit Index). Not very sensitive to sample size. Compares the fit of a target model to the fit of an independent, or null, model.	$\text{CFI} \geq 0.95$
TLI (Tucker-Lewis coefficient)	Also known as the Bentler-Bonett Non-Normed Fit Index (NNFI). Indicates that model being evaluated has a discrepancy that is way between the (terribly fitting) independence model and the (perfectly fitting) saturated model. Preferable for smaller samples.	$\text{TLI} \geq 0.95$

The fit indices above are chosen due to their popularity among researchers to report model fitness. We prefer indices that are either insensitive or optimized for smaller sample size, due

to our relatively small sample size available. The following model fit values are reported by the computation results:

Table 11. Fit Indices of HGEQ Core Module

Index	Value
CMIN/DF	1.791
CFI	0.672
TLI	0.640

Table 12. Fit Indices of HGEQ Post-Game Module

Index	Value
CMIN/DF	1.112
CFI	0.970
TLI	0.964

The CFI and TLI value for the HGEQ Core module are less than 0.95, which does not fulfil the good fit indicator.

Therefore, although the Post-Game module achieves good fit, we cannot sufficiently make the same claim for the Core module. However, this may be caused by the relatively small sample size (compared to the number of constructs), based on the fact that indices not sensitive to sample size reported good to adequate fit (CMIN/DF), while indices sensitive to sample size reported less than sufficient fit (CFI, TLI). This sample size constraint should be further investigated in future larger-scale studies.

6.3.4 Convergent Validity

Convergent validity is satisfied by analysing the bivariate correlations of constructs. Since the questionnaire results are reported in Likert scales, we use Spearman's Rho, the nonparametric version of the more common Pearson correlation coefficient as it is more suitable for ordinal/interval values. Spearman's Rho reports higher scores for non-linear correlations compared to Pearson correlation, which is a desirable trait in HGEQ as the linearity of correlations are not yet made known. Spearman's Rho formula is given in (2) below:

$$r_s = \frac{cov(rg_X, rg_Y)}{\sigma_{rg_X} \sigma_{rg_Y}} \quad \begin{array}{l} r_s = \text{Spearman's rank correlation coefficient} \\ cov(rg_X, rg_Y) = \text{covariance of rank variables} \\ \sigma_{rg_X} \sigma_{rg_Y} = \text{multiplied standard deviations of rank} \\ \text{variables} \end{array} \quad (2)$$

Responses for each question in every construct is averaged. With 51 participants, we obtain 51 sets of mean values; each set contains a mean value for every construct. The Spearman's rank correlation coefficient describes a pair of mean values. It is obtained by converting mean values into ranks before substituting them into the equation above.

In the following table, we present the correlations between all the constructs in the HGEQ Post-Game module.

Table 13. Bivariate Correlations of HGEQ Post-Game Module

	<i>mean_pe</i>	<i>mean_ne</i>	<i>mean_tire</i>	<i>mean_rtr</i>
<i>mean_pe</i>	1			
<i>mean_ne</i>	-0.148	1		
<i>mean_tire</i>	-.316*	.288*	1	
<i>mean_rtr</i>	0.168	-0.181	-.461**	1

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

There are moderately strong correlations between Positive Experience (*pe*) and Return to Reality (*rtr*). The weak correlation between Positive Experience and Negative Experience (*ne*) shows that the two constructs are not mutually exclusive (i.e. both can be experienced at the same time).

Constructs from the core module are explored in Table 14 below.

Table 14. Bivariate Correlations of HGEQ Core Module

	<i>mean_paff</i> ⁸	<i>mean_comp</i>	<i>mean_sii</i>	<i>mean_flow</i>	<i>mean_naff</i>	<i>mean_chal</i>	<i>mean_tens</i>	<i>mean_hv</i>	<i>mean_fam</i>	<i>mean_ihlp</i>
<i>mean_paff</i>	1									
<i>mean_comp</i>	.441**	1								
<i>mean_sii</i>	.490**	.253*	1							
<i>mean_flow</i>	.420**	.636**	.334**	1						
<i>mean_naff</i>	-0.162	-0.081	-0.212	-0.13	1					
<i>mean_chal</i>	-.506**	-.431**	-.263*	-.605**	0.111	1				
<i>mean_tens</i>	-.408**	-.359**	-.538**	-.488**	0.224	.461**	1			
<i>mean_hv</i>	0.171	0.101	.431**	0.164	-0.207	-.285*	-.258*	1		
<i>mean_fam</i>	.234*	-0.105	.397**	-0.025	-.277*	-0.152	-0.174	.333**	1	
<i>mean_ihlp</i>	0.157	.327**	0.144	.260*	-0.221	-0.105	-0.13	.241*	0.224	1

*, Correlation is significant at the 0.05 level (1-tailed).

**, Correlation is significant at the 0.01 level (1-tailed).

⁸ When calculating bivariate correlations, a mean score is calculated per construct per participant, yielding N=51 sets of 10-construct scores. Hence when presenting bivariate correlation results, the term “mean” is prefixed onto the construct names to indicate that it is computed using mean scores.

Some interesting observations can be drawn here:

- Health Values (*hv*) has positive correlation with Immersion (*sii*), Familiarity (*fam*), and Identification of Human-Like Properties (*ihlp*), while having negative correlation with Challenge (*chal*) and Tension (*tens*). This suggests that reducing Challenge / Tension and at the same time promoting Immersion, Familiarity, and Identification of Human-Like Properties (e.g. having a human to guide the elderly player) may help participants to perceive more Health Values from the game.
- Familiarity (*fam*) is positive correlated to immersion (*sii*), positive affect (*pa*) while negatively correlated to negative affect (*na*). This is anticipated as literature review suggests the positive affect of familiarity on the overall game experience [133] and lower perceived challenge / tension due to improved ability to play well [117].
- Identification of Human-Like Properties (*ihlp*) is positively correlated to competence (*comp*) and flow. This shows that our elderly participants have more confidence and engage better with the health game if they feel like they are being accompanied by a human during the gameplay.
- Positive Affect (*pa*) is positively correlated with Competence (*comp*), Immersion (*sii*), and Flow (*flow*). In fact, the four constructs are positively correlated with each other. This phenomenon is in line with the observation found in the original GEQ study [47, p. 32].
- Challenge (*chal*) and Tension (*tens*) are negatively correlated with Positive Affect, Competence, Immersion, and Flow.

Constructs from the post-game module and core module are explored in Table 15 below.

Table 15. Bivariate Correlations between Core and Post-Game Module Constructs

	<i>mean_pe</i>	<i>mean_ne</i>	<i>mean_tire</i>	<i>mean_rtr</i>
<i>mean_paff</i>	.415**	-.255*	-.505**	.379**
<i>mean_comp</i>	.422**	-.324*	-.130	.398**
<i>mean_sii</i>	.422**	-.096	-.412**	.498**
<i>mean_flow</i>	.387**	-.400**	-.253*	.512**
<i>mean_naff</i>	-.224	-.122	.362**	.057
<i>mean_chal</i>	-.313*	.336**	.390**	-.429**
<i>mean_tens</i>	-.366**	.243*	.376**	-.450**
<i>mean_hv</i>	.171	.043	-.263*	.415**
<i>mean_fam</i>	-.015	.214	-.230	.272*
<i>mean_ihlp</i>	.232	-.029	-.297*	.482**

**, Correlation is significant at the 0.01 level (1-tailed).

*, Correlation is significant at the 0.05 level (1-tailed).

Some interesting observations can be drawn here:

- Post-game Positive Experience is positively correlated with Positive Affect, Competence, Immersion and Flow, while being negatively correlated with Challenge, and Tension. Therefore, post-game Positive Experience scale is somewhat more correlated with the concept of game affects than what GEQ original studies suggested.
- Tiredness is negatively correlated with Positive Affect, Competence and Flow, while being positively correlated with Negative Affect, Challenge, and Tension. Interestingly, exactly same correlations with opposite polarity are displayed by the Return to Reality scale (with the exception of Negative Affect).
- Health Values, Familiarity and Identification of Human-Like Properties has prominent positive correlation with Return to Reality and slight negative correlation with tiredness.

Overall, the bivariate correlations show results which are mostly consistent with the original GEQ study [47, p. 32] and has support from theories pertaining the new constructs (Health Values, Familiarity, and Identification of Human-Like Properties).

6.3.5 Discriminant Validity

Discriminant validity can be established by comparing the squared correlation (r^2) of each pair of constructs with the Average Variance Extracted (AVE) of both constructs. AVE is a measure of the amount of variance that is captured by a construct in relation to the amount of variance due to measurement error. It can be calculated by averaging the squared factor loadings of each variable in a construct, as shown in (3).

$$AVE = \frac{\sum_{i=1}^n \lambda_i^2}{n} \quad \begin{array}{l} \lambda_i = \text{factor loading of } i^{\text{th}} \text{ item in this construct} \\ n = \text{number of items in the construct} \end{array} \quad (3)$$

r^2 refers to the squared Pearson's correlation coefficient. The formula is presented in (4) below.

$$r = \frac{cov(X, Y)}{\sigma_X \sigma_Y} \quad \begin{array}{l} r = \text{Pearson's correlation coefficient} \\ cov(X, Y) = \text{covariance of variables} \\ \sigma_X \sigma_Y = \text{multiplied standard deviations of variables} \end{array} \quad (4)$$

For every pair of constructs, AVE of both constructs should be higher than the r^2 of the pair.

This is known as the Fornell-Larcker testing system [162].

Below we present two tables on the HGEQ Core module. Table 16 shows the Average Variance Extracted (AVE) for each construct. Table 17 shows estimates of squared correlation (r^2) between each possible construct.

Table 16. AVE of HGEQ Core Module

Construct	AVE
Competence	.607
Sensory and Imaginative Immersion	.603
Flow	.599
Tension/Annoyance	.478
Challenge	.659
Negative Affect	.605
Positive Affect	.683
Health Values	.852
Identification of Human-Like Properties	.654
Familiarity	.620

Table 17. Squared Correlations between Different Constructs of HGEQ Core Module

Construct 1	Construct 2	Estimated r^2
Familiarity	⇔ Identification of Human-Like Properties	.103
Familiarity	⇔ Health Values	.076
Familiarity	⇔ Positive Affect	.065
Familiarity	⇔ Negative Affect	.063
Familiarity	⇔ Challenge	.035
Familiarity	⇔ Tension/Annoyance	.047
Familiarity	⇔ Flow	.001
Familiarity	⇔ Sensory and Imaginative Immersion	.181
Familiarity	⇔ Competence	.000
Health Values	⇔ Positive Affect	.084
Health Values	⇔ Identification of Human-Like Properties	.091
Health Values	⇔ Competence	.013
Health Values	⇔ Sensory and Imaginative Immersion	.208

Construct 1	Construct 2	Estimated r^2
Health Values	⇔ Flow	.069
Health Values	⇔ Tension/Annoyance	.100
Health Values	⇔ Challenge	.101
Health Values	⇔ Negative Affect	.032
Identification of Human-Like Properties	⇔ Competence	.104
Identification of Human-Like Properties	⇔ Sensory and Imaginative Immersion	.054
Identification of Human-Like Properties	⇔ Flow	.096
Identification of Human-Like Properties	⇔ Tension/Annoyance	.016
Identification of Human-Like Properties	⇔ Challenge	.033
Identification of Human-Like Properties	⇔ Negative Affect	.094
Identification of Human-Like Properties	⇔ Positive Affect	.040
Competence	⇔ Sensory and Imaginative Immersion	.181
Competence	⇔ Flow	.498
Competence	⇔ Tension/Annoyance	.170
Competence	⇔ Challenge	.317
Competence	⇔ Negative Affect	.028
Competence	⇔ Positive Affect	.262
Sensory and Imaginative Immersion	⇔ Flow	.281
Sensory and Imaginative Immersion	⇔ Tension/Annoyance	.403
Sensory and Imaginative Immersion	⇔ Challenge	.269
Sensory and Imaginative Immersion	⇔ Negative Affect	.057
Sensory and Imaginative Immersion	⇔ Positive Affect	.391
Flow	⇔ Tension/Annoyance	.314
Flow	⇔ Challenge	.501
Flow	⇔ Negative Affect	.036
Flow	⇔ Positive Affect	.432
Tension/Annoyance	⇔ Challenge	.303
Tension/Annoyance	⇔ Negative Affect	.054

Construct 1	Construct 2	Estimated r^2
Tension/Annoyance	⇔ Positive Affect	.306
Challenge	⇔ Negative Affect	.036
Challenge	⇔ Positive Affect	.426
Negative Affect	⇔ Positive Affect	.030

Similar to the Core module above, Table 18 and

Table 19 below show the AVE and r^2 respectively, this time for the HGEQ Post-Game module.

Table 18. AVE of HGEQ Post-Game Module

Construct	AVE
Positive Experience	.579
Negative Experience	.542
Tiredness	.656
Return to Reality	.735

Table 19. Squared Correlations between Different Constructs of HGEQ Core Module

Construct 1	Construct 2	Estimated r^2
Positive Experience	⇔ Negative Experience	.051
Positive Experience	⇔ Tiredness	.177
Positive Experience	⇔ Return to Reality	.096
Negative Experience	⇔ Tiredness	.168
Negative Experience	⇔ Return to Reality	.045
Tiredness	⇔ Return to Reality	.382

For both Core and Post-Game modules, the individual AVEs are all higher than the r^2 between the pair, which provides excellent evidence for discriminant validity.

6.3.6 Sensitivity

Several correlations demonstrate the HGEQ's sensitivity to various different player demographics. They show that the newly added elderly-related and health-related constructs respond well to reflect the positive (or negative) health game experiences among the elderly, which indicates HGEQ's relevance to the type of experience it is supposed to measure.

For this section, Spearman's Rho (same as 6.3.4 above) is calculated based on different participant groupings: health condition and age, and interesting correlations are highlighted below.

H1: Familiarity Has Higher Correlation Magnitude to Positive Affect and Negative Affect among Older Participants

Participants are split into two groups: less than 65 years old, and 65 years old & above. We then compare the correlations between Familiarity, Positive Affect, and Negative Affect.

Table 20. Correlations Between Familiarity, Positive Affect, and Negative Affect among Different Age Groups

Age			<i>mean_paff</i>	<i>mean_naff</i>
≥ 65 (N=23)	<i>mean_fam</i>	Correlation Coefficient	.378*	-.353*
		Sig. (1-tailed)	.038	.049
< 65 (N=28)	<i>mean_fam</i>	Correlation Coefficient	.085	-.230
		Sig. (1-tailed)	.334	.119

*. Correlation is significant at the 0.05 level (1-tailed).

**. Correlation is significant at the 0.01 level (1-tailed).

The correlation table shows that among the older group (age ≥ 65), Familiarity indeed has stronger positive correlation to Positive Affect (older group: 0.378 vs younger group: 0.085) and stronger negative correlation to Negative affect (older group: -0.353 vs younger group: -0.230). Both comparisons are statistically significant, which supports our H1.

H2: Identification of Human-Like Properties Has Higher Correlation Magnitude to Positive Affect among Older Participants

We split the participants by age, similar to the section above. We then compare the correlations between Identification of Human-Like Properties and Positive Affect.

Table 21. Correlations Between Identification of Human-Like Properties and Positive Affect among Different Age Groups

Age			<i>mean_paff</i>
≥ 65 (N=23)	<i>mean_ihlp</i>	Correlation Coefficient	.589**
		Sig. (1-tailed)	.002
< 65 (N=28)	<i>mean_ihlp</i>	Correlation Coefficient	-.059
		Sig. (1-tailed)	.383

**. Correlation is significant at the 0.01 level (1-tailed).

The correlation table shows that among the older group (age ≥ 65), Identification of Human-Like Properties has stronger positive correlation to Positive Affect (0.589 vs -0.059) in the older group than the younger group. The correlation is statistically significant, which supports our H2.

H3: Health Values Have Higher Correlation Magnitude to Post-Game Positive Experience among Participants with Pre-Existing Health Conditions

We split the participants into two groups: healthy, and with pre-existing conditions. We then compare the correlations between Health Values and post-game Positive Experience.

Table 22. Correlations between Health Values and Post-Game Positive Experience among Different Health Groups

Health Condition			<i>mean_pe</i>
Has Pre-Existing Conditions (N=25)	<i>mean_hv</i>	Correlation Coefficient	.306
		Sig. (1-tailed)	.068
Healthy (N=26)	<i>mean_hv</i>	Correlation Coefficient	.000
		Sig. (1-tailed)	.499

**. Correlation is significant at the 0.01 level (1-tailed).

The correlation table shows that among the group with pre-existing health conditions, Health Values has stronger positive correlation to post-game Positive Experience (0.306 vs 0.000) when compared to the healthy group. This supports that Health Values has greater effect on game experiences among participants with pre-existing health conditions.

Hence, the 3 proposed constructs are demonstrated to produce more prominent correlation to positive game experiences among certain demographics (grouped by age / health condition). These results agree with literature on the “serious game experience” [34, 73] and the “elderly experience” that prefers familiarity [117] and human interactions [118].

6.4 Findings from Open-Ended Questions

At the end of HGEQ, we prompted participants to share with us what they might have encountered in their gameplay:

- Do you enjoy the game session? What did you encounter that made you say so?

Only a little more than half of the participants filled in this question. However, it does provide us with hints on why some of them experience frustration when playing games. The comments featured some participants describing the feeling of “helpless” and “frustrated” when they are not able to figure out what the game requires from them. Despite the menus and hints, one of

them could not even find the start button and had to “trouble” the researcher to help them, which made them feel inferior.

For some of the elderlies who eventually figured out what to do, they expressed boredom when repeating the same movement during the water wheel minigame. One of the elderlies articulated that they had little idea on why they should play the game this way. Apparently, they are not used to the concept of being in a “game world”. To them, the game tasks felt like a chore rather than a relatable, enjoyable activity.

6.5 Summary

We conducted a quantitative study to fulfil the criteria of *reliability*, *validity*, and *sensitivity* on our proposed Health Game Experience Questionnaire (HGEQ). The HGEQ derived from [164] has 46 questions for its core module, while its post-game module remains unchanged at 17 questions. A study on 51 participants was conducted to obtain real data to validate our questionnaire model. Although the model fit cannot be confidently established due to small sample size, Confirmatory Factor Analysis (CFA) results provide sufficient evidence to our model’s internal consistency reliability, predictive validity, convergent validity, and discriminant validity.

Some hypotheses proposed in this study are also proven through statistical tests, providing additional support for validity as well as sensitivity of the questionnaire model:

- Familiarity has higher impact on Positive Affect in older participants than younger participants.
- Identification of Human-Like Properties has higher impact on Positive Affect in older participants than younger participants.
- Health Values has higher impact on post-game Positive Experience in participants with pre-existing conditions than healthy participants.

Overall, we have enough evidence to claim that HGEQ is a sufficiently capable measurement tool to assess health game experience. HGEQ with its Health Values, Familiarity, and Identification of Human-Like Properties constructs provide a better view on health game experience than GEQ alone. Larger-scale studies on HGEQ can be performed to further back the results of this study, especially on the model fit assessment. Once these issues are remedied, we strongly believe that HGEQ can be used as a standard method for health game experience assessment.

The findings from open-ended questions become useful in the following chapter where we try to pinpoint the problem that stops the elderly from enjoying a positive health game experience.

7. Review of Approaches and Theories for the Coaching Model

7.1 Introduction

From study 1, we observed that elderlies with no prior exposure to digital games encountered difficulties when they play our Pumpkin Garden health game. Despite the researchers providing guidance and pointers when asked, elderlies without prior experience with games often did not know what questions to ask in the first place. Although the Pumpkin Garden game has been designed with HCI tailored for the elderly [87], it appears that it is not enough to equip elderly players without prior exposure to digital games with the basic knowledge they need to enjoy the game.

HCI design for the elderly typically focuses on usability aspects for elderlies who are not as capable in using digital technology products. They often feature techniques like “bigger text”, “simpler interfaces” or “familiar environments”. This solves usability issues of health games to some extent; a game with these considerations in mind does have higher probability of helping the elderly understand what tasks are needed to be done in order to complete the game.

The more interesting part is when despite being able to carry out game tasks successfully, they did not know what the task leads to, nor the meaning of performing those tasks. For the elderly, there appears to be a lack of ability to make meaning out of games, hence they are unable to justify gaming as an enjoyable ability. In other words, the lack of game literacy.

7.1.1 Game Literacy as an Approach to Improving Game Experience

The elderlies are often described using the term “digital immigrants” in contrast with the “digital natives” who grew up with technology. Children born in mid-1990s already had access to powerful computing devices while an even younger generation (born around 2010) grew up with the internet which is mature [169]. The same immigrants / natives concept is applicable

to video games as well. While youngsters felt comfortable around video games, elderlies had trouble comprehending what are the gadgets about. In the elderlies' perspective, entertainment is more of like card games, board games and bingo. While those traditional games got their own digitized version, the advent of technology enabled game developers to innovate at an unprecedented speed. In a digital world, elderlies found themselves to be "immigrants", having to get accustomed in order to have any chance to join the "video-game literacy club" with their family members [170].

Possessing game literacy is more than just being able to understand games, it refers to "*the development of the expertise in designing rewarding experiences for oneself within a game world*" [171, p. 643]. The positive effect of good game literacy is not yet extensively studied, given that video games are only popular in the recent decades. Despite that, the rich experiences that games provide to the player is undeniable, exemplified by the growing commercial games industry. Bourgonjon [172] suggested that video games are an important site for meaning making and should not be analysed as traditional texts or media. Thus, video game literacy is unique in its own right, describing the general population's ability to read, interpret and derive satisfying meaning from playing video games. Game literacy points our attention towards its consumers as well by asking if our target audience is really able to enjoy games in their own ways. Although much research emphasis is still placed on health game design for the elderly, if we approach the problem from the elderly players' perspective, perhaps the solution can lie in instilling game literacy among the elderly; an approach that is easy to miss when everyone else focuses on designing the game itself.

Much room for exploration remains for game literacy to help enhance the elderly's appreciation towards games. With improved ability to relate to games, the elderly can then enjoy positive health game experiences which motivates them to play more or perform better in health games.

7.1.2 Coaching to Improve Game Literacy and Game Experience

We believe that coaching is a viable practice to help us improve the game literacy, and thus game experience among the elderly.

Elderly's Low Game Literacy and its Effects on their Gaming Experience

Among the many reasons that causes unpleasant experiences for the elderly when using health games, one recurring problem found in literature is the low game literacy that is present among the elderly. The main cause for low game literacy is the existence of the digital barrier. Several studies attributed difficulty, confusion, and consequently frustration in learning to use technology as the reason the elderly refrain from participating in technology-related activities [84, 85]. Elderlies often find themselves 'lost' whenever the digital application they are using shows an error, which is why error avoidance is an important usability aspect [84]. The feeling of helplessness or being overwhelmed as the result of these errors leads to frustration during learning process. The unpleasant learning process, being part of their experience, culminates into a negative health game experience.

In light of an emerging group of players with reduced abilities, Bayrak proposed *"there is a need for a design paradigm that draws attention to the abilities and limitations of the players"* [173]. According to his perspective that encourages compassionate design, health games which could not accommodate the abilities or restrictions of the elderly players needs to be re-evaluated. When player is not able to fulfil the moment-to-moment gameplay requirements, they lose interest in the game and find the experience to be unenjoyable. By bringing the "player model" into the "game perspective", health game designers can then truly achieve player-centric design.

Coming from a similarly compassionate approach, we propose that the elderly's game experiences can be elevated with some external help. In prior research, the elderly perceives

guidance as a very important factor when using digital applications [84, 174]. A usability study of mobile games for the elderly found that 73% respondents ranked the availability of a guide as important (with 50% of respondents ranking it as very important), and complained when there is a lack of it [174]. In a focus group discussion [175], elderlies voiced their apprehension on the lack of support and clarity when interacting with tablet computers which they found to be too complex, despite their willingness to learn. In summary, having a well-designed guide greatly improves the elderly's learning experience [84].

The positive impact of an effective guide to the elderly's daily activities has been proven in various other domains. For example, a majority of the elderly displayed inadequate inhaler use technique due to lack of proper guide, and the guide design technique outlined in the study had led to significant improvement in the elderly's inhaler use technique [176]. Another study on development of physical exercise virtual supervisor for the elderly using monitoring, feedback, and motivational elements, had received appreciation by participants, who were amazed by the encouragements given by the system [177]. As such, there is a need to properly guide and encourage the elderly to participate in behaviours that are beneficial to them, especially technology-related activities such as health games given their natural decline in cognitive abilities and attention levels.

Despite recommendations in literature to develop guide for the elderly to learn to play serious health games [178, 179, 180], there is lack of research on its implementation, especially outside the realm of game tutorial design. Researchers tend to resort to User Interface (UI) design solutions when designing a guide [181, 182] to alleviate the learning issues faced by the elderly. However, a more holistic view can be taken as a better (or at least complementary) approach to current UI-only approaches. We propose coaching to be the solution that can provide a systematic way to guide the elderly so that they enjoy a positive health game experience.

Coaching Practice's State-of-the-Art

Coaching is a promising approach to facilitate elderlies' interaction with digital health applications, as preliminary findings have concluded [183]. The term “coaching” can be understood as a means to effective learning and defined as a “*pro-active synthesis of centuries of acquired multi-disciplinary understanding with learning at its centre* [184, p. 57]”. According to Palmer et. al [185], effective coaching allows the individual to rapidly learn or develop a new skill, and a coach's role is to facilitate a smooth, enjoyable learning journey that produces positive learning outcomes.

Coaching is often practiced in different fields with the broad goal of “helping individuals achieve their goals”. A coach typically imparts relevant knowledge and encouragement to the individual in the goal achievement process. The concept of coaching sessions is common where the coachee speaks to or conducts a certain activity together with the coach. The conversation aims to drive the coachee towards action or at least motivate the coachee to perform activities that they would not otherwise decide to. While a coach seems to possess the responsibilities close to a teacher, they put heavier focus on unlocking an individual's potential, i.e. motivating coachees do it themselves rather than teaching them.

Coaching Models

Coaching as a practice tends to be case-specific with little generalizability. Despite so, several coaching models have been proposed to attempt to identify common practices that produce positive coaching outcomes. A coaching model provides a set of methods or processes that move the coachee from where they currently are to where they want to be. One of the most popular models is the GROW model, where the GROW acronym stands for Goal setting, Reality check, Options and Way forward [186]. According to the Handbook of Coaching Psychology [187, p. 10], coaching psychologists employ more than 28 different coaching

models, each of which are typically rooted in psychology theories. The various coaching models typically involve one-to-one sessions between the coach and coachee and acknowledges that ultimately the real-world practices are still up to providing personalized aid to the coachee in order to realize their goals.

Olsen [188] placed a broader understanding towards the act of coaching by describing the concept as a focused, goal-oriented process filled with both recurring and evolving methods of progression. We found this practice of coaching to be applicable in health games' context. The systematic, goal-oriented approach of coaching an elderly through an unfamiliar digital realm has potential to yield a fruitful learning experience for them. Seeing the EHGE as a learning journey helps us visualize a coaching model for a positive learning experience. The ideal implementation of the coaching model would take shape in the form of a personalized, goal-oriented coach which issues help upon facing errors, provides continuous feedback, and impart a constant stream of motivation and encouragement to the elderly player as they play a health game.

Research provides support in applying coaching practices to provide better game experience for the elderly. A phenomenological study revealed that elderlies are interested to learn about digital technology if they are provided with one-to-one learning sessions [38]. With the premises above, we are confident that there is potential for coaching practices to produce better health game experiences for the elderly. However, it is necessary to have a framework to prepare gameplay sessions that are experientially rewarding.

In the following chapters, we develop a coaching model to enhance the coaching process of the elderly playing health games, which will be a great improvement over the passive question-and-answer approach back in study 1 (section 6.2.3 above). We first review the concepts that we have selected as part of the mechanisms of our Goal-Oriented Storytelling coaching model.

7.2 Storytelling

Storytelling is a robust tool used for communication; it builds on top of human languages to convey ideas in a more engaging manner. That is why storytelling plays a crucial role in the modern world, where it is put into practical use into various fields of professions to enhance their capabilities. Its strength lies in its ability to bring messages, statistics and facts across to other people. Stories have a huge impact on human behaviour as indicated by several social studies. According to an article published in the *Journal of Business Strategy*, storytelling easily answers the audiences' question "what's in for me" by reframing arguments into a format which is easier to grasp [189]. Effects of storytelling on humans has also been studied medically, such as the finding that stories can stimulate our brain to release hormones to motivate people to engage in cooperative behaviours [190]. Both social and medical angles agree in different ways that storytelling is a major driver for human behaviour. Thus, over the years, many researchers have taken interest in theorizing what are the components of effective storytelling, and what makes a story effective.

For this thesis, we are interested in the practical side of storytelling: how storytelling has been applied in the fields of healthcare and education, and how it is used as a tool to generate positive experience to engage and persuade subjects in respective fields.

7.2.1 Practical Applications of Storytelling

Storytelling is relatively well-established in the education domain; it serves a broad array of purposes. Many researchers have dived deep into various fields like classroom education, workplace coaching, leadership training etc., personifying thoughts and reinforcing group identity [191].

The influential potential for storytelling has been extensively documented when applied in nursing education. It is found to be a good strategy to develop one's assessment skills, which

is important for healthcare workers. Success is achieved by having medical students recall facts through told stories instead of formal presentations. One notable achievement is when dealing with patients, nurses learned to listen to stories in a non-judgmental, contextual manner and subsequently were able to negotiate with their patients to gain their cooperation [192]. The second example of storytelling's practical application more closely resembles the use case of a serious game. Student nurses who have just transitioned into qualified nurses coped and adjusted to the real-world professional challenges, through the development of digital story driven learning environments. The application enabled them to engage with storytellers to reflect actively on their setbacks and come up with solutions to overcome the situation [193]. The stories served well in passing down valuable experiences and coping strategies. Specific applications aside, storytelling is also widely beneficial in the healthcare sector as explained by an article which highlights the role of storytelling in fields like clinical counselling, medical training and several different use cases like mass messaging, teaching and information gathering [194]. According to the article, humans make sense of their experiences and communicate them to others through formulating, verbalizing or writing down their experiences in the form of a narrative.

These promising findings and applications highlighted to us the effectiveness of storytelling when used in real-life applications. Although literature has highlighted storytelling's effectiveness in engaging with the player when applied in-game [195, 196], much has yet to be explored when applying storytelling to the real-life aspects of a gameplay session. The storytelling methodology remains promising as a solution to improve the EHGE.

7.2.2 Storytelling, Positive Experience, and Behaviour Change

When we zoom in on a more specific use case, the use of storytelling in behaviour change interventions appears to be effective in persuading subjects, at the same time enhancing their capacity to adopt and sustain new healthy behaviours. In an article that described how

storytelling may be used to encourage hand hygiene [197], the author pointed out that instead of evidence and logic, one should also consider the emotions and values in maintaining good hand hygiene to control infections. Storytelling excels in the latter approach of convincing people, provided it captures the holistic and live experience of the subject being taught according to the author. The article [197] also provided a detailed story of the thoughts by several different healthcare workers and how successful they were in encouraging others to keep their hands clean. A scoping review conducted to describe how storytelling serves as an intervention to help people with chronic illness manage themselves [198] has concluded that *“storytelling has the potential to provide patients with a more active role in their health care by identifying their specific needs as well as gaps in knowledge and skills, while allowing them to form strong bonds with peers who share similar disease-related experiences”*.

The behaviour change as a result of storytelling methods can be attributed to the positive experience that storytelling method generates. Researches have shown that *“one very positive experience (from reading a story) can create a reader”*, such a storybook is termed as the *home run book* [199]. This is especially true for entertainment media, since individual consumes entertainment for the reason of seeking hedonic benefits through experiencing excitement and stimulation [200].

Since a good story has potential to motivate listeners to change their behaviour for the better, we would like to understand more on how the motivating stories can be constructed. One of the key constituents of a narrative is the narrative structure, or the structural order and manner of story elements in which a narrative is presented. Structuralist literary theorists including Roland Barthes, Vladimir Propp, Joseph Campbell, and Northrop Frye attempted to argue that all human narratives have certain universal, deep structural elements in common. Experiments on narrative structure showed that structure indeed had effect on readers' story comprehension and recall, and readers made similar judgments about stories of the same structural type even

though the stories varied widely in content, supporting the position that people have in-built knowledge about the structure of stories which they use during processing [201, 202]. These generalizable aspects of stories are reviewed below.

7.2.3 Various Narrative Theories

In this chapter, we will analyse narrative elements via several storytelling techniques that has, through the ages, been compiled into theories by philosophers, practitioners and researchers. Analysing various narrative theories will provide us with a better understanding of what makes a story effective, how effective stories are structured, and what an effective story can achieve.

7.2.3.1 Freytag's Pyramid

One interesting theory that focuses on narrative techniques is Freytag's pyramid [203] proposed in 1863. Freytag has outlined a storytelling technique that consists of 5 parts and 3 moments. The 5-part story arc consists of exposition, rising action, climax, falling action and catastrophe, which outlines a typical story arc for a tragedy. The 3 moments correspond to the exciting force, the tragic force, and the force of final suspense, which refer mainly to the transitions between the 5 parts. People from other professions such as screenplay writers have different opinions on how many acts are required for a story, such as Syd Field's proposed 3-act story structure [204]. Nevertheless, the idea of acts and moments still holds.

Figure 27. Freytag's Pyramid of Narrative Technique

A notable research illustrated how the 5 acts and 3 moments of Freytag's pyramid map onto a story in the video game *Halo: Combat Evolved* [205]. Exposition of the story background is the first event presented to the player in the form of a sandbox tutorial. For now, players exhibit apathy towards the narrative until they can be engaged with a rising action. In this second act, the game ramps up the challenges and maintains a healthy level of stress to keep the players engaged. The third act shows the story's tension at its climax, typically with plot twists and surprises for the player, who is now drawn into a state of flow and eager to see more of the story unveil. Act four states the start of the decline of the narrative intensity, and manifests as a challenging "boss fight" or "final challenge". The fifth act draws a conclusion in the form of a final cutscene.

The fusion of narrative and ludic components, as well as the resulting game experience produced still requires further study. However, we can agree with one of the study's recommendation. Namely, the need to push players out of their initial comfort zones to get them more engaged within a shorter period of time. This will help us design our gameplay session and coaching process in a more engaging manner.

7.2.3.2 The Hero's Journey

Another famous story arc framework is proposed by Joseph Campbell titled "The Hero's Journey" [206]. The hero's journey dives into a level deeper than mere "acts" when describing the story arc of a good narrative. The framework proposes two contrasting worlds that the story takes place in, namely an "ordinary world" and a "special world". The hero starts on the ordinary world, and as he is confronted with a call to adventure, spirals deeper into the "special world" until he confronts an "ordeal", which then sees the hero's growth via a form of "reward". The hero eventually makes use of his new powers and motivations to make his way back into the "ordinary world", which ends in the hero's changed perspective towards life and the surrounding community.

Figure 28. The Hero's Journey

On the other hand, Vladimir Propp's 31 functions propose to break down narratives at an even more granular level by naming each unit of story element as a "function" or "narrateme". It bears heavy resemblance with The Hero's Journey, outlining a similar story arc for the main character starting out in a familiar hometown, received a call to embark on an adventure, confront major challenges, and return to hometown [207]. Popular fictions have been constructed with similar arcs like Harry Potter and The Lord of the Rings [208], which can be mapped to both Hero's Journey and 31 Functions. We shall focus on Propp's 31 Functions in this thesis, for its more modular structure.

7.2.3.3 Propp's Narrative Theory

Two distinct branches of analyses exist in folklore [209]. First is the *paradigmatic analysis* which seeks to describe the pattern which underlies folkloristic text. Paradigms were prioritized over structure, speculative deductions were drawn more liberally, and structures that seem linearly ordered are often thought of as "superficial". In contrast, the *syntagmatic method of analysis* exemplified in Propp's theory advocates generalizing a linear sequence of chronological events that can be used to depict other similar stories. Propp's *syntagmatic*

approach of analysing stories are deemed to be more useful in our context of designing a narrative-based coaching methodology for health games.

Vladimir Propp was a Russian structuralist who, through the study of Russian folk tales, established the concept of an atomic unit of character types and events. After analysing 100 tales, he generalized the types of events into 31 irreducible functions and types of characters into 7 main archetypes. Since the appearance of English translation of Vladimir Propp's *Morphology of the Folktale*, there has been a growing interest in attempts to perform structural analyses on various folklore genres [210]. From his studies, Propp has observed and established the prevalence of story events (in the form of 31 functions) and character types (in the form of 7-character archetypes). By breaking down a massive number of Russian traditional stories into their smallest narrative units, Propp was able to derive a typology of narrative structure and further summarise them into 31 irreducible functions. Propp's theory is popular and well-received for his two key findings: all the fictional parts have basically the same structure underneath; and that a story can be generated through a sequence of abstract plot elements.

Core Concepts: 7 Character Archetypes

Based on his analysis of 100 fairy tales, Propp identified the distinct attributes of every character type, which can be grouped into seven categories.

1. First and foremost is the legendary *Hero*; a figure of great strength and courage. The Hero is the major character with whom the reader will normally associate most strongly with. The Hero is the key figure that the story unfolds around.
2. The *Helper* is the second type of character whose function is to aid the hero. They often appear as a wise old man or magician at critical moments to provide support to the hero. The hero is typically contrasted with the helper's weaknesses to highlight defining characteristics of the hero such as intelligence, determination and courage.

3. The *Villain* is the third type of character, which is the sharpest contrast against the hero. The villain typically possesses negative moral values that directly opposes the hero. The Villain may seek to prevent the Hero from achieving the goal by chasing after the same artefact sought by the Hero.
4. The fourth type of character is the *False Hero* who claims to be the real hero. Such character potentially complicates the plot to appear and act heroically; they may even be mistaken initially for the real hero. They are driven to pose as the hero, steal credit, get close to the princess and resembles a villain “in hiding” whom the hero must too defeat or circumvent.
5. The fifth character archetype is the Donor who offers gifts with magical properties. The Donor is a person who gives the Hero something special, such as a magical weapon or some particular wisdom. They can appear as fairy-mothers or gatekeepers. A Donor can sometimes be considered as a Helper too.
6. The sixth type of character functions as the Dispatcher. The Dispatcher’s early role in the story is to send the Hero on the mission. The Dispatcher may manifest as a family member of the Hero. It can also be the Princess's Father, who gives the Hero a set of quests to be completed before he gains the hand of the Princess. The person who functions as a Dispatcher may also subsequently appear as another role, for example the False Hero who then trails along behind.
7. The seventh character is the Princess. She may be hero’s reward, such that after completing some mission, the Hero gains Princess’s affections or hand in marriage. The Princess may also be the object that is deliberately sought by the Hero, perhaps finding where the Villain has taken her. The Princess may not be seen frequently in the story; rather appearing at the end where the Hero may win the Princess’s heart through his acts of courage.

In summary, Propp's theory categorises different characters that commonly appear in folklore into 7 character archetypes [210].

Core Concepts: 31 Functions

Propp's theory also proposed 31 atomic plot elements that forms the basis of fairy tales, also known as "functions". Propp explicitly states that stories' compositions are limited to a subset of the 31 functions. Each function appears in a fixed sequence, and the sequence of the functions is strictly uniform. In other words, the absence of some functions does not change the order of the rest. Propp's 31 functions [211] provide an excellent methodology to write and generate interesting folkloristic text.

Each function is given a conventional symbol and an abbreviated definition in one word which summarizes its essence. A tale usually begins with an initial situation that is given the symbol α , which is not considered part of the 31 functions. After the initial situation is depicted, the tale's plot progresses along a subset of the 31 functions. The actions of a whole tale develop within the 31 functions, progressing from one to another with logical and artistic necessity. No single function is mutually exclusive with another.

Listed below is the name of each function, its assigned symbol and its brief summary.

1. Absentation (β) refers one of the family members absenting himself from home. The member can be either be an adult, such as parents leaving for work; or a younger member who goes out to play. The hero is normally introduced here.
2. An Interdiction (γ) is introduced to the hero after the absentation, where the hero will be stopped from doing something. For example, when a young hero leaves his house for fishing, his mother stops him by saying: "You are still little". Interdiction can be also presented in an "inverted" manner in the form of an order or a suggestion, such as "bring your brother out with you".

3. Violation (δ) corresponds to the forms of interdiction that is violated. At this stage, the villain enters the tale. The Villain's role is to disturb the peace of a happy family by causing some forms of misfortune, harm or damage.
4. Reconnaissance (ϵ) is done by the villain who makes an attempt to find out the information, such as a location of people or precious objects. It also can be the case that the victim questions the villain in an inverted form of reconnaissance.
5. Delivery (ζ) occurs when the villain gains information about his victim. For instance, a mother calls her son home for dinner in a very loud voice and unwittingly reveals their presence to an evil witch.
6. Trickery (η) means that the villain attempts to persuade and deceive his victim in order to take possession of him or his belongings, such as pretending to be a beggar seeking alms.
7. Complicity (θ) is a special form of trickery, as this time the victim falls into the deception and thereby unwittingly helps his enemy. This poses an interesting contrast with Violation; where the hero once went against a benevolent advice, he now submits to malicious pleas. The Villain typically obtain the hero's complicity when he is caught up in hardship (e.g. extreme poverty). Sometimes, the difficult situation is intentionally caused by the villain.
8. Villainy (A) marks the heart and purpose of a tale. The villain introduces hardship to the family or a member via the means of abduction, plunder, causing disappearance or an affliction of misfortune. Alternatively, a member lacks something or desires something. The earlier functions of interdiction, delivery and complicity pave way for this function.
9. Mediation (B) brings the hero into the tale when the misfortune or lack is made known. A call for help is provided, resulting in the dispatch of the hero. The dispatchment is

presented either in the form of a request or a command which may sound promising or threatening.

10. Counteraction (C) is often characterized in following words “Permit us to go in search of your princess’. The hero decides / agrees to take positive action.
11. In Departure (↑), the hero leaves home to search his goal. Moments of preparation and bidding family members goodbye may be detailed here.
12. In the Testing (D) stage, the Donor prepares a test for the hero, which results in the Hero receiving either a magical agent or a Helper. It can take shape as a “combat training” conducted by an ally instead of the Villain. In this case, the Donor bestows mercy upon the hero should he fail the test. At the end, the hero is offered a magical agent which he decides to accept or decline.
13. The hero’s Reaction (E) is either an affirmation or negation towards the actions of the future donor. There are 10 kinds of reaction: withstands a test; answers a greeting; renders a service to a dead person; frees a captive; shows mercy to a suppliant; completes an appointment; performs some other service; saves himself from an attempt on his life; vanquishes his adversary or agrees to an exchange.
14. The hero’s Acquisition (F) of magical agents take place after interacting with the donor. The magical agent can take shape as animals, objects or new abilities.
15. Guidance (G) is given to hero on the whereabouts of an object of search. Generally, it is located in another faraway kingdom. The journey can take shape in a multitude of themes, be it flying through the air, traveling on the ground, following bloody tracks or climbing a stairway.
16. Struggle (H) is similar to the Donor sequence, with the donor being replaced with a hostile character. Here, the hero and the villain join in direct combat.

17. Branding (J) is applied to body when the hero received a wound during the battle. Hence, the hero is branded.
18. Victory (I) can be encountered in both positive and negative forms. Positive Victory sees the villain's defeat (beaten in open combat / defected in a contest) and banishment. On the other hand, an example of a Negative Victory is when two or more heroes battle the villain and only one emerge alive.
19. The story sees a Resolution (K), which can be paired up with Villainy (A). The narrative reaches its climax in this function. A classic example is the breaking of a curse.
20. The hero returns (↓). It is accomplished through similar forms as an arrival, with the hero setting home this time.
21. Pursuit of the hero occurs (Pr). The pursuer tries to kill, eat, or undermine the hero. Pursuit is a common theme when presenting the hero's past during his travel; it reminds readers that the hero was once vulnerable too.
22. The hero is Rescued (Rs) from pursuit. The hero always arrives home at the end of the rescue.
23. Unrecognized arrival (o) can be classified into two types: 1) arrival at home to serve as an apprentice; 2) arrival in another country either as a cook or a groom. The lack of recognition can either be a plot against the hero's wish, or a deliberated move by the hero who has by now achieved so much that he no longer seeks the worship he used to crave.
24. Unfounded claims (L) are presented by a false hero. The role of the false hero is highly variable, and the false hero can be heroic in their own right. The false hero may be also be used to further demonstrate the qualities of the hero.

25. A difficult task (M) is proposed to the hero to show his true character and worth. It is a defining moment where the hero differentiates himself from the false hero. As the hero's final mission, it focuses on the importance of unwavering integrity and readiness.
26. Solution (N) happens when the task proposed to the hero is completed. It demonstrates the hero's character, capability, integrity and true worth.
27. Recognition (Q) serves a function similar to branding. The hero is recognized with a mark, a brand (i.e. wound), or something else that is given to him. It presents a moment of relief that people at last realise and accept the hero's qualities.
28. In Exposure (Ex), the false hero or villain is exposed through the display of non-heroic action, including cheating, false action and cowardice. In combination with recognition of the hero, exposure of the false hero or villain creates a doubled impact on the audience.
29. Transfiguration (T) is the symbolic of hero's rebirth from the image of a rugged and perhaps unattractive adventurer. The hero is transformed in some way to fit his new status in recognition of his acknowledged achievements. Whereas the hero may have been dirty and tattered, he is now clean and attractive.
30. Punishment (U) is imposed on villain. Punishment of the evil has long been done not just an act of retributive justice but also as a warning to others. The degree of punishment may be lenient or harsh, depending on the story and the kindness or severity of hero and other lead characters. Such tales are classic form of moral education in storytelling.
31. Wedding (W) draws the tale to a close. The hero gets the final rewards for all his actions. At the end of the story, the hero may marry the beautiful princess and live "happily ever after". Alternatively, he may continue to lead quiet a life, or even go on to have another adventure.

This thesis focuses on using Propp's 31 functions to build a coaching model, because it offers a comprehensive reading of what elements should a good story carry. Propp's granular and well thought out narrative structure can better help us assemble stories from the game experience. The description for some of Propp's functions will be recontextualized in Chapter 7.5, where we propose using some of Propp's functions to derive and assemble a coached gameplay session.

7.3 Persuasion Methods and Theories

Persuasion is a type of communication designed to influence the autonomous judgments and actions of others [212]. The human mind is considered to be a cognitive miser: *"People are limited in their capacity to process information, so they take shortcuts whenever they can."* [213]. Thus we, like animals, have a set of pre-programmed fixed-action patterns (such as attitudes) when reacting to certain triggers, which in many cases is the most efficient form of behaving (providing "shortcuts" in an extraordinarily complicated stimulus environment we live in). This leads to a possibility of exploiters who mimic trigger features for our own brand of automatic responding, which is typically an undetectable weapon of automatic influence [214]. With this in mind, the study of persuasion and its effects on attitudes remains a vital feature of contemporary social psychology.

Good game experience is beneficial in helping us persuade elderlies to play more health games, and thus persuasive techniques must take into account the understanding of the subject's game experience [215]. The relationship between correct persuasion technique and successful persuasion can be explained by the concept of "feels right" experience [216, 217]: where the message fits the subject's processing mode (e.g. promotion-focused or prevention-focused), it generates a regulatory fit manifesting in the form of "feels right" experience, which transfers to enhanced persuasion.

7.3.1 Overview of Persuasion Theories

Several theories are present to explain various methods of persuasion. Aristotle described rhetoric as composed of 3 basic tools: *ethos*, *pathos*, and *logos* [218].

- *Ethos*, argument by character, employs the persuader's personality, reputation, and ability to look trustworthy. Persuasion can be achieved by the speaker's personal character when the speech was so well delivered that makes us perceive them to be credible.
- *Pathos*, argument by emotion, forms the root of the word "sympathy"; a successful persuader must learn how to read the audience's emotions. In simpler terms, persuasion may be achieved when the messages are able to stir emotions.
- *Logos*, argument by logic, posits that persuasion is affected through the speech itself when we have proved a truth by means of convincing arguments that suits the context.

Cialdini suggested there are six basic tendencies of human behaviour which come into play in generating a positive response: reciprocity, consistency, social proof, liking, authority and scarcity [219].

- *Reciprocity* states that people tend to repay in kind; people are more inclined to treat others like how they have been treated.
- *Consistency* states that people align to commitments that they have made explicit, and are more likely to follow up on items they have written down or spoken out compared on those they only kept in their mind.
- *Social proof* suggests people tend follow their peers; they often look around in their circles, mainly towards other individuals similar to them, to obtain cues on how to respond to a certain situation.

- *Liking* suggests people like those who like them; offering genuine praise and uncovering real similarities can foster a positive relationship.
- *Authority* means that people tend to align their opinions with experts, which calls for the need to demonstrate one's expertise to establish their credibility.
- *Scarcity* means people will be convinced to want more of something if they believe they have less of it. The "something" can be perceived as more valuable solely by its scarcity.

Over the years, various persuasion models and theories have been developed. The following table depicts some well-known persuasion theories and their categories [220]:

Table 23. Categorised Persuasion Models and Theories

Theoretical Category	Theories Discussed [220]
Message effects models	<u>Message learning approach:</u> "Yale Model of Persuasion" <u>Fear appeals:</u> Protection Motivation Theory Extended Parallel Process Model Language Expectancy Theory
Attitude-behaviour approaches	Theory of Reasoned Action / Theory of Planned Behaviour Triandis Model of Interpersonal Behaviour
Cognitive processing theories and models	Elaboration Likelihood Model Heuristic-Systematic Model Social Judgment Theory
Consistency theories	Balance Theory Cognitive Dissonance Theory Probabilistic Models
Inoculation theory	Inoculation Theory
Functional approaches	Functional Approaches

The persuasion models presented can be broadly classified as either a single-process model or a dual-process model. The simpler single-process models suggest ways messages can be presented and processed (i.e. central arguments); individuals' attitudes and behaviours will

change if they are successfully persuaded. On the other hand, dual-process models consider individuals' motivation and ability to process messages. For those who are unmotivated or have inability to process messages, they may simply use the auxiliary features (i.e. peripheral cues) in a message's presentation to formulate their attitude / behaviour change response. Attitudes or behaviours formed through this manner are less persistent to subsequent influences. Undoubtedly, the dual-process model offers a fuller picture of how persuasion takes place. Most influential persuasion theories today belong to this category [221].

In this study, we will explore one such dual-processing model namely the Elaboration Likelihood Model (ELM) to persuade people to change their health behaviour by playing health games.

7.3.2 Literature Review of Elaboration Likelihood Model (ELM)

The Elaboration Likelihood Model seeks to explain how people process stimuli differently and the results of these processes on changing their attitudes then influence their behaviours. Elaboration refers to the amount of effort an individual use to process and evaluate a message before accepting or rejecting it [222]. There are 2 channels of processing: central route and peripheral route, which determines if a message receives high or low elaboration.

Background

Scientific research on attitude change began in the 1940s to understand propaganda and persuasion, especially in World War II efforts. At the time, the most popular persuasion theory was based on learning principles and the functions of attention, acceptance and retention of persuasive communication [223]. The framework identifies many variables as determinants of attitude change, which focus on the features of the source of message, the content of message, the recipient of the communication and how the message is presented. As more and more studies on persuasion are conducted, inconsistencies in findings surface. One example is that

the same variable may elicit different effects in different experiments. In addition, many theories on attitude change are developed to describe how the persuasion processes occur, but the theories seem to accurately predict persuasion only under certain condition. These theories are also in disagreement on the effects of variables that influence attitude change.

In the late 1970s, significant advancements have been made in addressing important methodological and theoretical issues regarding the consistency between attitudes and behaviours [224]. The Elaboration Likelihood Model (ELM) is introduced by Petty and Cacioppo [225] to provide a general explanation towards attitude change. ELM identifies variables that influence attitudes by different means at different points along an elaboration continuum. Its methodology of organizing, understanding and categorizing the basic processes underlying persuasive communications has been well-received by researchers over the years [223, 226].

Core Concepts: Central Route and Peripheral Route of Persuasion

The ELM is a type of dual-processing model that focuses on message-based persuasion. It describes the process of the individual's attitude change caused by the strength and appeal of messages. The ELM suggests two qualitatively distinct routes to describe how persuasion that results in attitude change occurs.

Central Route: Processing Messages in an Objective Manner

The first type of persuasion occurs through the central route. Central route processing involves a high level of message elaboration with thoughtful consideration towards the contents of a given argument such as logical thinking, in order to change attitude. Attitude changes that result from the central route will be more enduring and resistant to subsequent stimulus. Another advantage of the central route is that the behaviour is more predictive than the changes from the peripheral route.

For the central route, Petty & Cacioppo defined two manners that variables can affect message processing: relatively objective manner and relatively biased manner. Relatively objective manner is the variable that affects the person's willingness to seek the truth, and to consider arguments presented impartially; meanwhile, relatively biased manner is the variable that affects the generation of favourable or unfavourable thoughts on the arguments (motivation), and the person's tendency to choose one side of the argument [225]. The possibility that a message will be processed by the receiver (either objectively or biasedly) can be enhanced by increasing both their motivation and their ability to process messages.

Processing messages in an objective manner means to expend cognitive resources to actively scrutinise the content of messages; stronger messages will be more effective under greater scrutiny. According to ELM, people are more motivated to process issue-relevant arguments objectively under several high elaboration conditions detailed below:

- **Personal Relevance:** People tend to process messages that are more relevant to them. If the message is against their initial stance, it needs to be stronger to be accepted.
- **Personal Responsibility:** If subject is the sole person to evaluate the arguments, he/she will invest more effort to scrutinize. In contrast, if it is clear to the subject that the responsibility is shared among a group, less effort will be invested to scrutinize.
- **Number of message sources:** When the message is provided by multiple independent sources, it will likely receive more scrutiny.
- **Need for cognition:** People who are predisposed to enjoy thinking show greater differentiation of strong and weak arguments than people who are not. These results are true even under controlled differences in intelligence [227].

The quality of messages during the conversation also boosts a listener's ability to process messages objectively.

- **Distraction:** distract when disagree, focus when agree
- **Repetition:** Moderate amounts of repetition with strong arguments can shed different points of view on the same message, increasing objective processing.
- **Message complexity and comprehensiveness:** Messages that are crafted to be highly comprehensive and possess low complexity can be processed easier and faster.
- **Modality:** Messages with higher persistence can better help the receiver distinguish between strong and weak arguments. Printed messages are an example of high persistence message.

Under these high elaboration conditions, strong arguments are better accepted while weak arguments are rejected to a greater extent.

Central Route: Processing Messages in a Biased Manner

There is an alternate mode of processing messages in the central route, namely the “biased” manner. Processing messages in a biased manner means to interpret messages in a way that results in a positive or negative attitude bias towards the message, and the argument in extension. The following conditions can influence a person to conduct message processing in a biased manner:

- **Prior knowledge:** The more prior domain knowledge (also referred to as “knowledge schema”, e.g. law / religion) on the subject of discussion, the more they tend to oppose or refute messages that goes against their initial stance, at the same time cognitively bolstering supportive arguments that is presented in the same domain [228]. Also, when recipient with pre-existing stance is presented with arguments from both sides, they

tend to rate the side of argument that agrees with their initial stance as more convincing and better presented.

- Forewarning on message content: If recipient is warned about the upcoming content of the message, they will show more unfavourable attitudes towards the message (we suspect only applicable to “opposing messages”). Forewarning and real message delay provides time for subject to bolster their initial opinion, hence resistance.
- Forewarning on persuasive intent: If subject is warned about the intent to persuade them, they will demonstrate resistance. This is due to perceived as a direct threat to their freedom of thinking.

Forewarning increases a person’s motivation while prior knowledge increases a person’s ability to process messages in a biased manner.

Peripheral Route

In contrast, the peripheral route of processing messages happens as a result of persuasion cues, such as the attractiveness of the message source that can potentially induce behaviour change without the need to scrutinize the merits of the content. Peripheral route processing describes a low level of elaboration in the message recipient who has little to no interest in the message; or has lesser ability to process the message. In this case, they rely on simple cues, such as the credibility or attractiveness of the sources of message. In the peripheral route, individuals do not examine the information as thoroughly as compared to central route processing. Attitudes changed by this route is less persistent and have less impact on long-term behaviours. The two routes to persuasion are distinguished based on the “direction” (rather than the “degree”) of cognitive activity.

The peripheral route is less nuanced in the book of communication and persuasion [225, pp. 155-170]. It describes that messages can be made more convincing by factors other than the

message's content. According to Chapter 6 in [225], the following points can serve as peripheral cues to improve the acceptance of a message:

- Source credibility
- Source likability
- Number of message arguments
- Visual salience, pleasant music, false psychological feedback

While we welcome the use of peripheral cues to successfully persuade individuals to change their health behaviour, we strive to place our emphasis on persuading them along the central route to create a lasting self-motivation effect, and decrease reliance on peripheral cues as they require constant intervention to upkeep.

Although the peripheral route of persuasion may sound like a weaker form of behaviour change, ELM nevertheless placed merits on some use cases that can be effective despite using weak arguments. For example, constantly “refreshing” the cues to the audience can upkeep their attitude / behaviour change, and the generated effect may be good enough without a need for strong arguments. Interestingly, there is a chance for peripheral cue listeners to gradually start to process subject-relevant information as their interest is continuously stimulated over time. In short, both central and peripheral routes of persuasion have their own merits and perks.

The Elaboration Continuum and Multi-Channel Processing

The Elaboration Likelihood Model has attracted many researchers in the field of persuasion for further exploration. More recent research efforts have found out that:

- Unlike Petty and Cacioppo's assumption that individuals are incapable of simultaneously processing through central and peripheral route, there are studies that support Kahneman's view of humans as parallel information processors [229, 230].

While there are also studies that opposes this view, they recognize that test subjects were aware of both the arguments and cues available to them, somewhat indicating simultaneous processing [231].

- Based on literature studies, there are still questions regarding the ability of ELM to explain movement along the elaboration continuum, and it is generally accepted that both central and peripheral processes influence attitude and subsequently behaviour change [232].
- Alternatively, Maheswaran and Chaiken suggests that it should be possible to promote high elaboration processing even among individuals with low motivation and ability to conduct it. This can be done through undermining receivers' confidence in their heuristic-based judgments (i.e. low elaboration processing), which can be achieved by manipulating the congruency between the a piece of consensus information and a subsequently received persuasive message [233].

In our proposed model (outlined in chapter 8), ELM serves as a useful framework for tailoring parts of our coaching to persuade elderly players who are reluctant to play. This gives an extra measure to fall back onto instead of outright ending the game session when they do not want to continue. Health values can be promising arguments for central routes of persuasion here.

7.3.3 Literature Review of Familiarity

Familiarity is a pervasive memory phenomenon that occurs when someone recognizes a repeated stimulus without recollecting other aspects of the requisite prior learning experience [234]. The familiarity towards a person, object, idea or action increases as people come into regular contact with them. People tend to grow more positive and comfortable with the items and surroundings as time passes. The contrary is true as well; scholars warn that familiarity can continuously decrease the likeability of an unpleasant event or person over time too. The

negative outcome of the familiarity effect is termed as environmental spoiling [109]. The level of familiarity when combined with prolonged positive / negative feelings may encourage a person to take on a certain attitude towards health games. In some ways, familiarity does regulate individuals' elaboration likelihood too as shown by studies [235]. Hence, we believe that it is possible to utilize the feeling of familiarity to help create a favourable health game experience, especially among the elderly [133].

The concept of familiarity refers to the cognitive ability to apply the knowledge gained through experiences with external stimulus from objects, persons, places and environments. When a stimulus is first presented to the individual, it is classified according to its appearance and characteristics. For example, a small round white item may be recognised as any or all of the following: a cake, a moon, a ping pong ball, or a light bulb; depending on the perceivers' prior knowledge.

The elderly, due to a lack of prior knowledge towards technology in general, usually struggles when interacting with technologies when the software or hardware components are unfamiliar to them. This counterexample shows that prior knowledge which invokes familiarity allow faster cognitive processing (i.e. memory retrieval and recording) when exposed to repeated stimuli.

Researchers have suggested that positive effects of familiarity are the result of individual's positive experience. In one study, familiarity induced through re-exposure is demonstrated to increase participants' pleasurable subjective experience [236]. Meanwhile, study on market brands shows that improvement in brand familiarity results in more positive brand experience, eventually leading to brand loyalty [237].

Familiarity has important impact when designing healthcare applications for the elderly. The lack of familiarity with a particular environment may be the reason why one is reluctant to

change their health behaviour, which may cause health complications down the road. Hence, it is vital to utilize familiarity to help individuals improve their health behaviour. Familiarity can be invoked through usage of naming, gestures, semantics and personal objects.

When learning technology skills, familiarity evolves along 3 stages [238, pp. 94-96]: *cognitive* that revolves around acquiring basic knowledge required for task execution; *associative* in which the person moves from their declared understanding to learning through acting on the said knowledge; and *autonomous* in which the actions follow a smooth procedure, are quick and involve negligible effort. Based on the three-stage model of the effect of familiarity, an earlier study conducted by the author has proposed three dimensions of familiarity design elements [108]:

1. Symbolic familiarity: objects, activities or processes occurring in users' daily life;
2. Cultural familiarity: concepts, patterns, or rituals appearing in users' surrounding culture;
3. Actionable familiarity: interactions with familiar elements in a system that resemble interactions with certain real-life elements.

These dimensions of familiarity design elements are found to be relevant among the elderly. In the subsequently proposed GSM targeted for creating positive game experience for the elderly, the dimensions will serve as the backbone for the familiarity mechanism.

We remain optimistic that familiarity, as a cognitive processing system, can function well when introducing the elderly to health games. The learning process of the health game can be easily achieved if we are able to borrow the elderly's understanding and preference towards in-game health-related issues, or even gameplay elements.

7.4 Goal-Oriented Theories

Goal setting and motivation form an integral part of coaching [188], hence it is naturally included in our coaching model.

A goal is defined as “the end toward which effort is directed” [239]. The term “goal” has been associated to key words such as achievement, motivation, tasks, emotion, self-regulation, and attention. Goals tend to drive behaviour through a number of intermediate traits like competence and purpose [240]. For instance, health behaviour can be driven by a person’s goal to become healthy through performing a set of actions associated with the goal [241]. Goal-oriented theories attempt to address the question “how to design systems that can achieve goals more efficiently?” When implementing our model, our goal is to offer a better game experience to the elderly when playing serious health games.

Goal-oriented theories can help provide valuable guidelines that can make this goal achievable. Studies demonstrate that employing goal-setting techniques to an activity helps elicit positive experience and consequently positive attitude [242]. For example, applying goal-setting intervention results in significant overall increase in positive affect among junior multievent athletes [243]. This phenomenon is also observed in stroke rehabilitation, where goal-setting strategies have positive influence on patients’ perceptions of participation and self-care ability, leading to improved performance [244].

In this section, we discuss on the origin of goal-oriented theories and highlight noteworthy developments in the literature. We also introduce a goal-oriented modelling theory as a reference to structure our coaching model.

7.4.1 Literature Review of Goal Setting Theory

Goals, in its simplest form, are a set of instructions that outlines the expected deliverable for an individual. Below we review some frameworks that help us (as a game coach) set proper goals that help our elderly players perform better in the coached game session.

Four Principles of Effective Goal Setting

Goal setting theory sets to describe the process of formulating optimal goals that can serve as proponents of purposeful action [245]. The theory elaborated that working towards a goal can be a major source of motivation which in turn improves performance. Goal setting theory provides a direct explanation of why different people perform better on the same tasks from a motivational perspective. In essence, goal setting states that different people have different performance goals, and advocates tailoring goals for each person to increase motivation. Goal setting theory posits that task performance is essentially linked to setting goals properly. There are four key elements for setting goals that can be successfully achieved: feedback, specificity, intensity (difficulty) and commitment.

- Specificity

Specific and clear goals can result in greater output and better performance. A goal worded to be specific is a high-performance goal. In a quantitative and empirical experiment study, 87 students were divided into three groups: one with specifically assigned learning goals, one with a more generic performance goal, and one without any goals [246]. The results show that having specific learning goals lowered extraneous and intrinsic cognitive load. Furthermore, clear goals accompanied by a deadline for completion avoids misunderstanding.

- Intensity (Difficulty)

Goal intensity is better understood as goal difficulty, describable using words like easy, moderate, difficult, or impossible. Higher goal difficulty can improve an individual's performance, but only up until a certain point. An easy goal will not bring the desired improvements in performance, while an impossible goal is not attainable. Hence, to achieve the best performance, goal setting recommends a goal to be worded not only specifically, but also with an optimal difficulty for the individual tasked with the goal.

- Feedback

In the article “*Toward a Theory of Task Motivation and Incentives*” [247], Locke demonstrates that specific and challenging goals, when coupled together with appropriate feedback, contribute to better task performance. This shows that goal setting and feedback are correlated. Appropriate feedback of results changes the goal setter's behaviour in a way that contributes to higher performance. In corporate settings, feedback provides information to the goal setters in the form of appraisals of their performance. Contents aside, the interval of feedback also significantly affects its quality. Providing feedback in short and timely intervals help sustain motivation towards achieving a goal. The feedback obtained while working towards the set goals gives direction to an achiever about what needs to be done and how much more effort is required to be put in. Therefore, prompt and proper feedback is very essential. Proper, timely feedback allows one to set goals in a sharper and clearer way. Goal achievers will receive a boost to their confidence as they grow more confident towards their capability to meet the goals that they have set. Thus, feedback helps them work with more involvement and leads to a greater sense of satisfaction.

- Commitment

Goal commitment refers to the degree that goal setters is attached to the goal, and their determination to reach the goal. Goal setting theory exemplifies that a higher goal commitment results in strong goal performance. Given the presence of commitment to a goal, if achievers discover underperformance, they are likely to make more effort to attain their goals. In contrast, if they are less committed to their goals, particularly more challenging goals, they are more likely to give up. Goal commitment can be instilled by convincing the goal setters that the goal is both important and attainable [248, p. 119], which requires effective leadership skills.

Figure 29. The Goal Setting Theory and Task Performance

To recap, goal setting theory [249] provides an immediate level of explanation in the process of achieving a task. As shown in Figure 29, the four key mediators of setting a goal produces goal-directed effort towards anticipated results or at the very least, high performance in the task. Setting a specific goal focuses people's attention and direct efforts to goal-relevant activities, and away from goal-irrelevant actions. Although difficult goals can demand more effort, increased commitment motivates the goal setters to work through setbacks to pursue the set goals. Feedback provides opportunities to clarify expectations, adjust the goal difficulty and gain recognition towards productive goal-directed efforts.

In short, goal setting theory is a goal-oriented, ever-evolving approach that attempts to find out how setting proper goals can motivate people and increase performance. The research on goal setting continues to this day since Locke established how goals generate motivation and promote performance back in 1968 [247]. These insights from over 30 years of research can help us describe our GSM in a more impactful, actionable and goal-oriented manner, increasing the model's efficacy in providing a positive health game experience.

7.4.2 Literature Review of Goal Net

Intelligent agents have seen applications in digital games especially in aspects like storytelling and AI controlled characters [250]. Intelligent agents are also starting to be applied in e-health coaching, which typically involves making “smart” decisions on setting motivating goals for the coachee [251]. These agents are usually driven with a model that allows them to make correct or at least convincing decisions given a situation. The Goal Net modelling technique developed by Shen [241] is one such model.

Goal Net emphasizes on having agents achieve the goals that are set out for them. It does so by providing a systematic methodology to capture the dynamic relationship among goals and provide an orderly structure for them. Goal Net modelling encourages us to think in a modular way when breaking down complex goals into simpler achievable goals, which is desirable in helping us dissect the coaching process into different sets of coaching scenarios. The game coach (e.g. caregiver, virtual game companion) can then follow different sets of the coaching scenarios outlined by our coaching model. With a model that anticipates various scenarios in the coaching process, the goal net modelling methodology ensures our coaching model's generalizability across a wide variety of health games. A game coach (AI or human) could then follow the coaching model's guidelines to design a health game into manageable segments before deciding how much to put into a single gaming session. This guided approach to conduct

“gaming sessions” also helps elderlies without prior game literacy to ease into the process by engaging with it as a set of “trainings” or “learning sessions” instead.

Main Components of Goal Net

Figure 30. The Basic Elements of the Goal Net

In Figure 30, basic Goal Net components are introduced in an example goal net: goals / states denoted with $s1$ - $s3$ and $c1$ (s for state, c for composite state), transitions denoted with $tr1$ - $tr2$ (with corresponding task list and environment variables), arcs denoted with arrows and branches denoted with dotted lines. Each transition is associated to a task list, which defines the possible task(s) that may be performed by the agent to proceed to the output goal. The arcs are arrows that connect the input goal to the transition, then goes from the transition to the output goal.

Goals are represented as states that the agent transits along. States can be classified into composite states or atomic states. An atomic state represents a goal that is deemed specific enough and cannot be further broken down, while a composite state tends to be a more abstract goal that can be further divided into sub goals, eventually atomic goals. As such, goal net demonstrates a hierarchy of composite goals that eventually decomposes down into atomic goals. The exact set of goals needed are specific to each application. Each state may expose

several functions (in the programming sense) that allow external parties to manipulate them in a controlled manner. Some examples are initialization, reset, variable manipulation and getting state variables. In short, states are used to represent the goals that agent plans to achieve.

Transitions stand between two states and contains a list of actions that need to be completed to move from the previous state to the next. When choosing suitable tasks to execute given a situation, three types of transitions (direct, conditional and probabilistic) are available, corresponding to three different strategies of action selection (sequential execution, rule-based reasoning and probabilistic inference). The *direct* transition is the simplest situation, as the tasks to execute is fixed and only needs to be completed sequentially. The *conditional* transition requires rule-based reasoning to select a subset of tasks from the task list according to certain pre-set rules and current values of relevant variables. The *probabilistic* transition makes use of probabilistic inference to select tasks in an uncertain setting. An agent may choose different routes to achieve the same goal under different environment situations by applying different action mechanisms that propel them towards the desired goal.

Arcs link input states to output states through a transition. Arcs can be drawn using several different forms of arrows, which indicate branching or concurrent execution of processes between the connected states.

A branch connects a composite goal to its corresponding input goal output goal, which are often not reachable through a single transition. In this way, a Goal Net to can be composed from other sub-goal nets via decomposing states. Each composite goal can either be drawn as a black box “state”, or as a white box revealing its own complex set of sub goals, transitions and arcs. These sub-goal nets aim to achieve the singular, final goal which is the root node.

Goal Relationship

Goal relationships classify some advanced interactions between different goals, and 4 distinct types of relations are identified: sequence, choice, concurrency and synchronization. The *sequence* relationship features a direct connection from input state to output state. In the *choice* relationship, an agent may choose to progress from one state to another under a certain condition, which defines a choice it has to make. *Concurrency* relationship specifies a concurrent occurrence between the states. It means that after input goal is reached, it will pursue both outputs A and B concurrently. *Synchronization* relationship identifies a synchronization point between states. For example, two concurrently executing states are synchronized before the output goal. These combinations of the four relationships provides a wide range of possible relationship between the states. Thus, it helps us model complex goals in real life into something that is understandable by a computer agent.

The sub-goals may utilize different interaction relationships for achieving the higher-level goal. This fundamental relationship can be “one of”, “all of” or “sequential”. They are presented in the following diagrams.

(a) is the “all of” relationship; (b) is the “one of” relationship; (c) is the “sequential” relationship.

A goal-oriented methodology based on the goal net model can help ensure pragmatic steps are available in each situation faced by the elderly. The Goal Net will serve as a bedrock to anchor various constructs in our goal-oriented storytelling model, at the same time formalizing the coaching scenarios that we foresee in the form of standardized diagrams. At the same time, it helps ensure our model can be implemented in the future as a digital coach.

7.5 Putting the Approaches Together

7.5.1 Novel Approach: Reconstructing the Gameplay Learning Journey as a Narrative

Propp’s 31 Functions have been used extensively as story generation models, including stories promoting health behaviours. However, there has been little research on the role of Propp’s 31 Functions, or other narrative theories for that matter, in the behaviour change process itself. There are three points that support the use of storytelling in the behaviour change activity *other than simply telling a story*:

- Studies have shown that the persuasive effect of narrative promoting health behaviour is largely influenced by how relatable the story is to the reader's past experiences (i.e. self-referencing) [252, 253, 254]. Logically, the most relatable story that a person can experience is his/her *own* past experiences.
- In the context of healthcare, a powerful narrative of patients' experiences acts to shape their awareness and interpretations of their own illness. Sociologist Artur W. Frank suggested there are 3 main narrative types: *chaos* (feelings of vulnerability, futility, powerlessness and disorientation; characterized by *hopelessness*), *restitution* ("Yesterday I was healthy, today I'm sick, but tomorrow I'll be healthy again"; characterized by *concrete hope*), and *quest* (accepting illness and seek to *use* it to transform oneself into a better person through overcoming adversity and re-learning what is most important in life; characterized by *transcendent hope*) [255]. Re-storying people's lives in a more positive way to construct a more hopeful and meaningful identity and sense of self (i.e. into restitution or quest narrative) is shown to enhance the lives of men with serious illness [256].
- While the discontinuity view claims that stories are not lived but told, in reality they might be closer to everyday life than that as critics have pointed out [257]. In other words, stories are not simply told, but being lived in at the same time.

Storytelling, as a form of Art, has far greater impact to human life beyond mere entertainment purposes. Oscar Wilde, a proponent of anti-mimesis (Life imitates Art far more than Art imitates Life) reasoned that "...the self-conscious aim of Life is to find expression, and that Art offers it certain beautiful forms through which it may realise that energy", citing the beauty of fog in London as an example: only being noticed after "poets and painters have taught the loveliness of such effects" [258]. Stories that are personal and emotionally compelling engage

more of the brain, and thus are better remembered, than non-familiar stories simply stating a set of facts [259, 260].

Moreover, narrative theories are not only applicable in literary terms (i.e. writing stories), but also in real-life actions. Researchers have studied linkage between real-life activities and narrative before, such as Berger, who in *Narratives in Popular Culture, Media, and Everyday Life* [261] noticed that therapy sessions can be seen, as a kind of dramatic autobiographical narrative text in which the client plays the central role, a two-person play of sorts in which the client responds to questions and comments by the other actor (the therapist) and tries to find some way of resolving a problem or conflict that may be internal, external, or a combination of the two. Mattingly in *The Concept of Therapeutic 'Emplotment'* described this phenomenon as “narrative construction of lived time”, of narratives that are created before they are told [262].

In fact, Bruner in his piece of work aptly coins the term: *The Narrative Construction of Reality* [263]. He argued that we “organize our experience and our memory of human happenings mainly in the form of narrative: stories, excuses, myths, reasons for doing and not doing, and so on”. In particular, we organize our memory of an event as a story by selecting series of events and stringing them together under the umbrella of an overall narrative. In Propp's terms, to be made "functions" of the story.

In support of *The Narrative Construction of Reality*, McAdams stated that people convey to themselves and to others to terms of now, past and future with society through narrative identity. He formulated “*a life-story model of identity*”, contending that “*people living in modern societies begin, in late adolescence and young adulthood, to construe their lives as evolving stories that integrate the reconstructed past and the anticipated future (i.e. collective experiences, such as illness, death, and conflict, as well as interrelationships, including courtship, marriage, childbirth, and stewardship of nature) in order to provide life with some*

semblance of unity and purpose [264, p. 243]”. Carr, in his article *Narrative and the Real World: An Argument for Continuity*, argued against discontinuity view that stories are not lived but told, claiming that “*stories are told in being lived and lived in being told. The actions and sufferings of life can be viewed as a process of telling stories to we ourselves, listening to those stories, acting them out, and putting them into living them through ... Sometimes we must change the story to accommodate the events; sometimes we change the events, by acting, to accommodate the story*” [257, p. 126]. He noted that human beings are simultaneously the subject, principal teller, and the audience of their life-story [257].

On the other hand, several studies have shown that exploring negative life events in detail is associated with psychological maturity. McAdams referred to this phenomenon as the “redemptive self”: “*if an adult constructs a narrative identity in which the protagonist's suffering in the short run often gives way to reward later on, he or she may be better able to sustain the conviction that seemingly thankless investments today will pay off for future generations*”. It remains hopeful that the elderly, as a hero in Propp’s narrative, is able to withstand challenges and emerge victorious as they go through the uncomfortable in-game challenges.

Therefore, if we can help form a personal narrative to the elderly player in which they recount their rich past experiences over the years, establish a relevance between the challenge on hand and their past, accumulate tension on the now personally relevant in-game challenges, and finally relive their past through the satisfaction of completion, they have a strong psychological foundation to base their game experiences on their own development as a character in their life story. In simpler terms, structuring the elderly’s gameplay as part of their own life story may have positive effects in their game experience.

7.5.2 Persuasion and Familiarity as Augments

Throughout the process of gameplay coaching, the elderly may be tempted to act in a way which hinders their progress (i.e. return to status quo). One way to avoid this is to intervene whenever the elderly is about to do so. However, it is easy to acknowledge that each time we (or caregivers) intervene to change (or disallow) the outcome of the elderly's action, it tends to be perceived negatively as violating their sense of *agency* (i.e. the satisfying power to take meaningful action and see the results of his/her own decisions and choices) [265]. This in turn reduces the effectiveness of persuasion, especially self-persuasion techniques [266]. It is also known that persuasion, compared to directives, works better for encouraging activities which demand effort [267] such as learning to play a digital game. Thus, an alternative to coercing the user is to try to persuade them into acting in ways that aligns with their goals. Additionally, as studies have shown [260, 268], familiarity has an important role in story comprehension. While the elderly will be dealing with his/her own experience, known familiar techniques may be applied during the re-storying process (i.e. framing the elderly's experience into the desired narrative) to enhance the comprehension (and thus persuasive effect) of the narrative. Piecing together a framework for effective behaviour change should be within reach through careful selection and sound deductions the aforementioned concepts.

7.5.3 Infusing Storytelling with Persuasion, Familiarity and Goal Setting

We theorize that mapping and redefining Propp's 31 Functions to describe a gameplay experience can provide game coaches with a methodological, narrative view towards the elderly's state when playing health games. The coach can in turn develop suitable actions to help the elderly under their guidance to progress along the stages in the model. ELM helps the coach persuade the elderly to continue playing should they show signs of giving up halfway. Goal setting theory serves well as a set of guidelines that enforces the coach to maintain clarity

on expected outcomes throughout the gameplay session. Familiarity can be drawn from elements in the gameplay session to enhance the game experience.

With the premises presented above, we propose the Goal-oriented Storytelling Model (GSM) that aims to persuade the elderly to accept and eventually learn to enjoy health games, which culminates into a positive health game experience. The GSM presents the gameplay process as a flow of storytelling events that implementers (e.g. healthcare workers, computer agents) can follow. Given a health game, the GSM serves as a coaching methodology that accompanies and teaches an elderly about a digital medium originally unfamiliar to them.

7.6 Summary

In a nutshell, this literature review has demonstrated several rational approaches to induce strong motivation for the elderly to accept health games and enjoy good game experience. We reviewed the literature on several approaches that has potential to translate into good coaching practices, namely storytelling, persuasion and goal-oriented approaches. Out of these several approaches, we highlighted Propp's 31 functions, the Elaboration Likelihood Model, the Goal Setting Theory and the Goal Net Theory. These theories and models are subsequently used to derive mechanisms for the Goal-Oriented Storytelling Model in the next chapter.

8. Goal-Oriented Storytelling Model as a Health Game Coaching Methodology

8.1 Introduction

Here we recap the purpose behind the development of the Goal-Oriented Storytelling Model (GSM). We also provide the rationale for using storytelling, persuasion, familiarity and goal setting as mechanisms (i.e. components) of the GSM.

Motivating Elderlies Past the Digital Barrier to Adopt Health Games

The elderly, when attempting to play health games, often encounter difficulties due to the lack of confidence and direction when experiencing an unfamiliar virtual game world. From our study 1 above, we identified low game literacy as the primary reason that our elderlies are not able to enjoy health games, even those designed with best HCI practices.

By focusing on coaching elements and social interactions external to the game world, the proposed Goal-Oriented Storytelling Model (GSM) aims to fill in a research gap when developing solutions to *coach* the elderly in navigating the unknowns of health games. The eventual goal of this model is to enhance elderlies' game literacy which provides them with positive health game experiences.

The GSM aims to achieve this by taking in an existing health game, then provide a design methodology that tells the coach what to do when conducting a gameplay session using the health game. Through a goal-oriented process of enlightenment and empowerment [188], this methodology aims to craft game sessions that form a fruitful learning journey for the elderly players.

8.2 Mechanisms in the Goal-Oriented Storytelling Model (GSM)

Below we present an overview of four different mechanisms used in the GSM:

- The storytelling mechanism is used to keep track of the elderly's state of game experience and provide us knowledge of what the elderly needs to do next, directly structuring the elderly's game experience into discrete states instead of writing stories for the elderly. The storytelling mechanism is subsequently enhanced using the goal-setting theory to derive actionable statements which indicates progress (state transitions) in the form of guided prompts.
- The persuasion mechanism provides a targeted and tailored solution to persuade the elderly throughout different stages of change to achieve the set goals and hence move forward through the stages. The persuasion mechanism specified different ways in which change could be facilitated for individuals.
- The familiarity mechanism in our model addresses another potential dimension of what makes health games engaging. This mechanism addresses 3 dimensions: the cultural familiarity of message presentation, symbolic familiarity of game environment (either physical or in-game), and actionable familiarity in the sense of relating in-game tasks to real-life activities.
- The goal setting mechanism serves as a set of recommendations that should be referenced when deriving actionable statements at every single stage (the "actionable statements" are later referred to as *guided prompts*). We hypothesize that the recommendations in goal setting theory help us craft a more friendly, motivating coach by setting step-by-step goals. The goal setting mechanism in tandem with the storytelling mechanism are used to derive the *states* and their *transitions* in specific implementations of the model.

In summary of the above mechanisms, the flow of a gameplay is structured using the storytelling mechanism. The structured flow is subsequently modelled using the Goal Net theory. At the same time, the persuasion, familiarity and goal setting mechanisms serve to check and advise the creation of action items along each step.

For these mechanisms, we employ three theories: Propp's 31 Functions for the storytelling mechanism, Elaboration Likelihood Model for the persuasion mechanism and the Goal Setting theory. We also refer to a previous study of familiarity by the author to obtain a more in depth understanding of what makes a health game acceptable and enjoyable. The details of each mechanism are introduced in the following subchapters.

8.2.1 Storytelling Mechanism: Recontextualized Propp's 31 Functions

Similar to how Vladimir Propp himself breaks down folklores into discrete narrative units [210], the storytelling mechanism in GSM segments out different points in the coached gameplay process. In this gameplay process, the elderly is viewed as the "hero in their lived story at this very moment" and their ultimate quest is to "finish the game session with a good game experience". Propp's functions is, in our case, reinterpreted in context of playing a health game. For example, Interdiction's original meaning according to Propp is "the hero is addressed with a request". In a health game coaching scenario, Interdiction would play out as "the elderly is introduced to the health game they are about to play". Despite Propp's statement "*all functions known to the tale will arrange themselves within a single tale, and none will fall out of order*" [209, p. 10], we found it necessary to group certain functions together into re-arrangeable coaching scenarios, in order to describe the gameplay situation more accurately. We present the full re-contextualization of Propp's function in health game coaching below:

Table 24. GSM Design Implementation for the Study

Current Function	Original Context in Propp's Theory	Recontextualized Description in GSM	Guided Prompt (i.e. Action Items for the Coach)	Possible Transition(s) and Condition(s)
Introduction of the Health Game				
Interdiction	Hero is warned	The elderly is informed to play pumpkin garden	Tell the elderly they need to go through the minigames in Pumpkin Garden to complete the session	The elderly appears to not want to play the game: Violation of Interdiction The elderly immediately agrees to play the game: Departure
Persuading the Elderly to Continue				
Violation of Interdiction	Warning is violated	The elderly does not want to play the game	Ask for the reason that they don't want to play.	Proceed to Complicity
Villainy/Lack	Need is identified	Coach identifies reason the elderly rejects playing the game	Attempt to persuade them (ELM) <ul style="list-style-type: none"> • Promise to guide them throughout the game • Highlight health game objective: improve PD detection tool (central processing) • Offer encouragement, highlight the game will be simple and quick to finish (peripheral cue) 	Proceed to Mediation
Mediation	Hero discovers lack and approached with a request; hero is dispatched	The elderly considers; they are asked to play the game again.	Ask whether the elderly agrees to play	When the elderly still refuses to play: Violation of Interdiction When the elderly expresses interest in playing: Counteraction
Counteraction	Hero chooses positive action	The elderly is successfully persuaded to play the game	Hand the device to the elderly to commence the play session	The elderly starts to play: Departure

Current Function	Original Context in Propp's Theory	Recontextualized Description in GSM	Guided Prompt (i.e. Action Items for the Coach)	Possible Transition(s) and Condition(s)
Completing a Game Goal				
Departure	Hero leaves on mission	The elderly starts to play the game with a specific goal set out for them	Observe the elderly's playthrough until they encounter a problem	The elderly encounters problem while playing: Absentation The elderly completes a round without problems: Acquisition
Absentation	Something goes missing	Knowledge is missing in the elderly that makes them unable to play the game	-	Proceed to Testing
Testing	Hero is challenged	The elderly encounters a problem when playing the game	Observe if the elderly tries to overcome by themselves; intervene if they ask for help	The elderly asks for help: Reaction The elderly gives up: Violation of Interdiction The elderly overcomes problems by themselves: Acquisition
Reaction	Hero responds to challenges	The elderly shows difficulty when attempting to resolve challenges.	Investigate problems encountered <ul style="list-style-type: none"> • Guide the elderly through the challenge • Lower the passing criteria if necessary 	The elderly is making progress in the challenge: Acquisition
Acquisition	Hero gains magical item	The elderly is able to overcome the problem encountered	The problem on hand is resolved; observe for additional problems	The elderly encounters another problem: Absentation The elderly completes the assigned game goal: Guidance

Current Function	Original Context in Propp's Theory	Recontextualized Description in GSM	Guided Prompt (i.e. Action Items for the Coach)	Possible Transition(s) and Condition(s)
Guidance	Hero reaches destination	The elderly achieves their current game goal	Set the next game goal for the elderly to play and achieve	The next task is the final challenge: Struggle The next task is a regular game segment: Departure
The Final Challenge				
Struggle	Hero battles villain	The elderly has to finish the challenging round without giving up	Encourage the elderly until they finish the challenging round. Only help out when asked. Lower the passing mark if necessary	The elderly finishes: Victory The elderly gives up: Violation of Interdiction
Victory	Villain is defeated	The elderly is able to complete the final challenge without giving up	Applaud the elderly for completing the game session	-

By following the flow of Propp's functions, we identify a set of coaching scenarios as follows:

Table 25. List of Coaching Scenarios

Coaching Scenario	Description	Included Propp's Functions
Introduction	Introduce the health game to the elderly. Present the game's health values to the elderly to garner interest.	Interdiction
Completing a Game Goal	The coach presents a single game task to the elderly and encourages them while they complete it. The coach provides step-by-step guidance if necessary, but the elderly should first be given a chance to try out the challenges.	Departure, Absentation, Testing, Reaction, Acquisition, Guidance
The Final Challenge	Each health game session ends with a "final challenge" where the learnt gameplay skills will be tested in one of the game segments, selected by the coach.	Struggle, Victory
Persuading the Elderly to Continue	When the elderly expresses disinterest in the game, the coach needs to persuade them to continue.	Violation of Interdiction, Villainy/Lack, Mediation, Counteraction

Implications of the Identified Coaching Scenarios

From Propp's functions that describe the start of the story, we derive the need to formalize the introduction of the health game to our elderly players. Health values specific to the health game should be highlighted here to attempt to catch the elderly's attention. An impactful introduction provides the first line of motivation to spark their interest in the game, regardless whether they have prior experience with games or find gaming to be fun.

The scenario that highlights “Persuading the Elderly to Continue” describes what to do when the elderly expresses signs of disinterest towards the game. Persuasion is deemed necessary to shift their existing negative attitudes / perceptions so that they would at least give the game another try. The coach should hear out the elderly’s concerns and attempt to address them as part of the negotiation process of persuading them to continue. It is optimal to have some in-game mechanism to lower the game difficulty if they find the gameplay to be too hard, as we anticipate it to be one of the most frequent reasons why the elderly refuse to engage with games.

In “Completing a Game Goal”, the game coach needs to come prepared with segments of gameplay, each with a clear and defined goal. The preparation is necessary as existing health games may not present an explicit goal between various gameplay segments; it is up to the coach to decide how long each segment lasts. The target audience’s abilities should also be considered (e.g. Parkinson’s Disease patients have weaker motor functions). Help should be given if the elderly is clearly unable to overcome in-game challenges, and game difficulty should be lowered if step-by-step guide is still not enough for them.

A gameplay segment should be reserved for “The Final Challenge”, where the coach will ask the elderly to try out what they have learnt in this game session while providing help only upon request. This ties in well with storytelling’s three-act structure of a narrative (*exposition, confrontation, resolution*) [204] which have seen wide application in commercial games [205], where the resolution comes after a series of intensifying challenges. This implies the segment selected to act as the final challenge should not introduce new game mechanics, but rather impose some kind of time restriction or slightly increased difficulty on gameplay the elderly is already familiar with. We will explore how Propp’s function model this “Final Challenge” in 8.3.3.

8.2.2 Goal Setting Mechanism: Facilitating Progression

As GSM requires its implementations to adhere to the structure of Propp's functions, a certain degree of progressiveness is already present. After all, Propp's functions are progressive in the sense that it defines clear, orderly checkpoints in the process. The goal setting mechanism seeks to build on this element of progressiveness and enforce GSM to be implemented with specific, achievable goals along every step. Using techniques outlined in the goal setting theory papers [247, 269], we can plan and monitor the behaviour change process with better performance, thus enjoying the benefits from setting a focused goal.

In the context of GSM, goal-setting theory should be used when designing the various in-game tasks for the elderly. Given an existing health game, the coach should clearly define several segments of the game for the elderly to play out. For example in the Pumpkin Garden health game [87], the different minigames can form independent segments of gameplay with the goal of "complete 6 rounds of the minigame" in each segment. Ideally, each segment should not last for more than 30 minutes in order to keep the goal achievable in one sitting.

Regulating Task Difficulty to Obtain Commitment

One of Locke's earliest research concludes that clear goals (specific goals that require effort and high competence) tend to generate better performance from individuals compared to easier goals (goals that simply state "do your best"), on the premise that the goal is accepted by the individual [247]. Individuals may refuse to accept goals that expect too much more than their current ability, in which the performance boost will not occur. Thus, when setting goals for an individual, we need to ensure the goal is demanding enough to achieve the desired outcome. At the same time, the goal also needs to be within the individual's capability in order to obtain their acceptance and therefore commitment to the goal.

When we design a game session using a specific health game, we should be aware towards the amount of challenge that is inherent to specific game tasks. Using this awareness, we could, as a coach, constantly monitor the amount of assistance required. Players can overcome their own problems if they have the ability; on the contrary we can coach them more closely when the challenges are significant enough. This helps regulate participants' perceived challenge.

Designing Specific Guided Prompts for Each State

Goal setting theory also advises us to set goals that can obtain commitment by considering *the achiever's ability to perform*. This implies that the guided prompts (i.e. action items for the coach) should not be executed exactly as written; there is room for adaption to players' abilities. This and other requirements from the familiarity mechanism in 8.2.3 below suggest the need to build a knowledge base towards each participant on their motivations, abilities and list of items and themes familiar to them. Then, the coach can use this information accordingly during the gameplay.

The Coach's Role in Setting Goals and Obtaining Feedback

Goals can be set in several distinct ways. Cham et al. compiled a list of goal setting methods [270] that we reference in our model.

Table 26. Goal Setting Methods

Method of Goal Setting	Definition
Self-set	Goals are designed and chosen by an individual
Collaborative	Goals are designed and chosen jointly by both expert and individual
Group-set	Goals are designed and chosen on the performance of the group

Method of Goal Setting	Definition
Guided	The expert designs the goal choices and the individual chooses the goal
Assigned	Goals are designed and chosen by the expert without input from the individual

Out from the methods presented above, we use a mix of both assigned and guided goal setting methods for our proposed model to coach the player throughout the gameplay process. The coach, as an expert for a particular health game, sets what needs to be done clearly at every step beforehand. Hence, the sequence of gameplay is designed by the coach before the coached game sessions. Then during the gameplay, the coach obtains feedback on individuals' by *observing how well they are playing*. The coach will then scale the goal according to the individual's abilities. We hypothesize this provides a tailored, positive game experience in health games.

The points presented above are guidelines for game coaching in GSM's context, which admittedly still leaves plenty of room for different solutions. It is advisable to also refer to our Pumpkin Garden gameplay sequence in 9.2.3 for a better visualisation of the Goal Setting mechanism.

8.2.3 Familiarity Mechanism: Cultural, Symbolic, Actionable

The 3-dimensions familiarity model is included as one of GSM's mechanisms an additional way to understanding the qualities of health games experience.

In a previous paper, the author looked into how familiarity design helps provide better human computer interactions [108]. Three dimensions of familiarity were proposed. Symbolic familiarity refers to placing everyday objects from the user's world into the game. Cultural familiarity is similar but involves concepts, artefacts, patterns, traditions or rituals from the

user's culture, instead of from their day-to-day life. Actionable familiarity means the interaction process with the computer is familiar with another similar activity that the user conducts often in their real life.

The 3 familiarity dimensions can also be relevant in terms of coaching, seeing that GSM's role is to function as a coaching framework. Hence, the 3 familiarity dimensions above can be recontextualized from "what in-game design elements can help" into "how might the coach utilize familiar elements to enhance the elderly's health game experience".

- Cultural familiarity may translate into the gameplay coach's appearance, spoken language, attire etc. to appeal to the player's cultural background.
- Symbolic familiarity emphasizes on utilizing the player's existing knowledge towards certain objects to illustrate the health game's benefits, or lending strength from familiar objects to handhold the player through particularly tricky parts of the game that would have otherwise made them lose their patience.
- Actionable familiarity encourages the coach to enquire more about the physical activities that the subject is familiar with. The coach can then attempt to associate subsequent game task requirements to something the player has done before in the past. This is even potentially applicable to utilizing the coach's knowledge base, suggesting the coach to share more about their past relevant experience with the activity on hand to help the player visualise the actions in a real-world context.

We present some actionable thoughts on utilizing familiarity in the implementation guide (8.4 below).

8.2.4 Persuasion Mechanism: Elaboration Likelihood Model

ELM is leveraged in GSM as a persuasion mechanism to drive the user towards the set goals. ELM studies how persuasion works on individuals through two different routes. The “central” route describes how likely an individual can scrutinize and elaborate on a piece of information; it studies what variables can be modified in the presentation of messages⁹, and how it affects the *motivation* and *ability* of recipients to elaborate arguments both *in an objective manner* and *in a biased manner*. The “peripheral” route involves providing cues that help increase the perceived credibility of messages, usually on a subconscious level.

Based on the topics reviewed in 7.3.2 above, we strategize our persuasion method in the following manner:

- We simultaneously employ both central-based and peripheral-based persuasion methods. How much we should emphasize the central-based persuasion over peripheral-based persuasion and vice versa will be determined based on the level of elaboration the test subject exhibits at that moment.
- We continuously assess the level of elaboration of the test subject to determine progression from low elaboration to high elaboration (if any) which provides us information on strategizing our next move.

The strategies presented above are visualized in Figure 32 below.

⁹ It is important to distinguish between the two terms “argument” and “message” here. An “argument” is a stance that we would like the listener to adopt; a “message” is a piece of “argument” that is specifically tailored to persuade the listener either along the central or the peripheral route.

Figure 32. Visualization of ELM Persuasion Strategy

By testing individuals' capability to process messages in step 1, we can then derive an optimal mix of central-oriented messages and peripheral cues in order to successfully persuade individuals to attain set goals. Step 2 uses the prior information obtained in step 1 to determine what arguments can be effective. The arguments could then be crafted into messages and mixed in with cues, hence inducing simultaneous processing. Through this method, we hope to shift the individual towards central route of persuasion for lasting, resistant behaviour change through a methodological process of argument selection and crafting messages.

8.3 Modelling GSM Using Goal Net

The storytelling mechanism inspired by Propp's functions provides a structure to the process of coaching elderlies to accept and enjoy health games, with implementations adhering to recommendations within the goal setting mechanism. On the other hand, the messaging contents and techniques by the game coach utilizes the persuasion and familiarity mechanisms to produce a more convincing set of messages.

Here we introduce Goal Net, a goal-oriented modelling approach developed by Shen [271] as a method to present scenarios that may arise during the coached gameplay session. These coaching scenarios describe a series of events that are likely to appear across different gameplay sessions when players are elderlies with low digital literacy, regardless of the health game being played. Goal Net serves as a clear modelling method to angle in these different mechanisms that can formalize the definition of the GSM's model structure. Goal Net's methodological way of breaking down complex goals into sub-goals enables a clearer visualization of how coaching scenarios (Table 25 in 8.2.1) are broken down, when to use which scenario, and what techniques that we find particularly useful for each scenario.

In the following sections, we show each of the 4 coaching scenario as a "sub-goal-net", which are generalizable components across different implementations of coached gameplay sessions. Propp's functions describe atomic states that assemble into a coaching scenario, and each coaching scenario in turn can be replicated and assembled into an overarching Goal Net describing a single coached gameplay session.

8.3.1 Coaching Scenario 1: Introducing the Game

Figure 33. Coaching Scenario 1: Introducing the Game

In Propp's theory, a story typically starts with the Hero being addressed with a request. In the case of playing health games, the coach introduces the health game to the elderly. The Introduction of the health game consists of two states: an "Initial Condition" before commencement of the gameplay session, and the "Interdiction" where the coach introduces the health game to the elderly player. As part of the coach's preparation, we recommend spending effort on finding the best way to explicitly present the game's health values to the participant.

With the Pumpkin Garden game as an example, it may be suitable to highlight it as a Parkinson's Disease rehabilitation game to PD patients. Whereas to non-patients, it is more appropriate to introduce the game's early detection of PD to be more personally relevant.

8.3.2 Coaching Scenario 2: Completing a Game Goal

Figure 34. Coaching Scenario 2: Completing a Game Goal

A particular stretch of Propp's functions illustrate the Hero's journey to their adventure's destination. The journey is typically less than smooth. Challenges will be encountered and here is where the reader gets engaged with the story as they watch the Hero learn and grow from the numerous challenges they encounter. The health game session acts as a learning journey for an elderly and is similarly not without its challenges.

This scenario illustrates the coaching process when the coach sets a specific goal for the elderly and they start to attempt it (Departure). From here, either the elderly will have no issues in achieving the goal (Guidance), or they will realize that they have missing knowledge that prevents them from achieving the game goal (Absentation). We anticipate that elderlies with little to no prior exposure to video games (i.e. low game literacy) will fall into Absentation more often. After Absentation, 1 or more challenges will be encountered. All challenges must be resolved to reach the current goal (Guidance), hence the diamond-shaped arrow that indicates the "all-of" relation [241, p. 53].

8.3.2.1 Coaching Scenario 2-1: Overcoming a Challenge During Goal Completion

Figure 35. Coaching Scenario 2-1: Overcoming a Challenge

In the process of achieving a game goal, one or more challenges may be encountered by the elderly. Here we show the intermediate states that comprises of a challenge. The elderly is tested (Testing), the coach observes their reaction and determine if help is needed, and subsequently the elderly completes the challenge.

The elderly can sometimes figure out what to do by themselves. In this case, it is better to encourage them instead of directly helping them; doing is one of the most effective way to learn after all [272], and being able to figure out complex problems are one of the key satisfactions in gaming. However, they will more often not be able to accomplish the above if they do not have prior exposure to digital games. Help should be given to them in a step-by-step and easy to understand format. The coach could also consider lowering the passing mark if it means the elderly gets to continue with the rest of the game. From a “compassionate” point of view [173], researchers support that digital games can be easier if it meant providing a better game experience for the elderly [40, 273]. “Acquisition” marks the resolution of the current challenge.

8.3.3 Coaching Scenario 3: The Final Challenge

Figure 36. Coaching Scenario 3: The Final Challenge

One of a story's climax features the Hero facing off an ultimate challenge before claiming Victory. If we re-apply this concept into a coached gameplay session, it means the coach needs to prepare a gameplay segment as a "Final Challenge" to test what the elderly had learnt in the previous game tasks they have completed. The segment should only contain gameplay that is familiar to the player. The level of challenge perceived by the elderly can be increased via gameplay mechanics (e.g. set time limits, require more skills). The coach can also artificially create more challenges by prompting the player for responses instead of giving the usual step-by-step guidance. On the flipside, considering that the elderly player may have reduced ability to complete the game, the increase of challenge should not be overdone; the coach in this case needs to regulate the difficulty through the amount of help provided.

If successful, the optimal challenge provided in the gameplay session (with its conception guided by Propp's narrative theory) can help the elderly achieve a psychological need for achievement [274], thereby improving game experience for the elderly.

8.3.4 Coaching Scenario 4: Persuading the Elderly to Continue the Game

Figure 37. Coaching Scenario 4: Persuading the Elderly to Continue

It is a well-known issue that non-adherence is a frequent matter when attempting to teach the elderly on using digital products [82]. A similarity exists in Propp's storyline as well: when the Hero is addressed with a request, they may refuse to take on the challenge initially. It requires effort from their surroundings to change their mind over time.

In this case, persuasion techniques can come in useful as part of the coaching process as an attempt to obtain the elderlies' compliance. ELM's central or peripheral route of persuasion can be explored here. Following the 4 Propp's functions above, the coach should first hear out the elderly's reasons before attempting to provide re-affirmation that they will be well guided throughout (peripheral route) or remind them of the health benefits (central route). Flexibility needs to be exercised here to gain cooperation as conversations can be rather context-specific; however, the goal here is to have the elderly decide to give the games another try (Counteraction).

8.3.5 Assembling GSM sub-goal-nets into a Gameplay Session

The sub-goal-nets that describe the various coaching scenarios can be assembled into a general model. The general model outlines the essential components above as part of the GSM-driven coached gameplay session.

Figure 38. General Model of GSM-Driven Coached Gameplay Session

A GSM-driven coached gameplay session has to start with an introduction of the health game. Then, n number of game tasks will be assigned to the elderly player to complete (selection of game task sequence can be fixed, rule-based or random). During this process, the coach may need to persuade the elderly to continue playing if they express disinterest. Difficulty of game tasks should be adjustable, so that all game tasks can be completed. After completing n number of game tasks, players go through a final challenge to test what they have learnt in this gameplay session before they are considered to have finished the gameplay session.

8.4 Implementation Guide

Here we summarize the mechanisms presented above as an actionable step-by-step guide when implementing GSM-driven coached gameplay sessions for a particular health game:

1. Prepare a convincing set of facts relevant to the health game to help players perceive personal benefits from playing the health game. These health facts can be used in the introduction, or the persuasion process to motivate the elderly to play the health game.
2. With understanding towards the health game to be crafted into game sessions, divide its gameplay into several segments with clearly defined goals.
 - a. It is recommended to have more shorter segments to increase flexibility when coaching the elderly through the gameplay session.
 - b. The goals for each segment should be simple enough for the elderly, yet difficult enough to engage them.
 - c. Some games that comprises of minigames or well-defined rounds (e.g. Pumpkin Garden [87] or Ping Pong exergame [108]) are more easily segmented, while other health games with less pre-built segmentation may need to be redesigned to fit the purpose of conducting GSM game sessions.
3. Set aside a segment of gameplay to serve as the “final challenge” in a gameplay session.
 - a. The amount of challenge should be relatively higher in the “final challenge”.
 - b. No new gameplay elements should be introduced in the “final challenge” so that the elderly may focus on reapplying familiar gameplay knowledge gained beforehand.

4. Using the general model provided in Figure 38 above (or a variation of it), draw out the gameplay flow in the form of a goal net. The coach then plans out what to do at each state transition.
 - a. Ways to vary the general model above include but are not limited to:
 - i. enable dynamic selection of game task based on real-time gameplay behaviour; certain game tasks may be repeated or skipped entirely based on application-specific rules
 - ii. nesting game task to form more complicated game tasks (e.g. having minigames in levels)
 - iii. designing new sub-goal nets or flows of game tasks to handle situations that the coach foresee will happen during the gameplay session
 - b. We recommend maintaining these structures in the coaching model:
 - i. There should be exactly one Introduction and one Final Challenge.
 - ii. There should be at least 1 game task between the Introduction and the Final Challenge.
 - iii. The “Persuading The elderly to Continue” coaching scenario should be considered as a possible state that the elderlies may enter at any point during the gameplay session (unless the health game is simple, or the player is experienced in games).
 - iv. Despite the fact that coaching scenarios can be reordered, the exact sequence Propp’s functions in each coaching scenario should not be changed as it alters the proposed definition.

The finished goal net represents the flow of events that will take place during the coached gameplay session (with Figure 41 being an example). The coach should also prepare for the coaching session with the guidelines below:

- The game coach should familiarize themselves with in-game elements
 - It enables the coach to associate in-game elements with objects familiar to the player.
 - Prepare a convincing set of health game facts relevant to the health game to help players perceive personal benefits from playing the health game. These health facts can be used in the introduction, or the persuasion process to motivate the elderly to play the health game.
- Build a knowledge base for each player. Probe for and note down traits that help us work on personalizing the game experience:
 - Cultural background (work culture, ethnicity etc.)
 - Objects that the player is familiar with
 - Player's prior knowledge towards some different topics
 - Their ability to process messages

8.5 Summary

In this chapter, we have proposed a novel Goal-Oriented Storytelling Model as a design methodology for health game coaching. The model provides a methodological approach to tailor-make a coached gameplay session based on an existing health game. In GSM, coaching scenarios (containing recontextualized Propp's functions) are proposed as generalization of the sequence of events that take place during an elderly's gameplay process. Then, the selected

health game to be played by the elderly is scrutinised closely using the goal-setting theory to determine specific game tasks with clearly-defined goals. With clear, achievable goals being set, these game tasks form a health game session. The GSM also incorporates ELM-based persuasion mechanism for tailored messaging intended to convince the elderly to finish the game session without quitting, enabling the elderly to progress towards eventual game acceptance and enjoyment. We have also provided an implementation guide for the GSM.

All in all, an ideal implementation of the GSM can be effective in coaching the elderly through the unfamiliar realm of health games, ease their anxiety through the step-by-step coaching, spark their interest towards the usage of health games and ultimately encourage them to play health games regularly as a healthy behaviour. We look into one such implementation of the GSM in the next chapter.

9. Study 2: Gameplay Session with GSM-Driven Coaching

9.1 Introduction

The chapter above has provided a detailed overview of various mechanisms in the GSM theory. However, the advice offered can be rather generic, hence study 2 represents our effort to implement the GSM *coaching methodology* into a *coached gameplay session*. This would hopefully serve an illustrative purpose towards some implementation details to better understand how the mechanisms behind GSM work together to form a positive health game experience. Study 2 aims to answer the following question:

- How does GSM coaching improve participants' game performance, game literacy and game experience?

9.2 Study Methodology

9.2.1 Evaluation Criteria and Tools Used

We collect 3 different metrics to show that GSM coaching improves game performance, game literacy and game experience respectively.

Game Performance

First, we record participants' game performance in terms of time taken to complete each round, recorded using in-game timers. As introduced in 3.1, Pumpkin Garden consists of two minigames: the weed-clearing minigame and the water wheel minigame. Each minigame has 6 rounds, and participants played through 4 different minigames: water wheel minigame with fingers, with mouse and with pen; followed by weed-clearing minigame with fingers. Each participant's time taken to complete each round is recorded (in seconds), and the average scores across all participants are compared for each round. From the difference of time taken to

complete each round between control and experiment group, we evaluate the effectiveness of coaching on participant's game performance.

Game Literacy

Second, we evaluate participants' game literacy using a scale constructed by Rosenberg in his thesis [275]. Through Exploratory Factor Analysis, he has constructed a set of questionnaires to measure Game Literacy of players.

Identified constructs as part of game literacy are:

- Information, Learning, Resource Management and System Skills (ISM)
- Exploration and Enjoyment
- Teamwork
- Design
- Socialization

For our Pumpkin Garden game, participants play it with one-to-one coaching, hence social elements like *Teamwork* and *Socialization* are not used. As the game tasks in Pumpkin Garden game only requires elderlies to follow on-screen instructions to complete, they do not suit the *Design* constructs' question items which typically features the player creating their own contents in the game. *Exploration and Enjoyment* is omitted as it is too similar to HGEQ which is also part of our evaluation criteria.

Hence, we only administered the first construct (ISM) to our participants to compare their core game literacy skills [275, p. 67] across the coached group and the control group. As participants only qualify for this study if they do not have prior experience with digital games, we are confident that our sample population possess a relatively similar starting point for game literacy.

Since the questionnaire is not yet named officially, will refer to it as the Game Literacy Questionnaire in the remaining parts of this thesis (see Appendix).

Game Experience

We use the HGEQ devised earlier in Part II of this thesis to measure the elderlies' health game experience after the gameplay session. By comparing scores of individual dimensions across the control and experiment groups, we can gain better insights into which parts of the game experience are better improved by our GSM-driven coaching tailored for health games and elderlies with less ability to play health games (see Appendix).

Phenomenological Observations of GSM Coaching

Besides the quantitative metrics above, we also note down phenomenological observations of the coaching process to obtain real-world relevance on how various coaching scenarios (outlined in 8.3 above) play out in real life. Thus for 5 random participants in the experiment group who received coaching, a research assistant wrote down field notes detailing the interactions between the researcher and the elderly. The further analysis attempts to fit real-life scenarios onto the proposed coaching scenarios in GSM, adding face validity to our coaching model. These observations add depth and dimensions to further our understanding towards coaching as a new way to instil positive game experience among the elderly.

User Interfaces Developed for the Study

The above implementation of GSM was used to derive the dialogue of a computer agent that talks to the player. The computer agent is programmed with a pre-crafted response for each function. Function transitions are triggered by a research assistant (who overhears the conversation) without the participant's knowledge, after which the agent will speak the pre-crafted response. Participants mainly interacted with the agent when playing the Pumpkin

Garden game, while the researcher stayed out of sight, only coming in to persuade or provide step-by-step guides when the help needed goes out of the agent's capabilities. This methodology is also known as the Wizard of Oz testing [276].

(a). English Version

(b). Chinese Version

Figure 39. Computer Agent Implementing GSM to Facilitate the Wizard of Oz Testing

A simple dashboard used to control the computer agent is also designed for the researcher's use. Arrows will be tapped whenever the condition is fulfilled to trigger state transitions, while the current state (and its corresponding guided prompt) is shown in the centre.

Figure 40. Dashboard to Control the Computer Agent

By pilot-testing an approach that features a computer agent, we hope that the GSM can be fully integrated with intelligent agents in the future and can be used to create virtual game companions for the elderly. In this view, there is future potential in Goal Net to drive development of such virtual game companions.

9.2.2 Selection of Participants

We recruited 40 elderly participants who had little to no prior exposure to digital games to conduct a gameplay session, as they are the target audience that GSM is projected to benefit. Table 27 shows a simple set of screening questions to recruit participants who fulfil the above criteria.

Table 27. Short Survey for Study 2 Participant Selection

Pre-Survey Question	Options
Are you familiar with video games?	Yes / No
How often do you play video games?	Daily / Weekly / Not actively playing / Never played

First, we issued this short survey to 100 elderlies during a lucky draw event in the community. Then, we selected 50 respondents who answered “no” for the first question. Among these 50

selected participants, 10 answered “not actively playing” and 30 of them answered “never played” for the second question.

We contacted them to see if they are able to participate in our study, and 40 of them agreed. These 40 elderlies represent the group of elderlies who had little to no prior experience with video games. We evaluate how GSM coaching can help them better learn about video games and eventually enjoy health games.

Twenty of the elderlies are then randomly assigned to the experiment group which we actively coach them throughout the game session using the GSM coaching model. Out of the 20 participants in the experiment group, 5 are randomly selected where we closely observe their reactions during the gameplay and interview them before ending the session. This provides data for phenomenological study in section 9.3.3 below.

The remaining 20 elderlies form the control group where the researcher takes on a passive stance, only providing pointers when asked (much like study 1’s situation, see 6.2.3 above). All 40 participants were briefed on the IRB consent agreement and signed the form before taking part in our study.

9.2.3 Study Flow: GSM Implementation

In study 2, we designed an implementation of GSM for the Pumpkin Garden health game (the game is detailed in 3.1 above). The Pumpkin Garden gameplay flow from the pre-study (Figure 9, p. 64) is reused to conduct study 2. Each minigame forms a *gameplay segment* where the goal for our elderly is to complete 6 rounds in the minigame. We order the 4 gameplay segments sequentially to form the coached gameplay session, and we set the “Final Challenge” as the last round in the weed-clearing minigame due to the significantly increased challenges (where participants have time constraints to clear the weeds on-screen, opposed to the usual static gameplay at the player’s own pace).

The goal net generated from our GSM implementation features “generating positive health game experience in the Pumpkin Garden gameplay session” as our composite goal. It is then broken down into sub-goals that must be completed in sequence for the main composite goal to be considered complete (the sequential approach is selected for its simplicity as we are validating the coaching model’s effectiveness as a whole). The sub goals are the various Propp’s functions that represent different story points that our elderly players traverse throughout their gameplay session. Figure 41 below illustrates the generated goal net of our GSM implementation.

Figure 41. GSM Implementation for Study 2

The implementation above assists the game coach to:

- Map out the elderly’s current state of coached gameplay;
- Know the next course of action at each state in the gameplay;
- Know what conditions to look out for at each function. On condition fulfilment, the elderly’s progress in the game session will be updated in the goal net.

The real-life implications of the above implementation are as follows. In the coached experiment group, the virtual avatar (Figure 40) controlled by a research assistant responds to the situation depending on the progression in the gameplay session's goal net. For example, the virtual avatar introduces the Pumpkin Garden game's health values to the participants in the introduction, at the same time providing encouragements / prompts participants if they need help during the gameplay (actual help is still provided by the researcher).

In comparison, the control group were just briefed about the same sequence of gameplay they have to finish and to voice out if they need help. The biggest difference in their case is the absence of a proactive coach to chart their progress, encourage them and present the next goal.

In a nutshell, we designed the implementation of GSM for our study by recontextualizing Propp's functions, writing guided prompts and identifying possible transitions along with their conditions. The implementation is then realized in the form of a computer agent; the computer agent serves as the elderly's game coach throughout their Pumpkin Garden gameplay session while the researcher provides actual guidance and persuasion when needed.

9.3 Results, Findings and Observations

The findings for study 2 seeks to answer the question presented in 9.1 *"How does GSM coaching improve participants' game performance, game literacy and game experience?"*

Through the study of how participants react to the game challenges and how our coaching helped them, we are able to gain a better understanding towards GSM's effectiveness as a coaching model.

9.3.1 Participants' Demographics

The following table summarizes the demographics of the participants based on pre-survey questionnaire results.

Table 28. Demographics of the 51 Participants for Study 2

To understand how representative our sample is compared to the Singapore population, the percentage of each age group is compared. The graph shows the percentage of each age group for 3 different populations: Singapore Residents [277], Study 1 sample and Study 2 sample.

Figure 42. Participants Demographics Age Group Comparison with Singapore Population

The CORREL formula in excel is used to compare how closely the study participants' age group resemble the Singapore resident population:

$$\text{CORREL}(\text{Study 1 sample, Singapore Population}) = 0.737$$

$$\text{CORREL}(\text{Study 2 sample, Singapore Population}) = 0.799$$

Hence, both Study 1 and Study 2's samples are adequately representative of the Singapore population. Study 2's participants are more representative as it has higher positive correlation.

9.3.2 Quantifiable Metrics: Game Performance, Literacy and Experience

Here we compare the game performance, game literacy and game experience across the experiment group who received GSM coaching, and the control group who are not coached.

9.3.2.1 Time Taken to Finish Each Round

Although game performance is not a direct measure of game experience, it nevertheless has a correlation to enjoyment as literature suggests [65, 70]. Hence, we use game performance as a tool to obtain preliminary understanding towards how well participants are doing under our GSM-driven coaching.

We recorded participants' game performance in terms of time taken to complete each round, measured by an in-game timer in seconds. In the graphs below, we highlight the average playtime and the standard deviation playtime of each round for both the experiment and control group. We also group our findings into one chart per minigame so that 2 groups' performance in the same minigame can be compared together. Participants have played 4 minigames in each session; each minigame consists of 6 rounds (see Figure 9). This yields 4 graphs in total.

Independent samples t-test is used to compare the statistical significance of mean values of performance metrics between control and experiment group. If the differences between mean values are significant, we can conclude that coaching is likely the factor that caused the differences (i.e. confident to claim that the mean differences did not occur by random chance).

Figure 43. Time Taken to Finish Each Round in Water Wheel Gameplay Using Hand

Figure 43 compares the time taken for participants to finish the water wheel game with their hand. Here we highlight key findings for the data:

a) Coaching helps elderlies learn faster:

The first round took slightly longer on average to complete, but participants in the experiment group were quickly able to learn the mechanics of the water wheel game when using their fingers. The faster learning speed of participants that went through coaching are shown by the sharp dip in time after the first round. On the other hand, in the controlled group, their time taken saw slower improvement and only stabilizes until the 3rd or 4th round.

Table 29 below uses the average number of rounds taken to learn as a metric, which is defined as rounds taken for play time to improve less than 1%. In other words, the round that the elderly stops improving.

Table 29. Independent Samples t-test of Mean Rounds Taken to Learn for Each Minigame

Participant Group	Water Wheel (Hand)		Water Wheel (Mouse)		Water Wheel (Apple Pencil)	
	Coached	Non-coached	Coached	Non-coached	Coached	Non-coached
Average No. of Rounds Taken to Learn	2.2	4.2	3.55	3.95	2.4	2.45
Improvement in %	47.62% **		10.13%		30.43% **	

*. T-test is significant at the 0.05 level (2-tailed).

**. T-test is significant at the 0.01 level (2-tailed).

This learning effect produced by coaching is significant in gameplay with the hand and the apple pencil. However, it appears that the elderly generally struggled with learning the mouse as they did not use it regularly in everyday life. Table 31 below provides evidence that the mouse is perceived as a significantly harder minigame.

b) Coaching might motivate elderlies to achieve game goals faster

Each round in the experiment group is completed in shorter amount of time. Table 30 below summarizes the time improvement between each group in all 3 water wheel minigames.

Table 30. Independent Samples t-test of Mean Time Between Participant Groups

Participant Group	Water Wheel (Hand)		Water Wheel (Mouse)		Water Wheel (Apple Pencil)	
	Coached	Non-coached	Coached	Non-coached	Coached	Non-coached
Average seconds	33.089	41.643	62.966	78.592	25.312	30.098
Improvement in %	20.541%		19.882%		15.901%	

The improvement has low significance value however, which agrees with the overlapping standard deviation error bars in Figure 43, Figure 44 and Figure 45. The

performance difference between each individual elderly is large, indicating disparate gameplay skills among elderlies who has little prior experience with games. As a result of this disparity, the improvement in play time cannot be confidently attributed to the presence of coaching. A larger sample size should be able to reveal more insights to confirm this phenomenon.

Figure 44. Time Taken to Finish Each Round in Water Wheel Gameplay Using Mouse

We observed interesting trends when the participants were playing the water wheel minigame with the computer mouse (Figure 44):

a) Increase of challenge

Participants generally experienced a difficulty spike in this minigame. Table 31 below shows the difficulty change in terms of average time difference between the 3 minigames. The higher the average time difference, the more participants perceive a change in game difficulty.

Table 31. Independent Samples t-test of Average Time Difference Between Each Minigame

Time difference between minigames	Average Time Diff	Std. Error of Time Diff	95% Confidence Interval for Average Time Diff
Mouse vs. Hand	33.412**	6.376	[20.718, 46.107]
Mouse vs. Apple Pencil	43.073**	6.011	[31.107, 55.039]
Apple Pencil vs. Hand	9.661**	2.971	[3.746, 15.576]

*. T-test is significant at the 0.05 level (2-tailed).

**. T-test is significant at the 0.01 level (2-tailed).

From rows 1 and 2 in Table 31 above, the time taken to complete the water wheel minigame using the mouse is significantly longer, compared to the two other tools. The 95% confidence interval indicates substantial differences between time taken, as even the lower bound is more than half the mean of time difference. This signifies the challenge faced by elderly participants in this minigame.

b) Dropout observed from control group

Due to the increased difficulty, 4 participants requested to drop out in the control group (1 after round 2, 2 after round 3, 1 after round 4). In contrary, the experiment group saw no dropouts in this segment. Participants who dropped out tends to be those who spent the most time on each round as they expressed to be unfamiliar with the computer mouse. Thus, the control group's average time has reduced for R4 – R6, more closely resembling the experiment group (where slower participants are more motivated not to give up).

Figure 45. Time Taken to Finish Each Round in Water Wheel Gameplay Using Apple Pencil

Figure 45 above shows the time taken to complete the water wheel minigame using the apple pencil (referred to as “pen”). This segment came as a relief for our participants as they found the pen significantly easier to operate.

- a) Participants in the experiment group still performs faster on average (see the “Water Wheel (Apple Pencil)” column in Table 30).
- b) The faster learning speed is also visible here (see the “Water Wheel (Mouse)” column in Table 29).
- c) Average gameplay time is faster than gameplay with the hand. From row 3 in Table 31 above, participants are faster by 9.661 seconds on average with a 95% confidence interval of [3.746, 15.576]. Some participants attributed their familiarity to the pen that helped them perform better or prefer this method of play. Section 9.3.3.2 provides more detail to this observation.

Figure 46. Time Taken to Finish Each Round in Weed-Clearing Minigame

The weed clearing game (Figure 46) as a different minigame entirely from the water wheel presents several characteristics:

- a) Round 1 and 2 in the weed clearing minigame took little time to complete, while round 3 saw an increase in the time taken to complete. This is because the weeds spawn in a curving shape instead of a straight line from round 3 onwards, causing a slight difficulty increase.
- b) For round 1-2 and 3-5, we still observed a reduction of the time taken to complete a round. In other words, the “learning effect”.
- c) Special circumstances emerge for round 6 (the Final Challenge in coached experiment group) where participants chased a continuously growing stream of curving weeds. They are directed to the next scene if they did not clear all weeds in time in the current scene. The time deviation is significantly larger; this round is typically cleared either within 10 seconds or beyond 50 seconds. Either participants were able to catch up to the growing weeds before they grow off the screen, or they are not able to and had to spend

more time in subsequent screens. As a result, the group of participants who did not manage to clear the first screen spent a lot of time in subsequent screens, causing the average time to become disparately high.

- d) In this final challenge, 3 participants from the control group requested to stop; they did not continue to try after the first several screens. Whereas for the coached group, participants are encouraged to try harder, and those who did not catch up are fast-forwarded to the last scene, which helped them complete the final challenge.

Through the analysis above, we observed that coaching helps participants learn faster, play faster on average, and helps them focus on challenging parts instead of thinking of giving up. Thus, we conclude that coaching helps participants perform better and feel prouder of themselves after they are able to complete the game, especially the challenging parts (e.g. water wheel minigame with mouse and round 6 of weed-clearing minigame).

The Coach's Role in the Gameplay Session's Difficulty Curve

The average time taken to complete each minigame rises and falls based on the commonly experienced difficulty curve. Figure 47 in the following page provides an overview of the said difficulty curve.

Figure 47. Visualized Difficulty Curve of Different Minigames Based on Average Time Taken to Complete

Based on their time taken to play, we identify a theme of rising and falling game difficulty as one of the key gameplay experiences created in Study 2.

First, participants learnt about the basic gameplay mechanics by playing the water wheel game with their fingers. This is generally simple and does not pose a great challenge to the participants. This is when they grow familiar to the action of holding down a finger and turning circles with the other.

Next, we asked participants to play the same game using the mouse. The water wheel gameplay using the computer mouse is deemed hardest since participants spent the most time on it. Our

elderly participants experienced a difficulty spike in gameplay due to lower familiarity threshold with the computer mouse and less intuitive cursor behaviour compared to touching the screen with fingers. This is the point when our participants truly get pushed out from their comfort zone and engage with the game [205]. At this point of interest, we can observe how different participants react to this difficulty spike (see 9.3.3.1) and the coaching scenarios that emerge.

After the mouse, we let participants use the pen to play the water wheel minigame. The difficulty of this part is perceived as roughly similar to finger play (if not easier). The drop in difficulty provided some form of relief for participants, and they were able to complete it in the shortest amount of time out of all minigames.

Lastly, participants are required to play through all 6 rounds of the weed clearing minigame. The first 2 rounds allow participants to learn the new minigame mechanics (simultaneous upward movement with both fingers) while the following 3 rounds challenged the participants to produce curved, synchronized motion. These newly required skills had been difficult for some to pick up. The 6th and last round further challenged participants to catch up to the constantly growing number of weeds, which is the reason it is set as the final challenge the participant must face in order to complete the game session.

The series of game tasks posed different amounts of challenges to each participant. The coach is an important mediator in this case to regulate the actual difficulty presented to the elderly players so that they can be “optimally challenged” and truly engage with the game tasks. In the following sections, we review their learning outcomes (i.e. game literacy) and game experience to further assess the qualities of the coached gameplay sessions.

9.3.2.2 Comparing Responses of The Game Literacy Questionnaire

The Game Literacy Questionnaire is a suitable tool to assess the learning outcome of our coached game sessions. In particular, the Information, Learning, Resource Management and System Skills (ISM) subscale [275, p. 67] evaluates participant's ability to read, understand and subsequently apply knowledge into their gameplay.

The following questions have been omitted despite being part of the ISM construct, since the Pumpkin Garden game as a PD early detection / rehabilitation health game only required players to perform simple gestures following certain on-screen patterns. As such, it did not involve managing in-game resources.

- I know how to successfully manage in-game resources (like health, mana, seeds, land, vehicles, followers, or any other limited, useful and controllable element in a video game).
- I am good at maintaining satisfactory levels of resources.
- I enjoy balancing limited resources in games.
- I actively plan/schedule gameplay behaviour based on a need or desire for certain types or levels of resources.

The rest of the questions in the ISM construct are administered to participants after they finished the game session. Independent samples t-test is conducted to compare the mean scores between the coached experiment group and control group. Significant differences are highlighted below.

Table 32. Study 2 Results: Game Literacy Questionnaire ISM Construct

	Experiment Group		Control Group	
ISM Question Item	Mean Score	SD	Mean Score	SD
It is easy for me to obtain information in or about games.	2.40	1.231	1.70	1.174
I can successfully monitor inputs, meters, points, and other sources of information that video games present. *	2.65	1.182	1.85	0.988
It is easy for me to recall information about games after the gameplay experience.	2.50	1.235	2.15	1.309
It is easy for me to look up information about games after the gameplay experience.	2.30	1.218	2.20	1.105
I am confident in my ability to analyse information and feedback presented by video games. **	2.65	0.875	1.75	0.786
I am able to appropriately implement information from or about games. *	2.60	0.754	1.95	0.759
I am able to assess the quality of the information I receive from video games. **	2.45	0.605	1.80	0.696
I am good at explaining information from or about games to others.	1.95	1.146	1.95	1.05
I pick up the rules of most games fairly quickly. **	2.65	0.745	1.90	0.852
I am good at understanding the consequences of my in-game actions.	2.10	1.119	1.60	1.095
I tend to explore how the systems (including rules) of a game work in-depth.	2.05	1.146	1.70	1.342

	Experiment Group		Control Group	
ISM Question Item	Mean Score	SD	Mean Score	SD
When the situation changes, I actively attempt to update my information.	2.20	0.894	1.75	1.02
I build on my knowledge of games to better my understanding and/or proficiency.	2.25	1.07	1.90	1.21
I understand the more complicated parts of games because of the simpler actions that built up to them.	2.40	0.995	1.85	1.182
I know how to manipulate virtual environments.	2.20	0.834	1.85	1.137
I know how to navigate virtual environments. **	2.65	0.813	1.70	0.865
I am proficient at controlling games. **	2.35	0.671	1.65	0.671
I am proficient with the interfaces in games.	2.35	1.089	1.90	1.119

*. T-test is significant at the 0.05 level (2-tailed).

**. T-test is significant at the 0.01 level (2-tailed).

Results of the Game Literacy Questionnaire are satisfactory; elderly players who received GSM coaching reported higher confidence and ability in understanding the visual and auditory feedback provided by the Pumpkin Garden health game (**bolded scores**). This has manifested in their results above too as they are able to both learn and complete the game slightly faster than the control group.

Unsurprisingly, questions like “ease of recalling information”, “understanding in-game action consequences” and “exploring how game systems work in-depth” do not present differences that are as significant. This is expected as given our participants’ little to no prior experience with video games, they are able to play the Pumpkin Garden game well after simply understanding the basic feedback that games provide. Reading deeper in game mechanics or

recalling game information afterwards are not required in Pumpkin Garden; these skills are relevant in more sophisticated games.

Thus, the Game Literacy Questionnaire results support use of GSM coaching to help elderly players with low game literacy to engage and better interact with health games. Next, we look at the effects of GSM coaching on participant's health game experience.

9.3.2.3 Comparing Responses of The Health Game Experience Questionnaire

Table 33. Study 2 Results: Health Game Experience Questionnaire Results

	Experiment Group		Control Group	
Constructs	Mean Scores	SD	Mean Scores	SD
Core Constructs				
Positive Affect	2.650	1.004	2.240	1.120
Competence**	2.720	0.817	2.120	0.447
Sensory and Imaginative Immersion*	2.650	0.893	2.033	0.675
Flow	2.450	0.892	2.020	0.615
Negative Affect	1.025	0.826	0.950	0.798
Challenge*	<i>1.430</i>	1.010	<i>2.010</i>	0.706
Tension*	<i>1.601</i>	0.826	<i>2.167</i>	0.525
Health Values*	2.690	1.069	1.930	0.948
Familiarity*	2.883	1.067	2.168	0.745
Identification of Human-Like Properties*	2.840	1.249	1.970	0.898
Post-Game Constructs				
Positive Experience*	2.692	1.035	1.809	1.037
Negative Experience	1.075	0.760	1.268	0.721
Tiredness*	<i>1.200</i>	1.237	<i>1.850</i>	1.105
Return to Reality**	2.550	1.194	1.584	0.926

*. T-test is significant at the 0.05 level (2-tailed).

**. T-test is significant at the 0.01 level (2-tailed).

To recap, the HGEQ is an extension to the GEQ that aims to factor in health game-specific and elderly-specific constructs to better capture the health game experiences among the elderly. With the scale validated in our study 1 (6.3 above), we can use it to measure the EHGE produced by GSM coaching.

The higher mean scores (**bolded scores**) for health values indicated that the game's health values highlighted in the introduction and persuasion process (for some participants) are well-received by participants. Our elderly participants are also able to better identify with human interactions and familiar objects when playing the Pumpkin Garden game under coaching.

The higher competence suggests that players with presence of coaching have more confidence in their abilities to perform well in the game, thus agreeing with the Game Literacy Questionnaire results (section 9.3.2.2 above). Whereas the significantly higher immersion, post-game positive experience and return to reality suggest a higher level of immersion for players who received coaching as a result of being able to engage better with the game.

Conversely, players who did not receive coaching reported higher amounts of challenge, tension and feeling of tiredness after the game (*italicized scores*). These may have originated from the less fruitful game session that they had where they may encounter similar issues to participants interviewed in study 1: unintuitive gameplay and lack of direction that makes them not know what questions to ask in the first place.

Thus, the HGEQ supports the effects of health game coaching in producing better game experiences for the elderly.

Summary of Quantitative Findings

The time taken to complete each round, game literacy questionnaire and HGEQ provides proof that GSM coaching improves the gameplay quality and game experiences of our elderly participants who had little to no exposure to video games before the study. With these, we are

confident that the GSM coaching methodology can produce fruitful learning experiences for the elderly.

9.3.3 Qualitative Observations: The Coached Game Experience

This section presents how our GSM implementation mapped the whole process of our elderly participants' gameplay session as a story, and how we coached them throughout this story that caused them to report a positive game experience after the gameplay session. We base our findings off the detailed field notes taken for 5 random participants in the experiment group. The field notes consist of real-world observations from mainly 2 sources: the researchers' observations of participants' gameplay process, and the sharing of participants' personal experiences in the post-game interview. We only conducted such in-depth data collection and analysis for 5 random participants in the experiment group for practical reasons, as such sessions can take up to half-a-day (the pre-study is a good example of this).

Obtaining a Narrative Perspective in Viewing the Health Game Experience

The numbers presented in section 9.3.1 above presented GSM coaching's ability to improve participants' game performance, literacy and experience. We then identified difficulty curves as a theme and analysed how participants cope with challenges under our coaching. Several themes appear in our gameplay session: how our player deals with challenges, and how we can coach them to enjoy a better game experience. Although certain coaching scenarios were planned (section 8.3 above), these events from an overarching story are still unique to each participant.

This view (that an overarching story exists in participants' game experiences) is in unison with the narrative construction of reality [263], which suggests that our lived experiences can be reconstructed into a storyline which bear great relevance to the person in the living. It suggests that the GSM implementation which is based on a narrative theory itself is a valid method to

interpret a situation and provide points of intervention to persuade a better outcome for the lived story. For our case, we will investigate into the different roles of the coach (i.e. Propp's Character Archetypes) throughout different segments in the gameplay session (i.e. Propp's Functions).

9.3.3.1 Storytelling Mechanism: Four Key Segments of Propp's Functions

In line with Propp's theory, we use the term "Hero" to refer to the elderly, the central character of the story. The game coach, in this sense, wears the hat of various characters in Propp's Archetypes that helps the hero along with his journey (e.g. helper, donor, dispatcher).

Below we present some key segments of the hero's learning journey as examples to validate the proposed coaching scenarios in 8.3 above.

Coaching Scenario 1: Introduction

The researcher started by addressing an Interdiction to the hero, which comes as a prompt to try out the game in order to complete the "quest" (study). Some participants felt nervous as they are not well-trained in using touchscreen devices. In the interview, P2 shared that when he is asked to play initially, he felt pressured to play well. Others are more carefree as they are confident the researchers will guide them well. When we asked P5 if she is nervous when we handed her the iPad, she responded with "not at all, I'll follow what you say". The contrasting reaction resembles how different heroes would have reacted to the same Interdiction.

Since participants has been told about the Pumpkin Garden game's health benefits, they tend to oblige and attempt to play the game when prompted, thus fast-forwarding us to the Departure stage.

In the Departure stage, participants proceed with a minigame by themselves after receiving a briefing on how to play the minigame. For the water wheel minigame, they are told to place a finger on the red dot and use another hand to turn circles, following the shape of either the

small or the big wheel (requirements alternate between different rounds of the same minigame). For the weed-clearing minigame, they are simply told to use both hands to gesture along the shape of the weeds. This briefing is deemed necessary as they would not have been able to start playing otherwise and could be thought of as “packing up before the journey”. After “sending them off to begin the journey”, we observe them until they encounter difficulties. The diagram below sums up the common path taken by all 5 observed participants.

Figure 48. Study 2 Coaching Scenario: Introduction

According to Propp’s Character Archetypes, the game coach in this segment acts simultaneously as a *Helper* and a *Dispatcher*. Helper for providing initial help to the hero by giving them direction, and Dispatcher for sending the hero onto the journey.

Coaching Scenario 2: Completing a Game Task

A game session requires participants to complete a number of tasks. However, knowledge barriers are present when the elderly interacts with digital games, especially for participants with little or no prior exposure to digital games. When P5 first started to play the water wheel minigame with the mouse, he does not possess prior knowledge on using the computer mouse. Hence, we observed a troubled expression on his face. At this point in the gameplay session, the knowledge required to complete the game task on hand is absent, hence he is unable to proceed with the game task. This knowledge gap manifests as challenges he has to overcome.

Coaching Scenario 2-1: Encountering and Overcoming Challenges

As participants eventually encounter challenges, they will try to overcome the test. This phenomenon can be mapped to Testing in Propp's functions. Here is where we paid attention to how they cope with the test and whether they are able to cope with the test by themselves. The test presents itself in a variety of ways throughout the study. The most commonly observed challenge is the lack of knowledge towards digital games. To various extents, this phenomena has caused some form of lack of confidence to develop in them, which hampered their ability to keep to the target of making well-formed circles (in the water wheel minigame) or receiving audio-visual feedback when cutting the weeds (weed clearing minigame).

It is oftentimes best to let the participants overcome the problems themselves if they have the ability to do it. P3 felt challenged when he uses a computer mouse to play the water wheel minigame, which can be observed through his extremely slowed down gameplay and his look of concentration. He also reported the feeling of being challenged in the subsequent interview. However, he did not show signs of quitting; instead he was able to complete the 3 rounds of the game through self-motivation and, as he put it, "staying immersed and focused". Hence, in each round, he has proceeded to the Acquisition stage without the need of our assistance. The diagram below indicates the path P3 has taken.

Figure 49. Study 2 Coaching Scenario: Overcoming a Challenge

There are measures we can take when it becomes obvious the participant could not solve the challenges by themselves. P1 and P5 both encountered difficulties when synchronizing their fingers in the weed clearing minigame. For more than half a minute, they not making any progress; in their perspective the screen seemingly did not react to their inputs which is a source of frustration. Now in the Reaction stage, we explained the step-by-step process to her on how to synchronize the fingers and move upwards together, at the same time providing real-time feedback by asking them to go back when her fingers have slid too far ahead without registering progress. With specific instructions to help them break a problem down into understandable goals, their performance improved, and they are able to complete the first 5 rounds of the weed clearing minigame. The following diagram indicates the path P1 and P5 have taken.

Figure 50. Study 2 Coaching Scenario: Overcoming a Challenge (Help Required)

An interesting story usually features the hero facing off with challenges hard enough for them to develop their character, and achievable enough for them to survive the challenges. The role of the coach in this case is the *Donor* who provides assistance (albeit sparingly¹⁰), in the process producing an optimal level of challenge to maximize satisfaction. This act is also known as dynamic game balancing [278] and is in line with how goal-setting recommends tasks which

¹⁰ The *Donor* and *Helper*, although alike in functionality, differs in the way that the donor attempts to put the hero through some kind of test before rewarding them (hence the *Testing* function); whereas the helper may help the hero without their knowledge.

are “difficult enough to stimulate performance and fair/reasonable enough to obtain commitment” [269].

Coaching Scenario 3: The Final Challenge

The game session concludes with a challenging round 6 of the weed clearing minigame where it is possible to lose by getting overrun by the weeds, known as the hero’s Struggle. We described the round as the ultimate challenge of what participants has learnt in the previous rounds of the weed clearing minigame. Upon the warning, all participants assumed a ready stance to chase the weeds as they grow on-screen, appearing to be within reach visually. P2, P3, P4 successfully caught up to the growing weeds and won the round in a short amount of time. P1 and P5 had the same issues they had before; they could not clear the weeds as fast as the others. With our encouragement, they tried their best and managed to eventually catch up with the constantly growing number of weeds. We applauded them for achieving Victory in our game session, and they too showed smiles of relief in return.

Figure 51. The Struggle to Victory Signifying the Completion of the Game Session

By applauding the elderly for their dedication towards completing the game session, we draw their learning journey to a close by providing the reward (the *Princess*) that the Hero has proved worthy of.

Coaching Scenario 4: Persuading Participants not to Give Up in the Face of Challenge

Participants' motivation to play the game appears to be hampered if the dissatisfaction persists for too long. When turning the water wheel, P2 has stopped a few times mid-game, which presents a Violation of Interdiction. We asked what is wrong and she vaguely expressed about not wanting to continue playing. Upon further inquiry, the Villainy / Lack is made known. She said, *"my reaction is very slow, I don't know how to play."* From our interaction, we noticed that she reacts better to cues and prompts rather than logic and reasoning, hence we encouraged her through a peripheral route. *"You played very well just now, keep it up."* After the encouragement, she continued to play but still mumbled on her unsatisfactory performance, which we prompted with *"you are doing great, go on and you should complete it in no time."* After spending some time in Mediation, she chose positive action (Counteraction), and continued to play subsequent rounds without further complaint (Departure).

P1 when first playing with the weed clearing minigame asked if she can choose not to play the part, as she found it challenging and unsatisfying (Villainy / Lack). She seemed like a fact-driven rational individual. In ELM's terms, the need for cognition is high, thus we decided to go through the central route of persuasion. We explained that her gameplay result is part of our data gathering process to improve the game's detection capabilities, hence her gameplay data is valuable to improve the game and help future PD patients in their diagnosis. She thought about it (Mediation) and agreed to continue despite the foreseeable production of unsatisfying results (Counteraction).

The diagram below indicates the path P1 and P2 has taken in the above 3 scenarios.

Figure 52. Violation to Counteraction Requires Persuading Participants to Accept the Game

Unlike Propp's theory, the Violation of Interdiction in GSM's context typically do not occur after Interdiction (i.e. Hero asked to play). Rather, it only comes after an initial Departure (i.e. started to play for the first time) which the Hero withdraws after discovering the significant challenges presented ahead of them in the game session. The coach in this case has to complete his duty as a *Dispatcher* by leveraging ELM persuasion techniques.

In the above analysis, we did not explicate the False Hero nor the Villain; although one could argue the health game to be a source of challenge for our players (like the Villain), we nevertheless played down that aspect avoid attaching a negative stigma to the health games they are supposed to enjoy. Another interesting "potential Villain" can be the elderly's pre-existing unwillingness to participate in health games; an abstract "dark side of the self". While not explicated in this study, it may be an interesting coaching technique to personify a player's unwillingness to themselves in future studies.

Table 34 below concludes the points illustrated above.

Table 34. Summary of the Coached Game Experience as a Proppian Story

Coaching Scenario	Propp Functions	Segment Description from Hero's Perspective	Coach's Character Archetype
Introduction	Interdiction → Departure	Setting off for the journey	Helper Dispatcher
Completing a Game Task	Departure → Guidance	Completing a Game Task	Observer
Overcoming a Challenge	Testing → Acquisition	Encountering and overcoming difficulties	Donor
Persuading the Elderly to Continue	Violation → Counteraction	Regaining interest towards the game	Dispatcher (using persuasion)
The Final Challenge	Struggle → Victory	A stretch of unassisted gameplay as a final challenge	Donor (more conservative with providing help)

Above summarizes the GSM *storytelling mechanism* as observed in real life. It has shown that Propp's theory of storytelling is a viable method to chart down our elderly participant's gameplay learning journey as a story of their own experiences. In the following section we will discuss how the goal setting, familiarity and persuasion mechanisms are applied in our study.

9.3.3.2 Goal Setting, Familiarity, Persuasion Mechanisms

Different mechanisms worked in different stages of the study to provide our participants with a positive health game experience.

When coaching participants to play the Pumpkin Garden game, we heeded goal setting's recommendation to pose adequate challenges and regulated our intervention frequency. We allowed P3 to find his own way around a problem and helped out P1 and P5 when things get too hard for them. Based on P3's description of feeling relaxed and satisfied after the challenge

and P1's appreciation towards our "helpfulness", we can recognize that they appreciated the dynamic scaling of the challenge tailored to them.

"I saw the goal, I saw your (water wheel) bar! You are very encouraging."
(P1, Female, 64 years old)

"How do you motivate yourself to continue playing, when you notice you are losing focus on the game?"

"I just try my best to maintain my performance and try to draw faster whenever possible. I never thought of giving up."

(P3, Male, 72 years old)

Familiarity was observed and utilized during the gameplay when we drew relevance of game task to real life. When P4 had issues when playing with the mouse, the relevance of the pen to her everyday life helped her regain the interest towards the game.

"Which tool (pen, mouse, finger) do you prefer the most to play the water wheel minigame?"

"I prefer to use the pen as it is easier to play. When using my finger, I need to apply more force. I dislike the mouse the most."

(P5, Male, 66 years old)

P3 also attributed his hobbies when asked about his good performance in the weed-clearing minigame.

"How do you find the weed-clearing game?"

"That one is easy. I play Ukulele! That's why I can coordinate my hands. I am now trying to learn piano, self-taught through online. I find it very difficult... have to keep on trying."

(P3, Male, 72 years old)

During "Violation to Counteraction" when we persuaded participants not to give up, we applied central and peripheral routes of persuasion onto P1 and P2 respectively. They were, as a result, able to finish the game and have a better overall game experience for knowing they accomplished the game without quitting.

"I tried to coordinate but (I was) not able to. It is quite frustrating... But I stayed positive and kept trying, and you encouraged me to play on."

(P1, Female, 64 years old)

“I lose control easily while playing the water wheel minigame. But I still try to keep playing to finish it... I try my best to complete the game even if I face challenges.”

(P2, Female, 70 years old)

The practices presented above illustrates how familiarity, goal setting and persuasion mechanisms work within the storytelling framework to keep players on track (i.e. avoid the “Violation to Counteraction”) and tackle in-game challenges with a positive attitude (i.e. embrace and enjoy the “Testing to Acquisition cycle”).

Summary of Qualitative Findings

Based on the observations above, the gameplay session can be summarized as a cycle of monitoring and intervention featuring the player (as a Hero), the coach (as different types of characters that helps the Hero) and the game (as a challenge provider that is not explicated into a character). The coach encourages the elderly to commence the game session and takes the role of various characters that help the Hero (the elderly) when they encounter challenges. The coach also persuades the elderly to continue the game session whenever they wanted to give up. The dynamic scaling of game difficulty, encouragement and central / peripheral routes of persuasion carried out by the game coach helps the Hero complete their journey with meaningful development and outcomes.

9.4 Summary

In study 2, we have devised an implementation of the Goal-Oriented Storytelling Model and showed that it helps improve the elderly’s game performance, game literacy and game experience using appropriate metrics. Then, we painted the participant’s learning journey as a story and put forward examples to describe GSM coaching scenarios. These real-world observations were presented to detail how each GSM mechanism contributed to our participant’s positive game experience. We also presented real-world relevance for persuasion, goal setting and familiarity mechanisms from participants’ interview responses.

With both quantitative and qualitative results, the GSM is shown to provide a sound, step-by-step coaching strategy that allows participants to engage with, complete and eventually enjoy health games.

10. Conclusion

The eventual goal of having a positive health game experience is to allow the elderly (the *digital immigrants*) to enjoy playing health games. Through positive experiences with health games, they find it easier to accept it as part of their daily routine. In turn, the health benefits brought by health game adoption contribute to the creation of a healthy aging population.

In this thesis, we approached the challenge of promoting health games among the elderly from a novel perspective, considering the elderly's health game experience as a point of improvement instead of an in-game element. Using this approach, we have investigated what is *the* health game experience for the elderly, how can we measure it, and how to bring about positive health game experience for the elderly through the development of a coaching model and feedback tool. The Elements of the Elderly Health Game Experience, Health Game Experience Questionnaire and Goal-Oriented Storytelling Model are then presented in this thesis. The contributions are summarized below.

10.1 Depiction of the Health Game Experience among the Elderly

In the pre-study, we conducted 5 one-to-one game sessions and interviews with Parkinson's Disease patients. Through the analysis of participants' sharing, more insights are gained towards the elderly's game experiences when playing health games.

The presence of a human guide and health values have been recurring themes of discussion that appear across different interview sessions with the elderly. On one hand, the presence of a human guide along with familiarity made our game sessions smoother, more relatable and more enjoyable. Health values, on the other hand, was also a relatable topic when participants learnt of the Pumpkin Garden health game's purpose. We found that they are eager to engage with the game through the health values (presented both by the coach and in-game) that can directly address them in their health conditions.

The above findings provide preliminary understanding towards the elements unique to the EHGE.

10.2 Design of the Health Game Experience Questionnaire

We have developed Health Game Experience Questionnaire (HGEQ), which is an extension of the popular GEQ tailored for measuring health game experience. It attempts to tackle GEQ's lack of validation in health game use and lack of utilitarian experience dimension.

HGEQ includes three additional constructs: Health Values, Familiarity, and Identification of Human-Like Properties, all of which have theoretical and practical support. Health Values consists of perceived health value, relevance of health value, utilitarian over hedonic, and explicit address of health value. Familiarity manifests in 3 categories of symbolic, cultural, and actionable familiarity. Identification of Human Like-Properties, on the other hand, comprises 5 subconstructs of autonomy, situation awareness, proactiveness, interactivity, and personification. 13 additional questions were generated based on these constructs, which are then added to the Core Module of the original GEQ.

To fully evaluate the suitability of HGEQ, we have conducted a quantitative study to establish the criteria of reliability, validity, and sensitivity. Fifty-one elderlies participated in the study, providing us with real health game experience data. Despite insufficient score from some sample size-sensitive fit indices, sufficient evidence can be drawn from Confirmatory Factor Analysis (CFA) to our model's internal consistency reliability, convergent validity, and discriminant validity. Further studies should confirm the HGEQ's predictive validity.

10.3 Design of Goal-Oriented Storytelling Model

The GSM has been developed to provide coaching that is tailored to specific health games. When implemented, it enacts a game coach that can help the elderly improve their game literacy

and subsequently enjoy a better health game experience. The GSM has been constructed from various practices in the field of coaching like storytelling, persuasion and goal setting.

Drawing inspiration from storytelling's applications in both video games and real-world behaviour change, the GSM proposed to recontextualize the elderly's gameplay process as a narrative journey. The moment-to-moment story points are selected from Propp's 31 functions and modelled into coaching scenarios using the goal net theory. In the model, we also provided suggestions to design the coached gameplay session in a goal-oriented manner, utilizing persuasion strategies where needed to overcome rejections that may stem from the initial unpleasant game experiences. Familiarity was also used to highlight what makes a game appealing to our elderly.

In study 2, we have demonstrated a comprehensive implementation of GSM in the Pumpkin Garden health game, which was used design our gameplay session. We then recruited 40 elderly participants with little to no gaming experience. Various metrics between the control and experiment group were compared: game performance, game literacy and game experience. We also randomly selected 5 participants from the experiment group to collect more real-life observations and conduct phenomenological analysis. Ultimately, storytelling is a viable method to "storify" a game session with the elderly while persuasion, familiarity and goal setting are presented as coaching techniques that allow the coach to take on different roles (and hence attitudes) in different phases of the story. The metrics agree that GSM helps provide a more fruitful game session to the elderly as a form of a learning journey.

Thus, we are confident that the GSM is able to provide a methodological way to coach the elderly in an unfamiliar world of health games and through the process, help them obtain a better health game experience.

10.4 Future Research Direction

All 3 contributions in this thesis provide a new perspective on health game adoption factors, namely on the essence of health game experience itself and a storytelling approach towards the formulation of health game coaching. They may serve as a basis for setting the direction for future work. Here we present some points of improvement that are worthy of exploration.

10.4.1 Improvements to HGEQ

Verification of Social Presence Module

The social presence module, although part of HGEQ, is not covered in our study as we tested HGEQ on a single player game. It would be beneficial for future studies to uncover the relationship between the newly added constructs and the social presence module, as well as possible new constructs relevant to the EHGE.

Broader-Scale Testing on Larger Sample Size

As mentioned earlier, we cannot confidently establish the predictive validity due to a few suboptimal fit indices. This is likely due to small participant size relative to the number of question items in HGEQ. While there is no clear evidence-based approach towards finding the optimal number of participants, most researchers have used at least 100 participants or 2 participants per question items for their studies [279], both of which we were short of. Therefore, broader-scale testing will be beneficial to provide further evidence for HGEQ's validity.

10.4.2 Improvements to GSM

Exploration of More Varied GSM Implementations and Goal Net Compositions

The GSM implementation demonstrated in study 2 focused on validating model constructs, which leaves plenty of exploration for a wider variety of implementations. Other GSM

implementations that select a different subset of Propp's functions or use more advanced goal selection mechanisms may uncover an entirely different phenomenon. More research can be done to explore these implementation variations and in extent, new methods of coaching that is effective for elderlies from other demographics, apart from the PD patients that we have studied.

Future implementations of GSM can also utilize more design methods outlined in Goal Net theory such as goal composition, goal relationships and goal selection mechanisms. The details of these design concepts may provide valuable insights for more dynamic forms of coaching.

Development of the Villain or False Hero

The GSM as a coaching model can be expanded to properly define the Villain or False Hero (possibly both at the same time). This approach of personifying the Villain may generate positive effects such as allowing players to visualize their internal hurdles. However, care should be taken to avoid players from perceiving it as a personal attack.

Computer Agent Implementation

Since GSM is designed based on the goal net theory, design recommendations are available to help create a coach that is fully driven by AI, which can successfully respond to real-life game coaching scenarios through a storytelling driven methodology with the aid of the predefined coaching scenarios. The potential of such intelligent agents can be further explored.

Generalizability for Other Learning Purposes

The GSM coaching model, although designed for health games, could potentially be recontextualized to support the elderly in the process of learning to use digital products. "Learning sessions" could be similarly structured as a story to become more engaging, enhancing the experience and process of digitalizing elderlies' lives.

10.4.3 Utilization of Crowdsourcing

Through the collective wisdom of crowdsourcing, more data samples can be obtained to validate or uncover new dimensions of the HGEQ. Crowdsourcing may also help train a digital coach that runs on the GSM model to build large knowledge bases on various topics to be used as familiarity-inducing topics or perform context-aware persuasion that is more convincing.

10.4.4 Potential Benefits of the EHGE Approach towards Health Game Design

10.4.4.1 Affective Design for Health Games

From an experiential point of view, health games that have obvious, appealing health benefits and elements familiar to the elderly are better received by the elderly, even when they have weakened ability to play (such as the PD patients in pre-study). A health game coach can act as an excellent mediator to personalize the game experience, which can interest elderlies to play more regularly, thus generating better health outcomes.

By proposing a first-of-its-kind approach of focusing on the EHGE, the contributions in this thesis can hopefully help health game designers implement affective design to better tailor health games for elderlies. For instance, the aspects of the EHGE validated in this thesis can be measured using sensors and be used to alter the health game to tailor it to the elderly [280].

10.4.4.2 Maximizing Health Outcomes

Effort placed into enhancing the EHGE should serve the ultimate purpose of enhancing the health outcomes provided by health games. More focused studies on how effective positive EHGE can generate health outcomes should be conducted down the road to refine this approach. For instance, rehabilitation progress can be tracked together with the EHGE for correlation analysis. If scientific evidence can be established for EHGE's relationship with health outcomes, it would be possible to collect metrics on in-game behaviour trajectories and use it to predict elderlies' intention to play the health game again in the future. This helps health

game designers assess their product with a more integrated view towards both game experience and health outcomes.

10.4.4.3 Health Game Rating System for Elderlies

Based on dimensions of the EHGE proposed in this thesis, future work can focus on refining suitable categorization methods for health games, much like rating systems for commercial games. Commercial games are typically rated by matching content suitability with teenager's age. For example, ESRB ratings cater to parent's concerns about exposing their children to inappropriate content at young age [281]. However, similar practices are not yet in place for elderly health games who are also typically under the care of someone else, and their caretakers require such ratings as a quick and reliable way to determine suitable health games for elderlies.

Instead of rating based on content inappropriateness, health games can be labelled or rated by their specialization or target audience. Health values and familiarity help pinpoint the suitable audience among the diverse elderly population, while the amount of human interactions can be used to rate a game for elderlies with varying levels of game literacy. A mature rating system for health games will make it easier for caregivers to find suitable health games for elderlies under their care, which can broaden the scope of the serious health game industry.

10.4.5 Further Research on Coaching's Effects on Positive Game Experience

While prior studies have been intensively focused on finding or validating dimensions that might be part of the game experience [42, 43, 47] (section 4.2 above), we noted that when one tries to take action to improve the game experience, they tend to be constrained into thinking how to improve the *in-game design* to create better experiences for different players.

Aside from player and game, this thesis has hopefully shed light on a third party which can play a crucial role in shaping a good game experience, known as the coach. In our study, the coach functions well as an add-on to the gameplay session. We created positive health game

experiences for our elderly participants by altering our coaching strategy via different mechanisms in the GSM, instead of focusing on changing game design itself. These efforts should run parallel to the commonly taken in-game design approach.

Simply put, the introduction of a coach comes with the addition of an avenue to enhance our participants' game experience. Future discoveries on how to integrate in-game elements with coaching elements would also be tremendously helpful towards the adoption of health games. The health game experience as a 3-way interaction between the elderly, health game and coach (sections 3.5 and 10.1) can be a starting point for the aforementioned integration work.

The future work that can be built on this exploration of EHGE remains broad and diverse. Outside of health games, other digitalization aspects could also potentially benefit from this experiential point of view. Insights for the EHGE uncovered in this thesis has hopefully provided a promising starting point to broaden the scope of health games, and in extension, encourage usage of digital technology among elderly for enhancing their lives.

Appendix A: Pre-Game Questionnaires Used in Study 1

Pre-Game Survey

Name : _____

Age : _____

Gender: M / F

1. Do you have a smartphone/tablet? (If no, skip to 8)

☐ Yes

☐ No

2. What do you use the smartphone/tablet for?

☐ Voice call

☐ Texting/WhatsApp

☐ Listening to music

☐ Watching videos

☐ Reading news

☐ Others: _____

3. Do you play games on your smartphone/tablet? (If no, skip to 8)

☐ Yes

☐ No

4. How often do you play games?

☐ Less than 1 hour daily

☐ 1-2 hours daily

☐ 2-4 hours daily

☐ More than 4 hours daily

☐ Don't know

5. Are the games that you play recommended by your family/friends/relatives?

☐ Yes

☐ No

☐ Don't know

6. Are you currently playing a same game with another family/friend?

☐ Yes

☐ No

☐ Don't know

7. Do you take time to play even when you are busy?

☐ Yes

☐ No

☐ Don't know

8. Are you familiar with using a computer mouse?

☐ Yes

☐ No

☐ Don't know

9. How proficient are you in using smartphones/tablets?

☐ Able to learn new features independently

☐ Needs help learning new features, able to use learnt apps independently

☐ Needs help using previously used apps

☐ Don't know

10. Do you have existing health conditions?

☐ None

☐ 1-2

☐ 3-4

☐ > 4

Appendix B: Game Literacy Questionnaire Used in Study 2

Game Literacy Questionnaire (ISM Question Items Only)

Name : _____

Age : _____

Gender : M / F

Answer below questions based on your feelings **after you played** the game:

	Not at all	Slightly	Moderately	Fairly	Extremely
1. It is easy for me to obtain information in or about games	0	1	2	3	4
2. I can successfully monitor inputs, meters, points, and other sources of information that video games present.	0	1	2	3	4
3. It is easy for me to recall information about games after the gameplay experience.	0	1	2	3	4
4. It is easy for me to look up information about games after the gameplay experience.	0	1	2	3	4
5. I am confident in my ability to analyse information and feedback presented by video games.	0	1	2	3	4

6. I am able to appropriately
implement information from or
about games.
0	1	2	3	4
7. I am able to assess the quality of
the information I receive from
video games.
0	1	2	3	4
8. I am good at explaining
information from or about games
to others.
0	1	2	3	4
9. I pick up the rules of most games
fairly quickly.
0	1	2	3	4
10. I am good at understanding the
consequences of my in-game
actions.
0	1	2	3	4
11. I tend to explore how the systems
(including rules) of a game work
in-depth.
0	1	2	3	4
12. When the situation changes, I
actively attempt to update my
information.
0	1	2	3	4
13. I build on my knowledge of games
to better my understanding and/or
proficiency.
0	1	2	3	4
14. I understand the more complicated
parts of games because of the
0	1	2	3	4

simpler actions that built up to
them.

15. I know how to manipulate virtual
environments.

0	1	2	3	4
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16. I know how to navigate virtual
environments.

0	1	2	3	4
---	---	---	---	---

17. I am proficient at controlling
games.

0	1	2	3	4
---	---	---	---	---

18. I am proficient with the interfaces
in games.

0	1	2	3	4
---	---	---	---	---

Appendix C: HGEQ Used in Both Study 1 and Study 2

Health Game Experience Questionnaire

Name : _____

Age : _____

Gender : M / F

Answer below questions based on your feelings **when you were playing** the game:

	Not at all	Slightly	Moderately	Fairly	Extremely
1. I felt content	0	1	2	3	4
2. I felt skilful	0	1	2	3	4
3. I was interested in the game's story	0	1	2	3	4
4. I thought it was fun	0	1	2	3	4
5. I was fully occupied with the game	0	1	2	3	4
6. I felt happy	0	1	2	3	4
7. It gave me a bad mood	0	1	2	3	4
8. I thought about other things	0	1	2	3	4
9. I found it tiresome	0	1	2	3	4
10. I felt competent	0	1	2	3	4
11. I thought it was hard	0	1	2	3	4
12. It was aesthetically pleasing	0	1	2	3	4

13. I forgot everything around me	0	1	2	3	4
14. I felt good	0	1	2	3	4
15. I was good at it	0	1	2	3	4
16. I felt bored	0	1	2	3	4
17. I felt successful	0	1	2	3	4
18. I felt imaginative	0	1	2	3	4
19. I believe this game has useful
health value to me	0	1	2	3	4
20. I enjoyed it	0	1	2	3	4
21. I would be willing to play this
game again because it has some
health value to me	0	1	2	3	4
22. I felt that I could explore things	0	1	2	3	4
23. I was fast at reaching the game's
targets	0	1	2	3	4
24. I felt annoyed	0	1	2	3	4
25. I felt pressured	0	1	2	3	4
26. I felt irritable	0	1	2	3	4
27. The health issue being presented in
the game is relevant to me	0	1	2	3	4
28. I play the game more for the health
benefits than for the fun	0	1	2	3	4

29. I lost track of time	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
30. I felt challenged	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
31. I found it impressive	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
32. The health issue is being explicitly addressed in the game	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
33. I am familiar with the objects displayed in the game	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
34. I was deeply concentrated in the game	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
35. I felt frustrated	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
36. It felt like a rich experience	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
37. I lost connection with the outside world	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
38. I am familiar with the language, expression, and behaviour being displayed in the game	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
39. I am familiar with the way to interact with the game	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
40. I felt time pressure	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
41. I had to put a lot of effort into it	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		
42. The game difficulty is continuously adjusted to my ability	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table>	0	1	2	3	4
0	1	2	3	4		

43. I felt the game was aware of my situation	0	1	2	3	4
44. I felt the game was proactively guiding me throughout the gameplay	0	1	2	3	4
45. I felt the game was interactive	0	1	2	3	4
46. I felt like interacting with a human	0	1	2	3	4

Answer below questions based on your feelings **after you have finished playing** the game:

	Not at all	Slightly	Moderately	Fairly	Extremely
1. I felt revived	0	1	2	3	4
2. I felt bad	0	1	2	3	4
3. I found it hard to get back to reality	0	1	2	3	4
4. I felt guilty	0	1	2	3	4
5. It felt like a victory	0	1	2	3	4
6. I found it a waste of time	0	1	2	3	4
7. I felt energised	0	1	2	3	4
8. I felt satisfied	0	1	2	3	4
9. I felt disoriented	0	1	2	3	4
10. I felt exhausted	0	1	2	3	4

11. I felt that I could have done more useful things	<table><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr></table>	0	1	2	3	4
0	1	2	3	4		
12. I felt powerful	<table><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr></table>	0	1	2	3	4
0	1	2	3	4		
13. I felt weary	<table><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr></table>	0	1	2	3	4
0	1	2	3	4		
14. I felt regret	<table><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr></table>	0	1	2	3	4
0	1	2	3	4		
15. I felt ashamed	<table><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr></table>	0	1	2	3	4
0	1	2	3	4		
16. I felt proud	<table><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr></table>	0	1	2	3	4
0	1	2	3	4		
17. I had a sense that I had returned from a journey	<table><tr><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr></table>	0	1	2	3	4
0	1	2	3	4		

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