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The Framework of Anthropomorphic Interface in Gamification Application for Transitional Healthcare

By

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ABSTRACT

FACULTY OF PHYSICAL SCIENCES AND ENGINEERING

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Thesis for the degree of Doctor of Philosophy in Computer Science

THE FRAMEWORK OF ANTHROPOMORPHIC INTERFACE IN GAMIFICATION APPLICATION FOR TRANSITION HEALTHCARE

Nooralisa Mohd Tuah

Anthropomorphic interfaces in gamified applications may offer different effects on human and computer interactions. Applying them in healthcare applications, particularly for a transition care, could help to support the transition process, transferring a patient from hospital care to self-care. Anthropomorphic interfaces virtually imitate the patient's health progress in the transition process which could aid in helping to maintain the patient's motivation throughout the process. Furthermore, an anthropomorphic interface is seen as a tool to support a long-term relationship, especially when human components are applied in a human-computer interaction. Combining gamified applications with an anthropomorphic interface is expected to provide a motivational effect. This can happen when an anthropomorphic interface is designed with its characteristics deemed trustworthy and preferable. However, little consideration has been given to the gamification of anthropomorphic interfaces as a supportive tool for transitional healthcare.

This research proposes a framework for the application of anthropomorphic interfaces in gamified applications for transitional healthcare. The framework analyses existing research on anthropomorphic interfaces, gamification, and transitional healthcare. The framework has been validated by triangulating previous literature, expert interviews, and a patient survey. The research further develops an instrument to measure the extent of the gamification of anthropomorphic interfaces for transition care in games. To be validated, the instruments went through a series of tests. The test results showed that the instruments were reliable. Following from the framework and the instrument, a set of guidelines was developed and validated in a focus group discussion. The outcome of this research has provided constructive recommendations for future designs of an anthropomorphic interface in gamified applications for the transitional healthcare.

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Club Penguin (downloaded from the apple store)

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Pirate101 - https://www.pirate101.com/

Re-Mission2 - http://www.re-mission2.org/games/

DECLARATION OF AUTHORSHIP

I, Nooralisa Mohd Tuah

Declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

A Framework of Anthropomorphic Interface in Gamification Application for Transition Healthcare

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. Parts of this work have been published as:
    - Nooralisa Mohd Tuah, Wills, Gary, & Ranchhod, A., (2015). The Used of Anthropomorphic Interfaces for Persuasive Interaction, *Position Paper at Workshop on Understanding Persuasion: HCI as a Medium for Persuasion, British HCI*, 13 July 2015.
    - Nooralisa Mohd Tuah, Wills, Gary, & Ranchhod, A., (2016). The Characteristics and Application of Anthropomorphism in Computing: A design spectrum. *In Proceeding of the 9th International Conference on Advances in Computer-Human Interaction*, pp. 398-402. 21-24 April, Venice, Italy: IARIA.
    - Nooralisa Mohd Tuah, Wanick, V., Wills, Gary, & Ranchhod, A., (2017). Exploring Avatar Roles for Motivational Effects in Gameful Environments*. EAI Endorsed Transactions on Creative Technologies*, 17(10), e3, EAI.
    - Wanick, V., Nooralisa Mohd Tuah, Gary Wills, & Ranchhod, A., (2015). *Personalisation as Persuasion in Serious Games for Health.* Book chapter proposal in Serious Games for Mobile eHealth. Manuscript submitted for publication.

- Won £500 fund for FPSE Public Engagement Awards for Science and Engineering Day 2016, project title “Designing a game for chronically ill children in transitional care process”. Event was successfully carried on the 12th March 2016.
- Nooralisa Mohd Tuah, Wills, Gary, & Ranchhod, A., (2018). The Application of Anthropomorphic Gamification within Transition Healthcare: A conceptual Framework. EAI Endorsed Transactions on Serious Games, 18(14), e2, EAI.

Signed: .....

Date: .....

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Thank you all so much for everything, this would not have been possible without you.

Definitions and Abbreviations

AI: Anthropomorphic Interface

ANOVA: Analysis of Variance

Anthropomorphic Interfaces: Human like representation in computer application interfaces

ARCS: ARCS (Attention, Relatedness, Confidence, Satisfaction) Model of motivation

ECA: Embodied agent or Embodied Conversational Agent

EFA: Exploratory Factor Analysis, one of techniques in factor analysis to analyse the relationship between measurable variable.

Gamification: application of game elements in non-gaming context

HB: Human Behaviour

HCI: Human Computer Interaction

IBM SPSS: A software to statistical analyse the collected questionnaire.

IMMS: Instructional Material Motivational Survey

KMO: Keiser-Meiyer-Olkin

M: Mean

NVIVO: A software used to analyse qualitative data

PCA: Principal Component Analysis

SD: Standard Deviation

TAG: The framework for Anthropomorphic Interfaces in Gamification for Transitional care in Health

TAGS: The Transitional Anthropomorphic Gamification Scale

TRAQ: Transition Readiness Assessment Questionnaire

UAAG: The User Agent Accessibility Guideline

WAI: Web Accessibility Initiative

Chapter 1: Introduction

Anthropomorphic interfaces have been applied in many different forms of human representation, aiming to provide an interactive application that can maintain user engagement (Cheong, Jung, & Theng, 2011; Morie & Verhulsdonck, 2008). Anthropomorphic interfaces are commonly implemented as a tutor, a shopping assistant, a medical assistant, a companion, or a help desk. The roles and functions vary and these are reflected in the anthropomorphic designs, interpreted as a spectrum of designs (Catrambone, Stasko, & Xiao, 2002; Kao & Harrell, 2015; Mull, Jamie, Moon, & Lee, 2015). This includes more human-like designs (avatar), medium human-like designs (interface agent), or less human-like designs (abstract character). These designs result in different outcomes for users' preferences and for the effectiveness of an interface. As delivering an effective interface is quite challenging, Baylor (2009) and Mumm & Mutlu (2011) argue that an interface should come with both effective and motivational elements. Apart from that, an anthropomorphic interface could play an important role in achieving an effective interface for a long-term relationship between humans and computer applications. One of the design elements in developing a long-term relationship is embedding a trusted feature in the anthropomorphic interface (Benyon & Mival, 2013). As a result, there is an increase in interest about the type of elements and characteristics of an anthropomorphic interface that portrays trust and preferable features.

Anthropomorphic interfaces also lead to an increase in user motivation. Previous research showed that an avatar, as one type of anthropomorphic interface design, has an impact on motivation through gamification (Barata, Gama, Fonseca, Gonçalves, & Jorge, 2013; Otake, Sumita, Oka, Shinozawa, Uetake, & Sakurai, 2014). Gamification is a concept that embeds game elements and a game experience in a non-gaming context, to expressly encourage user motivation and engagement with the system (Deterding, 2012; Seaborn & Fels, 2015). Anthropomorphic interface through avatars is one of the game elements identified in gamification. Even though there are a number of game elements in a gamified application, the implementation of an anthropomorphic interface has scarcely been explored. Moreover, previous research in gamification mainly focuses on how gamification can increase users' motivation (Domínguez, Saenz-De-Navarrete, De-Marcos, Fernández-Sanz, Pagés, & Martínez-Herráiz, 2013; Halan, Rossen, Cendan, & Lok, 2010; Mekler, Brühlmann, Opwis, & Tuch, 2013; Montola, Nummenmaa, Lucero, Boberg, & Korhonen, 2009). As gamification promotes motivational effects towards users' engagement, it is suggested that gamification should conform to an accepted theory of motivation (Deterding, 2012; Hamari, Koivisto, & Sarsa, 2014).

A conjecture for this research is that the gamification of anthropomorphic interfaces will virtually imitate the patient's health progress in the transition care application and thereby, could improve patient's engagement and motivation towards self-management. Engagement is generally referred to as a temporal behaviour state of interaction that makes a user want to get involved and interact in the environment (O'Brien & Toms, 2010; Wiebe, Lamb, Hardy, & Sharek, 2014). In a gamified application, engagement is seen as an association of a user's attention, experience, and interactivity, which leads to the user's continued involvement in the application (Domínguez et al., 2013; Sailer, Hense, Mayr, & Mandl, 2017). In this research, the "engagement" is understood as a state of behaviour of continued interaction with a computer application. A user's engagement is affected by their motivation. A motivation is a psychological construct which related to a personal orientation towards a task (Ryan & Deci, 2000; Wiebe et al., 2014). In this research, motivation is understand as a desire that stimulate and sustain a patient's behaviour throughout the transition process.

Kralik, Visentin, & Van Loon (2006) indicated that a transition is a process whereby patients will learn to understand, manage, and control their health condition. Marape (2013) advocates the transition process as transferring one's health setting from hospital care to self-care, or from paediatric care to adult care, or from one stage to a better stage of health. In this research, transition healthcare is defined as per Marape's first definition and scope, where transition care is a process that transfers a patient from hospital care to self-care. During the process, patients are required to equip themselves with an adequate knowledge of their condition, medication, or any further treatment needed, so that they are ready to self-manage and be independent (Freyer, 2010; While, Forbes, Ullman, Lewis, Mathes, & Griffiths, 2004). The transitional care takes place over a period of time, depending on the patient's condition and readiness (Marape, 2013).

In the transitional care process, the involvement of a gamified application will enable the patients to learn about their health condition in a playful environment (Wilson & McDonagh, 2014). However, it is a challenge to maintain patients' participation and motivation in learning about and improving their conditions during the transition care process. As transitional care requires engagement from the patient in the process of transition, an anthropomorphic interface in a gamified application is suggested as an additional tool for the process. It is expected that the application could help to motivate the patients to learn about their condition throughout the process of transition.

1.1 Purpose of the Research

Although current research in anthropomorphic interfaces has been established, and the research on gamification and transition care is expanding, research looking at the application of

anthropomorphic interfaces in gamified applications for transitional healthcare has yet to be conducted. Current research in anthropomorphism, gamification, and healthcare generally concern;

- Users' preferences or effectiveness of anthropomorphic interfaces (Kao & Harrell, 2015; Mull et al., 2015) or
- The motivational effect of game elements (Hamari et al., 2014; Mekler et al., 2013) or
- on how one's health can be improved through anthropomorphic application (Y. Hsu, 2012; Schmeil & Suggs, 2014; Van Vugt, Konijn, Hoorn, & Veldhuis, 2009) or
- How one's health can be improved through gamification (Hu & Fico, 2014; Wilson & McDonagh, 2014).

These previous works did not reflect all the three research elements. For that, the purpose of this thesis is to understand the application of anthropomorphic interface in gamification for transitional healthcare.

The work in this thesis has identified several research opportunities that can contribute to the gaps in knowledge in applying an anthropomorphic interface in gamified application for transitional care (see Chapter 5), such as;

- The lack of a framework that integrates anthropomorphic interfaces, gamification, and transition healthcare
- The lack of motivational theory used to confirm the informed used of anthropomorphic interfaces in gamification
- The lack of a measurement tool to measure the application of anthropomorphic interfaces in gamification for transitional care
- The lack of design recommendations for the application of anthropomorphic interfaces in gamification for transitional care

These research opportunities, suggest that an additional study is needed to investigate the used of anthropomorphic interface in gamification to motivate patients in the transitional care process. With this in mind, the work in this thesis interlinks anthropomorphism, gamification, and transitional healthcare. The interrelations of these subjects have led to the development of the following research questions, presented in the section 1.2.

1.2 Research Questions and Objectives

There is a lack of a theoretical viewpoint that can support a standard design for an acceptable interface tool when considering anthropomorphic interfaces in gamification for a transitional care

application. By consolidating the research areas in anthropomorphic interfaces, gamification, and transitional healthcare, this research aims to design a guideline to be utilised as reference points in the development of gamification applications implementing the anthropomorphic interfaces for transitional care. Taking this into consideration, the research questions are as follows;

RQ1. What is a suitable framework for the use of anthropomorphic interfaces in gamification for transition healthcare, transfer from hospital care to self-care?

The research investigates the key design elements of the application of an anthropomorphic interface in gamification, in providing a motivational interaction. The research also assesses what requirements are needed for the healthcare transition. In this thesis, a conceptual framework has been developed and confirmed through a triangulation of the literature review, experts' interviews, and patient surveys.

RQ2. What are the appropriate metrics to measure the gamification of anthropomorphic interfaces in transitional care applications?

The research develops a new instrument that can be used to evaluate the extent of the gamification of anthropomorphic interfaces in transitional application in facilitating the user's acquisition of knowledge about his/her health condition towards self-management. The instrument was developed as to validate the use of the confirmed framework into a context. Detailed descriptions for each of the appropriate metrics were provided for ease of measurement. This instrument was developed adopting the *Goal-Question-Metrics* approach and validated through a series of validation tests.

RQ3. What are the applicable guidelines for designing a gamified application for transitional care, implementing anthropomorphic interfaces?

A set of design guidelines was created to facilitate the work of researchers and practitioners in designing a transitional care gamified application, by implementing the anthropomorphic interfaces. Detailed descriptions for each of categories in the guideline were provided for ease of use. The guideline was developed as a result of the framework and the instrument. A stepwise approach was implemented in the guidelines development and the confirmation of its content was obtained from expert feedback and discussions.

1.3 Thesis Structure

The structure of this thesis is illustrated in Figure 1-1. Following Chapter 1, the thesis is organised as follows;

Chapter 2 - Anthropomorphism in Computer Application: This chapter reviews the related research about the use of anthropomorphism in computer applications. The reviews involved the reasons behind the use of anthropomorphic interfaces, how the anthropomorphic interfaces are applied, the key characteristics of an effective anthropomorphic interface, and how this anthropomorphic interface performs in terms of accessibility.

Chapter 3 – Gamification and Healthcare Issue: This chapter explores previous research in two parts. First part is about gamification, in particular the idea behind the concept that is widely used in research and being implemented in games and serious games. Gamification focuses on the implementation of game elements, in which it could enhance services, users' experiences and users' motivation. General game elements were identified. The link between game elements to users' motivation and its conformity with the motivation theory was reviewed. The second part is reviews the unresolved issues in healthcare and current practices related to the process of transitional healthcare. The review of previous work helps to understand the concept, process, and characteristics of transitional healthcare. The reviews also included an overview of the available technology implemented for transition care.

Chapter 4 – The Transitional Anthropomorphic Gamification Framework (TAG): In this chapter, previous studies in chapter 2 and 3 are first consolidated and reviewed to grasp the current trends and emerging issues in the area of; 1) anthropomorphic interfaces in gamified applications, 2) anthropomorphic interfaces in transition care, and 3) gamification in transition care. Each of the three areas is correlated with the others and these areas are identified as the research gaps that this study addresses. Then, this chapter demonstrates the process of developing the framework particularly on identifying the factors and components of the conceptual framework. These factors and components are then proposed as the research idea for the framework.

Chapter 5 – Research Methodology: This chapter describes the methodological approaches and rationale for choosing them in conducting research for this thesis. This chapter outlines the method of data collection, sample requirement, method of analysing the data, and the research ethics for each of the research conducted in this thesis.

Chapter 6 – Confirmation of the Transitional Anthropomorphic Gamification (TAG) framework: This chapter presents the initial study to confirm the proposed framework. These initial studies involved expert interviews and patient surveys. Each of the studies is outlined accordingly. This chapter also presents the findings and results from the studies, the analysis, and the discussions. Based on the analysis, confirmation to the TAG framework is made.

Chapter 7 – Development of the Transitional Anthropomorphic Gamification Scale (TAGS): This chapter presents the development of the TAGS instrument, developed to measure the application

of an anthropomorphic interface in gamification for transitional care. An incremental approach was applied in identifying, defining, and describing each of the components and measurement items in the TAGS instrument.

Chapter 8 – Validation of the Transitional Anthropomorphic Gamification Scale (TAGS) Instrument: The chapter explains the validation tests in validating the new developed TAGS instrument. These validation tests involved with content validity test, pre-test, and formal validation test. The method, participants, and procedure for each test are discussed and the validated TAGS instrument is outlined.

Chapter 9 – Guidelines for Researchers and Practitioners in Designing Transitional Healthcare Gamified Applications, Implementing Anthropomorphic Interfaces: This chapter presents the development of a set of guidelines for researchers and practitioners in designing a gamified application for transitional care by implementing an anthropomorphic interface. The contents of the guideline reflect the TAG framework (in chapter 6) and the TAGS instrument (in chapter 7 and 8). This guideline was validated in a focus group discussion comprised of eight experts.

Chapter 10 – The Final Discussion: This chapter presents the discussion of the research questions related to the framework, the instrument, and the guidelines in this research. The chapter summarizes three implications of this research on its effect on the research field, on other researchers and practitioners, and on the healthcare context. The chapter also includes the limitations encountered when conducting the research.

Chapter 11 – Conclusion and Future Work: This chapter draws a brief summary of the research conducted in this thesis. This thesis concludes with an outline of possible future directions of the research.

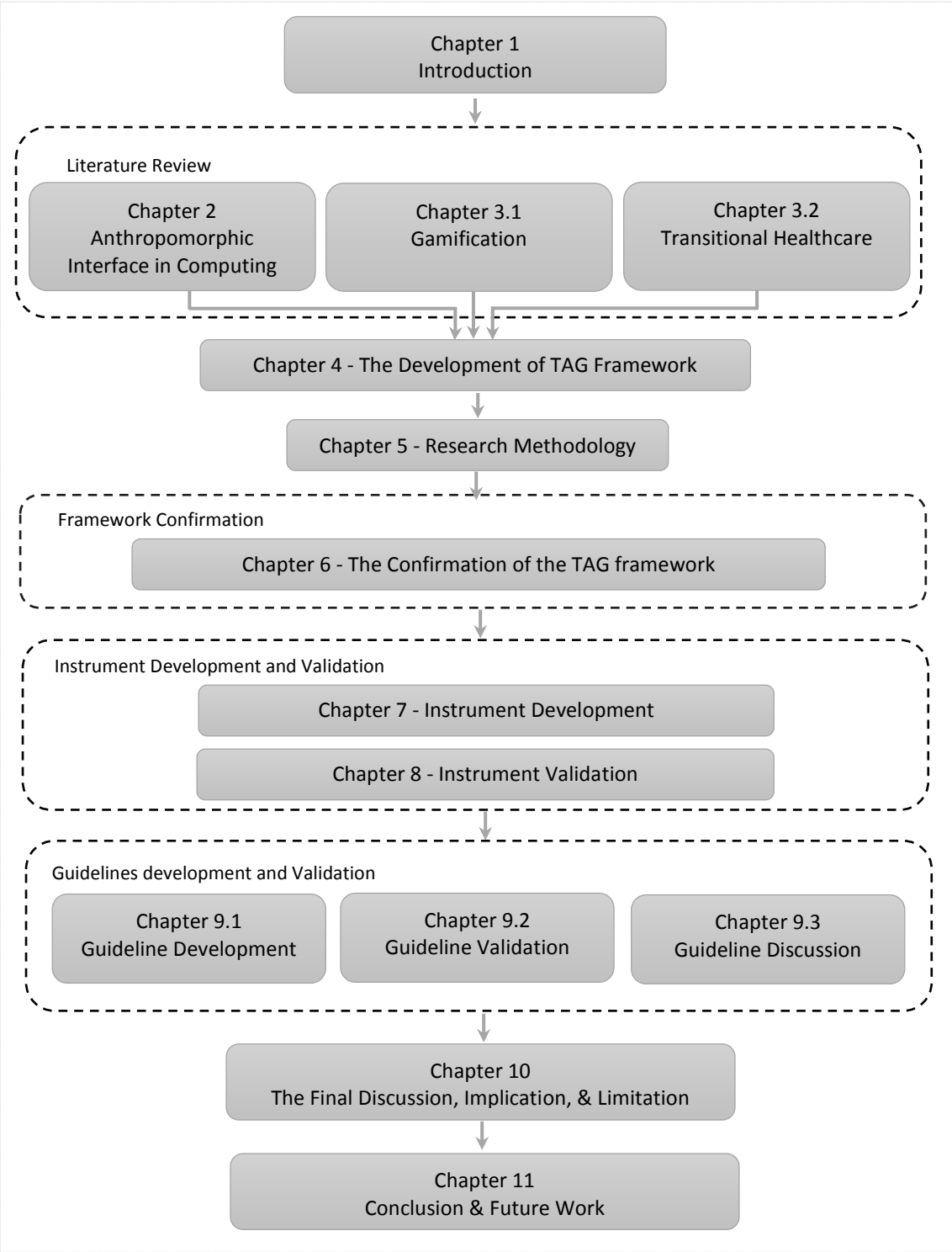


Figure 1-1 Overview of the report structure

Chapter 2: Anthropomorphic Interfaces in Computer Applications

This chapter reviews the use of anthropomorphic interfaces in computer applications, why anthropomorphic interfaces are used in computer applications, how they were applied and the types of anthropomorphic interface designs that can be considered in any computer application.

2.1 The use of Anthropomorphic Interfaces in Computer Applications

The use of an anthropomorphism in a computer application describes an object that impersonates human characteristics and qualities (Disalvo & Gemperle, 2003) within something that is not human (Schmitz, 2011). It resembles a human form in design, for other objects with given purposes. Złotowski, Strasser, & Bartneck (2014) found that this amounted to recognising life in an inanimate object, as well as attributing design to anthropomorphic forms. These include the application design for a hardware appliance or software application, the design of a product (toys, vase, book, souvenir, etc.), computer application interfaces, human video recording and robotic imitation. According to Kallery & Psillos (2004) and Schmitz (2011), anthropomorphism is related to animism, a kind of human-like design.

Animism is used widely in the field of psychology and education for learning purposes. Brown & Walker (2008) and Haber (2009) defined animism as “a non-human object that contains essences and qualities of a human”. Animism and anthropomorphism seem to be founded on the same concept, but, the designs could be classified into more human-like or less human-like designs. Meanwhile, anthropomorphism refers solely to the representation of a human form (more human-like), while animism uses other life forms (less human-like) such as animals, birds, abstract characters and inanimate object forms. Examples of animism are the paperclip Wizard used by Microsoft, characters in games such as Sonic the Hedgehog and Angry Birds. Second Life characters and Sims characters could also represent anthropomorphist designs. Both animism and anthropomorphism refer to attributing life-like qualities to entities in computer applications.

A considerable range of terms have been defined and associated with anthropomorphic interface in computer application since 2000. Its initial introduction was as the model of Computer As Social Actors (CASA) (Nass & Moon, 2000; Nass, Steuer, & Tauber, 1994). CASA instilled social cues within human-computer interaction. The research in anthropomorphic interfaces explored different formats and the most commonly found formats were the Embodied Conversational Agent (ECA), human-likeness interfaces (Qvarfordt, Jönsson, & Dahlbäck, 2003;

Schmitz, 2011; Złotowski et al., 2014), human-like computer interface (Qvarfordt et al., 2003), and Avatar (Cheong et al., 2011; Lortie & Guitton, 2011; Morie & Verhulsdonck, 2008). To some extent, the anthropomorphic interface has also been regarded as a personification agent (Benyon & Mival, 2008) and a companion agent (Benyon & Mival, 2013; Payr, 2013).

Morie & Verhulsdonck (2008) categorized the avatar as an anthropomorphic interface because an avatar is given animated human physical characteristics to virtually represent the user character, and is applied to encourage social interaction. Creating an avatar is not only limited to the design of a character, it also covers specific roles customised for user preferences (Cheong et al., 2011). The avatar is normally designed with elements familiar to the user, which may stimulate better engagement with the avatar. According to Cowell & Stanney (2005) and Morie & Verhulsdonck (2008), an avatar should be designed with characteristics such as verbal features, expressions, gestures, and postures. These characteristics will be discussed further in section 2.4.

An Embodied Agent or Embodied Conversational Agent (ECA) is an interface agent that represents the user in an associated task. This agent usually acts as a smart assistant or as a companion which will help the user with their online activities, such as learning, shopping, paying bills, and organising information (Catrambone et al., 2002; Cavazza & Vargas, 2010; Forlizzi, Zimmerman, Mancuso, & Kwak, 2007; Pereira, Prada, & Paiva, 2014). An interface agent can take the form of a human, cartoon, icon or animal and can imitate human faces or even the whole human body. In this approach, an interface agent can exhibit animism or anthropomorphism. An interface agent usually is designed with scripted answers to generate standard communication with the user. The user may perceive it as an intelligent and pleasurable interface. Both avatars and interface agents have been widely applied in human-computer interfaces. It is complicated to differentiate between them, but they are considered as anthropomorphic interfaces at a particular level of design.

Other than the avatar and the interface agent, different degrees of anthropomorphic interfaces have been used to evaluate the users' acceptance and the application's effectiveness in different domains of study. A study by Murano & Holt (2011b) used a human video as an anthropomorphic interface application. Murano & Holt (2011b) indicated that the human video was perceived as significant when compared to the interface with the text-based element. In this case, the text-based element was designated as a non-anthropomorphic element and it represented the experiment's control condition. It has been argued that applying human social rules into design considerations may not be necessary for a real human representation. Therefore, having a real human representation in video format is dissimilar to the other anthropomorphism forms of presentation.

Another study conducted by Hongpaisanwiwat & Lewis (2003) investigated the effects of anthropomorphic and non-anthropomorphic characters to capture users' attention in a multimedia presentation. They presented one interface condition with a voice and another without a voice. A subsequent study by Kramer, Bente, Eschenburg, & Troitzsch (2009) investigated the effects of ECA in a biometric face recognition security system in text-based and voice-based interfaces. A study by Murano & Holt, (2011a) also manipulated an anthropomorphic interface with various design contexts to investigate the interface effects on users' preferences and acceptance. These designs include, 1) an anthropomorphic interface with text, 2) an anthropomorphic interface with voice, 3) just the anthropomorphic interface itself, and 4) a text-only interface. Noticeably, the three mentioned studies indicated that a human voice was a crucial element of an anthropomorphic character in determining the users' preferences. It demonstrated that a human voice resulted in different perceptions of both an anthropomorphic interface and a non-anthropomorphic interface. Despite that fact, the human voice was not designed to evaluate the effects of interfaces based on the different degrees of anthropomorphism.

Different anthropomorphic interfaces used in previous studied, from across the spectrum, were categorised into several designs. For example, early research by Catrambone et al. (2002) used two anthropomorphic interfaces. They identified the anthropomorphic interface as lifelike and iconic characters. The interfaces were used to confirm their framework of the user's effectiveness and preferences, and they found that the anthropomorphic interfaces had a very limited impact on the user's effectiveness and preferences. A study by Power et al. (2002) classified anthropomorphic interfaces as human-like, cartoons and icons. They investigated the effects of anthropomorphic interfaces based on users' assumptions during interaction. The result showed that the human-like interface was considered scary, the cartoon interface was perceived as friendlier and pleasant, and the icon was perceived less interesting compared with the other two. In Nowak & Biocca (2003), three interfaces were used, which were high-anthropomorphism (avatar), less-anthropomorphism (agent) and no image. The study examined which characters afforded more presence in a virtual environment. The result confirmed that the interface with less-anthropomorphism was perceived to have more presence than the one with high-anthropomorphism.

A recent study by Kao & Harrell (2015) employed three different avatar designs to represent the users in their experiment. The experiment aimed to see if users' performances and experiences varied, based on the types of avatars they chose. Kao & Harrell experimented with three avatar designs comparing a human design with a shape. The experiment avatars were the scientist avatar (well-known scientist like Einstein), athlete avatar (well-known athlete like Michael Jordan), and shape avatar (octagon, square, hexagon). A similar study by Mull, Jamie,

Moon, & Lee (2015) used four different types of 3D avatars and compared the humanlike designs with other lifelike characters. These 3D avatar designs (categorised as human, fantasy of human, animal, and humanoid) were used to represent a salesperson in an online retail website. The study examined which type of avatar affected the consumers' perceptions of credibility, homophily, and attractiveness when using the websites. Lugrin, Latt, & Latoschik (2015) studied different types of avatars to evaluate the effect of avatar realism on the feeling of ownership in a virtual environment, these include machine-like, cartoon-like, and human-like avatars.

Based on the different designs of anthropomorphic interfaces in a computer application, the spectrum of anthropomorphic design range from more into human-like designs (avatar), to medium human-like designs (interface agent), and to less human-like design (abstract character). In associating the design spectrum with anthropomorphism and animism, the more human-like designs correspond to anthropomorphism and the less human-like design correspond to animism. Figure 2-1 shows the spectrum of anthropomorphic design.

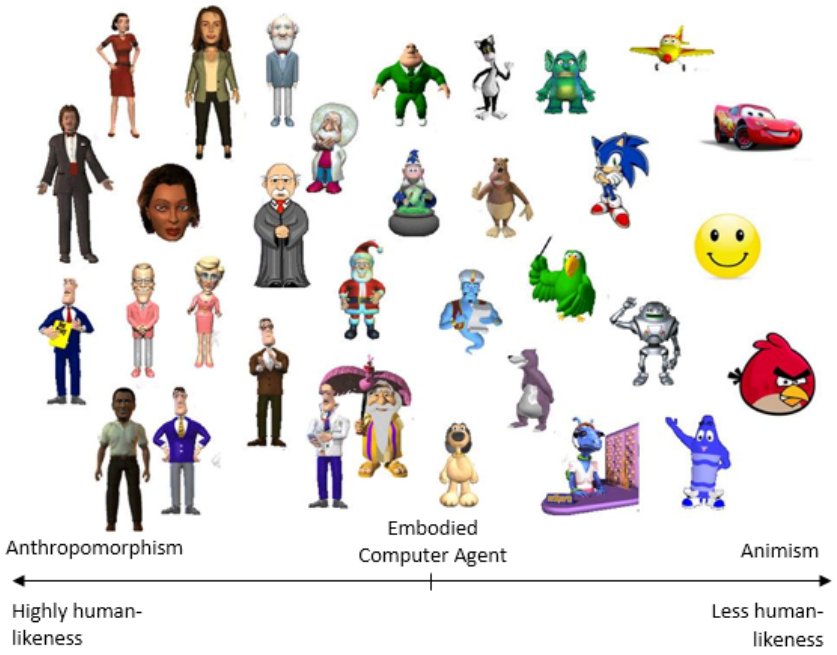


Figure 2-1 Spectrum of Anthropomorphic Interfaces Design in Computer Applications

The previous discussion of anthropomorphic interfaces (also illustrated in Figure 2-1) emphasizes its application in virtual settings. Another use of anthropomorphism is for a 'tangible interface', where the design of anthropomorphism is applied onto the surface of an object or into the whole object (Schmitz, 2011). For example, in human and robot interaction, a robot is designed with the qualities and images of a human. The design could be more a human-like or less human-like. This 'tangible interface' can also be referred to in the design of a product like a doll, a vase, or a soft toy. Figure 2-2 shows the possible use of anthropomorphism in tangible and virtual interfaces. The use may vary from virtual to tangible interface, but the design concept of anthropomorphism remains the same, meaning that the possible use of 'tangible interfaces', such

as robots or a product, could be mapped with the same design in the virtual setting, and with a specific purpose.

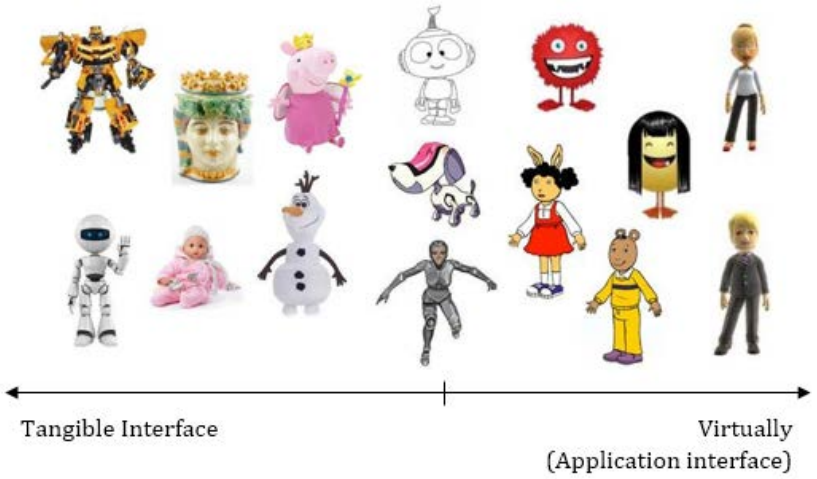


Figure 2-2 Possible utilisation of Anthropomorphism for Tangible Interface and Virtual Interface

Ranging between anthropomorphism to animism, more human-like to less human-like designs, and tangible and virtual interfaces, the degree of anthropomorphism within this spectrum can be mapped into virtual and tangible interfaces, as illustrated below in figure 2-3.

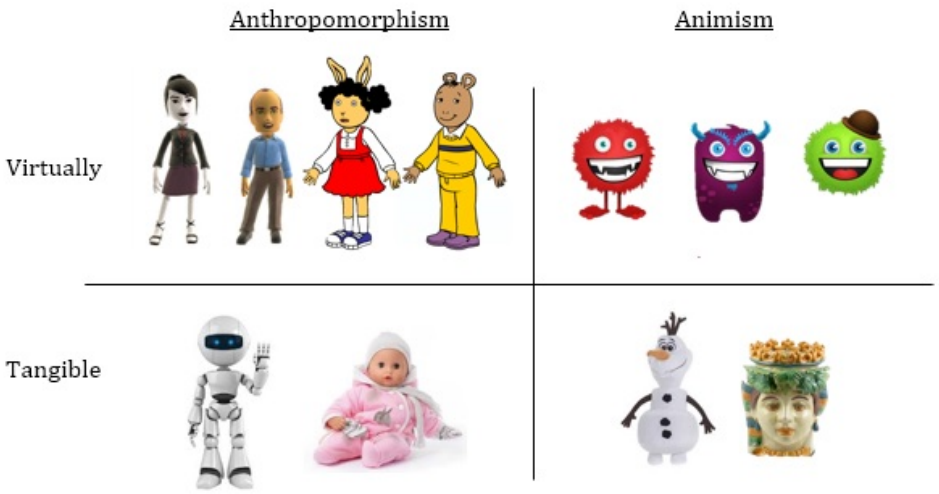


Figure 2-3 Mapping Anthropomorphism, Animism, Virtual, and Tangible

Considering the design of anthropomorphism and animism for virtual and tangible interfaces, Figure 2-3 mapped the design of human resemblance to indicate which design of anthropomorphism could be used in which applications or purposes. However, as this research will focus more on the use of anthropomorphic interfaces in virtual application, tangible interfaces will lie beyond the scope of this research.

To design an anthropomorphic interface, it is essential to understand why an anthropomorphic interface should be implemented in a computer application and what characteristics of anthropomorphism should be applied as part of the design element for a significant human computer interaction. This will be further discussed in the next section.

2.2 Why Anthropomorphic Interfaces?

The interaction between humans and computers requires simple interfaces that are easy to use, are understandable, and guide the user throughout their session. In 2002, the future direction for interfaces was comprehensively discussed to design an interface that enabled social and emotional rules in a human-computer interaction (Picard, Wexelblat, & I., 2002). They believed one of the methods whereby social and emotional interfaces can be achieved is through the use of human-like interfaces, as they bring a more positive social-emotional response from the user. However, positive social-emotional effects last only for a short time, and the user needs to recreate that feeling from scratch at their next visit. Thus, human-computer interaction is no longer a one-off activity.

Continued interaction in a long-term relationship implies a specific requirement within human-computer interaction (Benyon & Mival, 2008, 2013; Bickmore & Picard, 2005; Leite, Castellano, Pereira, Martinho, & Paiva, 2012). It is not only about designing a good interface with positive social-emotional effects, but also designing an interface that enables users to develop a relationship especially when personification agent is used as a companion for a longer period (Benyon & Mival, 2008, 2013; Payr, 2013). As an example, a patient with high-blood pressure builds their relationship with the health application (companion agent) to maintain medication adherence as well as to monitor their health over time. This kind of situation has inspired the need for long-term relationships in human-computer interaction. Another example of companion is a tutor in learning application. The tutor will represented by a virtual human to accompany the learner throughout their learning sessions, which may take a longer time. The application provides a tutor with simple presentation, no stress appearance and who offers verbal support such as “well done!!”, “you have done a great job!!”, or “this is amazing”. The examples support the changes in interaction from one of traditional interaction to relationship. However, this movement needs further research as indicated by Benyon & Mival, (2013), Bickmore & Picard, (2005), Leite et al., (2012), and Payr, (2013).

Long-term relationship issues also indicate that social-emotional and ethical issues need to be balanced (Bickmore & Picard, 2005; Leite et al., 2012). This is because a user feels deceived when an interface behaves exaggeratedly on something that is supposed to be straightforward. This is ethically wrong in response to the realism of an anthropomorphic interface. Moreover, if the anthropomorphic interface’s design and interaction is too realistic, it will face the Uncanny Valley problem (Beck, Stevens, Bard, & Cañamero, 2012; Benyon & Mival, 2013). The Uncanny Valley concepts was introduced by Mori (1970) in robotics where a highly realistic anthropomorphism in robots can potentially provoke a negative response from the users. This could bring about a

decline in trustworthiness when an anthropomorphic interface has a strong similarity to humans. These similarities refer to human resemblances in the design (physical presence) and in the characteristics (behaviour or movement) of the anthropomorphic interfaces. It is believed that the unrealistic anthropomorphic interfaces with unrealistic or realistic behaviour could be accepted and trusted by the user and even a realistic anthropomorphic interface with unrealistic behaviour could be trusted (Beck et al., 2012; Gong, 2008; Lee, 2010). It is important to design a helpful anthropomorphism interface rather than designing an interface that is trying to replace a human responsibility.

Questions have been raised about the realism of anthropomorphism. To avoid the uncanny valley issues, a careful design implementing the significant features of anthropomorphic interfaces should be designed (Beck et al., 2012; Lee, 2010). In order to do so, further explanation on how physical appearance and behavioural responses could be affected in an anthropomorphism application will be discussed in the next section.

2.3 Application and Implementation of Anthropomorphic Interfaces

Many studies (e.g. Gong, (2008), Pereira et al., (2014) and Złotowski et al., (2014)) debate the application of anthropomorphic interfaces, particularly on the issue of perception and how an anthropomorphic interface significantly provokes a convincing social response from the user. Social responses and social presence complement each other to deliver feelings of empathy in human-computer interaction. However, these two have different requirements. Social presence is what users feel of the interfaces and their perception in delivering the sense of being connected with others in a virtual environment (Nowak & Biocca, 2003; Pereira et al., 2014). Nass & Moon (2000) defined social response as the psychological and cognitive process, which they call “mindlessness”, wherein users apply and accept social rules in interaction with computer applications. Nass & Moon examined ten years worth of studies that studies had expressed a rejection of human-like representation like anthropomorphism. They suggested that a better social response attribute should be designed for practical application according to the level of anthropomorphism. However, the challenging question is what types of social rules elicit human similarity in anthropomorphism.

Later research by Cowell & Stanney (2005) proposed a social response that identifies trustworthiness in anthropomorphism as non-verbal behaviour (i.e. eye contact, facial expression, gesture, posture) in order to increase users’ perceptions. These behaviours have singled out trustworthiness only on anthropomorphism with a facial (close-up) interface, and not on human physical (half or three-quarter body) interfaces. Thus, the type of human gesture and posture in Cowell’s study was not discussed in-depth and detailing it may help reveal a better outcome.

Facial expressions help with user perception, but Gong (2008) questions whether the user may confuse facial expression with facial attractiveness. To establish a trustworthy anthropomorphic interfaces, design and experimentation is needed to help determine users' preferences. Gong concluded that a more anthropomorphic interface yielded more social responses from users, and thus gained more trust in the interface. Additionally, Gong also suggested further investigation of embedding verbal behaviour (voice), as it is salient in providing a better impact by the anthropomorphic interface. Lee (2010) highlighted verbal communication in expressing flattery in human facial interfaces. Even though flattery results in only minor improvement in social responses, some modification of verbal communication (level of voice, from voice synthesis to human voice) has to be considered in association with the degrees of anthropomorphism. This will yield a better match between the image and the voice and thus produce a more trusted anthropomorphic interface.

Another trust element to be considered is intelligence. An early study by Power et al., (2002) showed an insignificant effect as the user found the anthropomorphic interface intimidating. However, anthropomorphism was perceived as more intelligent than an abstract character (smiley face) and a cartoon character. A later study by Forlizzi et al., (2007) and Pereira et al., (2014) indicated that a human form interface was preferred by users as it looked more intelligent and talking to one inspired greater confidence than talking to an interface without a human form. They believed intelligence to be an important aspect in creating an interface with social response and presence. Besides intelligence, emotional aspects could also make a human-like interface more familiar and thus create a trustworthy character to interact with (Beck et al., 2012). In contrast to Złotowski et al. (2014), they found that intelligence does not affect user perception, but the emotion does bring about significant effects. They believe this was due to the manipulation of the experiment, which resulted in a limited impact on the intelligence factor.

Another element contributing to a convincing anthropomorphism is the elements of social presence (Gong, 2008; Pereira et al., 2014; Złotowski et al., 2014). Further exploration on this subject is discussed next.

2.4 Characteristics of Anthropomorphism

An anthropomorphism should be perceived as socially present in human and computer interaction (Pereira et al., 2014). The presence elements include physical appearance (attractiveness) and demographic (age, gender, ethnicity). Gender consideration plays an important role regarding the purposes and functionality of an application. Research by Cowell & Stanney (2005) indicated that there were no significant differences in gender preferences when defining the impact of non-verbal behaviour of anthropomorphism. Qiu & Benbasat (2010)

experimented with virtual advisers for an e-commerce website, and also found no impact on gender similarity attraction. Unlike De Angeli & Khan (2007) and Forlizzi et al. (2007), they showed that gender preferences had a significant impact when choosing types of anthropomorphic interfaces, especially for female users. Female users preferred talking to an agent that is more human-like and, importantly, of the same gender. However, the studies showed that male users did not exhibit gender preferences. These findings however, are not generally applicable, and seem to depend on the experimental setting and the specific context of study.

Anthropomorphism ethnicity was demonstrated by Cowell & Stanney (2005), De Angeli & Khan (2007), Pratt, Hauser, Ugray, & Patterson (2007), Qiu & Benbasat (2010) and Spence, Lachlan, Spates, Shelton, Lin, & Gentile (2013). They all showed that users prefer to interact with anthropomorphic interfaces that match or are similar to their own ethnicity. Anthropomorphism ethnicity also been studied through emoticons or *emoji*. The emoticon is a representation of facial expressions used in electronic messaging systems that show a different type of presentation and expressions, which could also represent ethnic differences. Park, Barash, Fink, & Cha (2013) believed that using a universal emoticon may place a barrier on communication, but using an ethnically-based emoticon may favour only a certain ethnicity. To support the diversity of users using mobile technology, in early 2015, all messaging applications embedded a set of emoticon characters that represented the ethnic diversity of mobile phone users.

As per Pratt et al. (2007), ethnic prejudices implicitly exist in human nature. User preferences will be highly influenced by the same ethnic group. De Angeli & Khan (2007) argued that an agent should be designed with an ethnocentric approach. This kind of design is also argued to be only favourable to a specific group of users, limiting the design's general acceptance. Meanwhile, Qiu & Benbasat (2010) indicated that female users were more affected by ethnic similarity than male users. Anthropomorphism ethnicity could develop the feeling of being connected and supported within one ethnic group (Spence, Lachlan, Spates, & Lin, 2013; Spence, Lachlan, Spates, Shelton, et al., 2013). It helps the user to increase their trust and confidence during interaction. Most studies in anthropomorphism ethnicity have been carried out in ethnic groups such as African-American, Caucasians/European-American (e.g. in Pratt et al., 2007; Qiu & Benbasat, 2010; Spence, Lachlan, Spates, & Lin, 2013), with a few studies looking at Asian and Oriental groups (De Angeli & Khan, 2007).

Other than gender and ethnicity, some studies focused on anthropomorphism physical appearance, such as young or old anthropomorphic interfaces (Cowell & Stanney, 2005), and facial attractiveness (De Angeli & Khan, 2007; Khan & Sutcliffe, 2014; Qiu & Benbasat, 2010). In these studies, users preferred a young and attractive agent or an agent thought to be at the same age as the user rather than an old and unattractive agent, because these agents were perceived

as more convincing and therefore may increase users' motivation. Attractiveness is subjective however, and difficult to measure.

These dimensions of anthropomorphic characteristics show that there is a need for rigorous study to design a set of anthropomorphic characteristics to provide convincing human and computer interactions.

2.5 Accessibility Features

Developing an anthropomorphic interface requires accessibility guidelines for designing accessible content and widely acceptable applications, regardless of individual needs. Accessibility is associated with usability and it influences users' attention and trust (Petrie & Bevan, 2009). It presents a significant challenge, especially to users with disabilities and those with a mobility problem like unsupported computer capability (Jim Thatcher, Burks, Heilmann, Henry, Kirkpatrick, Lauke, & Waddell, 2006). Different disabilities will have different requirements, though the general requirements have been included in the W3C's Web Accessibility Initiative (WAI) (J. Brewer, 2003).

The User Agent Accessibility Guidelines (UAAG) 2.0, (2014) in the W3C's Web Accessibility Initiative (WAI) have listed several guidelines related to agent-based interfaces. One of the guidelines is perceivability, which outlines the availability of speech, text, and image. These features will ensure the interface elements are provided with alternative contents. Providing slower pronunciation, a higher voice volume, or speech to text conversion, could be alternatives for speech features. A text description is an alternative content for the image features and different sizes of text are the options for the text features. However, other features could be explored to comply with the guideline. W3C's compliance becomes a trend for providing a trusted web application. Further verification is required to provide an accessible anthropomorphic interface and strengthen its function for better interaction.

2.6 Chapter Summary

The use of anthropomorphic interfaces in human-computer interaction addresses a significant claim to be an effective interface and therefore establish a long-term interface relationship. Many suggestions have been made based on the users' preferences, such as installing a trustworthy agent with non-verbal behaviour (Cowell & Stanney, 2005), voice (Gong, 2008), a flattering effect (Lee, 2010), emotion (Beck et al., 2012), and intelligence (Forlizzi et al., 2007; Pereira et al., 2014). In addition, the anthropomorphic interface's social presence also affected users' preferences. This included gender (Forlizzi et al., 2007), ethnicity (Qiu & Benbasat, 2010), age (Cowell & Stanney,

2005), and facial attractiveness (Khan & Sutcliffe, 2014). The accessibility features also play an important role. This chapter has discussed the anthropomorphic interfaces for a long-term relationship, the different degrees of anthropomorphism in computer applications, a trustworthy anthropomorphic interface, and the characteristics of anthropomorphism for delivering a socially present anthropomorphic interface.

Chapter 3: Gamification and Healthcare Issue

The study of human-computer interaction explores usable applications for a better experience, more engagement, and higher motivation. The video games industry has explored further. Since 2010, the video games industry has progressively extended the playfulness and attractiveness of its designs to different application contexts with specific purposes, and it is called gamification. Gamified applications have attracted considerable interest from academic researchers as well as game practitioners. The interest extends to the gamification of healthcare, in particular how gamification could help to increase users' motivation in improving their health conditions. This chapter reviews research in gamification, the motivational effect of gamification on users' interactions, related healthcare issues, and gamification in healthcare.

3.1 What is Gamification?

Gamification is an approach that applies game designs, features and procedures to a non-gaming environment, service or product (Deterding, 2012; Deterding, Dixon, Khaled, & Nacke, 2011). Recent research by Werbach (2014) reconceptualised gamification as a process for making and designing activities in a system being more or less game-like, whereby players will engage with the system voluntarily. This concept of gamification seeks to make a non-gaming environment more game-like.

The gamification concept has actually existed for a long time, especially the reward programme: collecting points when at certain level, converting the points into rewards, and creating interesting designs such as a 'piano' staircase. The later concept is a marketing strategy employed by a company to engage with its customers (see *TheFunTheory.com*), other examples are given in Figure 3-1, Figure 3-2, and Figure 3-3. Gamification in a non-gaming environment has lately made significant impacts, such as;

- in the workplace (Nelson, 2012). For instance, implementing a role-playing character, using credit points to reward positive work involvement, and giving badges for collecting the most points;
- in education and training (Domínguez et al., 2013). For instance, using levels to see learning progressions and learning difficulties;
- in healthcare (Brezinka, 2014). For instance, using credit points as a reward system every time a patient follows their prescribed treatment or take their medication.

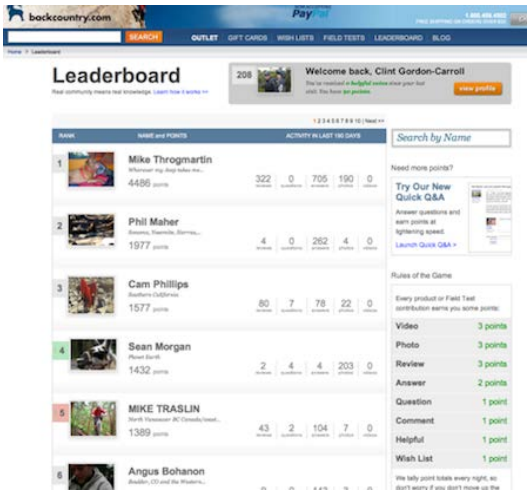


Figure 3-1 A Leaderboard retrieved from *http://uxmag.com* on September 2015

Figure 3-2 Points rewards example retrieved from *www.recyclebank.com* on September 2015

Figure 3-3 Example of badges, trophy earned by user Dens, retrieved from *http://blogs.imediaconnection.com* on September 2015

In these examples, gamification can be a persuasive tool in maintaining user motivation. In addition to the gamification practices mentioned above, there is a noteworthy discussion within the games industry itself on the presence of gamification.

In an article on games, Bogost (2011) disagrees with the term gamification because gamification exploits the game elements in contexts other than for profit. Bogost suggested the term 'exploitationware' be used instead of gamification. However, he does agree that the concept is encouraging. Likewise, Nicholson (2012) claims that the word 'game', apparently referring to gamefulness experience when in gamification, only involves some game elements that are short of the full game experience. Another criticism of gamification is when most game elements focus on a points-based system, whereas this gamification should rather be referred to as 'pointsification' (Nicholson, 2012). Gamification is far more than 'exploitationware' or 'pointsification'. It requires game design employing game elements in order to invoke a gamefulness experience (Deterding, 2012; Seaborn & Fels, 2015).

Early studies by Hunicke, LeBlanc, & Zubek (2004) proposed a game design framework, called MDA, to support the game designer's idea of delivering a fun environment. It consists of three components: Mechanics, Dynamics and Aesthetics. The MDA framework works in association with the gamification concepts (Deterding et al., 2011; Seaborn & Fels, 2015). The mechanic element is related to the game elements (points, badges, Leaderboards, etc.). The dynamic element is the procedure or behaviour applied to game elements, and aesthetics refers to a player's responses from their interaction with the gamified application. Still, the MDA framework requires further verification to specifically determine the effect of games in designing a gameful experience.

The outline of gamification deliberately moderates the complexity of the game mechanics. Thus, it can be applied to a non-game context with less difficulty in a day-to-day application for a specific purpose (Deterding, 2012; Deterding et al., 2011). However, it still preserves the idea and characteristics of experiencing fun and excitement during interaction. The excitement will encourage users to further continue their interaction with the system (Deterding, 2011; Hamari et al., 2014; Seaborn & Fels, 2015). As motivation is one of the key purposes of gamification, there are a number of arguments especially on intrinsic and extrinsic motivation in behavioural outcomes (see in - Deterding (2012); Hamari et al. (2014); Nicholson (2012); Seaborn & Fels (2014)). Motivation is triggered by types of game element (such as level, point, Leaderboard, etc.) and their adoption in the gamified application. Following Werbach (2014), selecting, deploying, implementing, and integrating game elements is important to make an activity more game-like in gamification. These game elements are discussed in the next section.

3.1.1 Game Elements

Designing a gamified application emphasizes game elements to enhance services, experiences and further improves the likelihood of the user being motivated (Deterding, 2011; Hamari et al., 2014). A number of different game elements are implemented in various ranges of application.

Some elements summarized in Hamari et al. (2014), Pedreira et al. (2015) and Seaborn & Fels (2014) are: points, badges, Leaderboard/dashboard, levels, storyline/narrative, progression, rewards, roles, ranking, feedback, and avatar. Table 3-1 gives a brief description of each of these elements.

Table 3-1 Type of Game Elements

Game Elements	Description
Points/point-based-system	Points as a reward system (displayed as a number) given when player has completed a given task within a certain time limit, whether it was successful or unsuccessful.
Badges	Badges as a reward system (displayed as an icon) given as an indication of an achievement by the player.
Leaderboard/dashboard	Displays the player's achievement (name, score, level), usually displayed by rank for easy comparison.
Levels	Game stages. The player needs to complete a lower stage (either by task completion or points achievement) to proceed to a further stage, until the player reaches the final stage of the game.
Storyline/narrative	Used as a guide for the player to be aware of what to do or to achieve in certain levels.
Progression	Indicates the player's recent progress.
Rewards	Incentives given on completion of certain levels or achieving certain purposes of the game.
Roles	Character that needs to be commanded by the player.
Ranking	Player's position in the games, displayed from highest to lowest, based on their achievement (usually defined by points or level).
Feedback	A player's comments, for instance, on their achievement, progress or roles, to enhance performance.
Avatar	A player's personalisation. Normally used as a player's profile and character identification.

The most influential element of a user's motivation is points, followed by badges and then the Leaderboard (Deterding, 2012; Hamari et al., 2014; Pedreira et al., 2015; Seaborn & Fels, 2015). A points-based system is easy to implement for a simple application. Empirical studies by Cheong, Cheong, & Filippou (2013), Mekler, Brühlmann, Opwis, & Tuch (2013), Montola, Nummenmaa, Lucero, Boberg, & Korhonen (2009), and Thom, Millen, Dimicco, & Street (2012), showed a

significant response to the use of points, badges, levels and a Leaderboard in their respective applications. The point-based system plays a great role in the applications stemming from the fact that badges, levels, and the Leaderboard are based on points earned by the player.

According to Mekler et al., (2013) the use of points, levels, and Leaderboard showed a significant increase in a player's performance but did not affect the player's motivation. Subsequent research by Hamari et al. (2014) argued that gamification had a positive effect on user's motivation in their experiments, and more or less repeated the same game elements such as points, badges, levels, and the Leaderboard. Likewise, Pedreira et al. (2015) indicate that the studies of gamification, from 2010 to 2014, show a higher use of the points-based element in their experiments. This situation led to confusion between gamification and 'pointsification', as discussed earlier, but other potential game elements have been forgotten. As argued by Nicholson (2012), gamification should focus more on elements of play rather than on the elements of scoring. Yet little alteration was made for the experimental procedure, thus resulting the same outcomes of gamification.

Therefore, it is suggested that a rigorous approach to types of game elements could have a promising impact on user experiences, engagement, and motivation (Deterding, 2012; Pedreira et al., 2015; Seaborn & Fels, 2015). It is proposed that game elements are in accordance with motivational concerns (Deterding, 2011, 2012; Hamari et al., 2014). The gamified application needs to have some intrinsic value for the players to stay in the game. Thus, motivational effects on gamification driven by motivation theory will be discussed in the next section.

3.1.2 Gamification Effects on Motivation

Motivation is a key aspect in designing a gamified application as it leads to behavioural outcomes (Deterding, 2012; Hamari et al., 2014). Self Determination Theory (SDT) by (Ryan & Deci, 2000; Ryan, Rigby, & Przybylski, 2006) is the most discussed motivation theory adopted in gamification. The discussion of SDT in gamification deals with the effect of game elements on a player's motivation and engagement. In SDT, having a sense of independence (autonomy), the capability to make changes (competence), and the environmental effect (relatedness), could reflect on the intrinsic and extrinsic motivation towards gamification (Cheong et al., 2013; Ryan et al., 2006). These three elements look specifically at whether the player's intrinsic and/or extrinsic motivation is actually facilitated or undermined. The intrinsic and extrinsic motivation may decrease when people are being forced to do something (Ryan & Deci, 2000). This issue is important in designing a game-like experience. Game elements such as points, badges and rewards displayed a positive impact on intrinsic and extrinsic motivation (Cheong et al., 2013; Domínguez et al., 2013; Montola et al., 2009; Thom et al., 2012). Through gamification, there is a strong relationship between

game elements, desires satisfaction, and fun (Deterding, 2011, 2012). Therefore, SDT indicates plausible acceptance of gamification (see Deterding, 2011; Ryan et al., 2006; Ziesemer, Müller, & Silveira, 2013).

Another motivation theory that had considerable application in gamification is the ARCS model of motivation design (Hamzah & Ali, 2014; Hung, Lee, Chao, & Chen, 2011; J. T. Kim & Lee, 2015; Proske, Roscoe, & McNamara, 2014). ARCS was introduced by Keller, M. (Keller, 1987) and consists of;

- A (Attention) – Process of gaining a learner's attention and giving a suitable response to the learners on specific instruction in order to maintain the learner's motivation.
- R (Relevance) – Mapping preceding knowledge or learning experience to the current learning instruction.
- C (Confidence) – Cultivate a learner's faith for positive learning outcomes. There is a high possibility of achieving something with some effort.
- S (Satisfaction) – A learner's satisfaction after completing the given instruction and motivation arises if the learner is given a token of appreciation or reward at the end of the lesson.

The ARCS model was created to try to understand the factors that influence a learner's motivation to learn. In gamification, the ARCS implementation is mostly found in the educational games application, particularly in learning by using an instructional strategy (Hamzah & Ali, 2014; Hung et al., 2011; J. T. Kim & Lee, 2015; Proske et al., 2014). Researchers refer to this as game-based learning. It is designed to create a more attractive learning environment and to enhance a learner's motivation, thus maintaining the learner's engagement throughout the learning session (Hung et al., 2011).

Both SDT and the ARCS motivation models have a great impact on gamification. Notably, the implementation of the SDT model in gamification is more comprehensive in its concepts and empirical evidence. In contrast, the ARCS model in gamification is commonly applied to the learning environment. This gives rise to further exploration in other fields of study, such as healthcare.

Motivation factors are different for younger and older people, especially if embedded within the technology. This is because different age cohorts have different levels of understanding and acceptance (Punch, 2002). Younger people are more familiar with the uses of technology than older people. Psychologically, when people are getting older, the development of psychomotor learning will decrease as well (Punch, 2002). There has been substantial research concerning the motivation of younger people (R. Brewer, Anthony, Brown, Irwin, Nias, & Tate, 2013; Proske et al.,

2014; Wilson & McDonagh, 2014), older people (Montola et al., 2009), and a mixed population (Mekler et al., 2013) as regards gamification. Empirically, gamification does show a positive impact on motivation (R. Brewer et al., 2013; Montola et al., 2009; Proske et al., 2014). However, research involving motivation for younger and/or older people is open to further investigation, because different settings and requirements may produce other results specific to their context of study. In the next section, an exploration of gamification aspects in the health context is further discussed.

3.2 Healthcare Issues

Healthcare has a wide range of unresolved issues whose solutions are important for a developed country. One that could be classified as a healthcare issue is transition care. In his review of health transition care in England from young adults to older adults for the Care Quality Commission (CQC), Field (2014) reported that the transition process is yet to be established. Of the 180 young people with a long-term condition, only half had received support and followed their transition process towards the end. The rest were not sure as they dropped out and left the process confused and distressed. Even though there is a standard guideline produced by the Health Service, the successful outcome of transition has shown little progression. Research by Crowley, Wolfe, Lock, & McKee (2011) and While et al. (2004) indicates that poor management and support in implementation in following the guidelines have resulted in a low survival outcomes by those in the transition process. The solution to this process thus remains elusive. For that, the next section reviews related issues about transitional healthcare (3.2.1) and how the involvement of technology such as gamification could help the patients through their transition process (3.2.2) and thus, self-manage their condition.

3.2.1 Transition Care

Transition of health is a process to grasp information and manage the uncontrolled situations or events in life (Kralik et al., 2006). During the process, a person will modify their behaviour and rebuild him or herself, so that they will be able to control the uncontrollable events of their lives. The important achievement is when there are changes in routine or behaviour patterns of a person's health condition during the process. The transition of health is also viewed as a process to transfer one's health condition from hospital care to self-care, or from paediatric care to adult care, or from one stage of their health condition to a better stage (Marape, 2013). Following Marape, the transition process requires a patient to equip themselves with knowledge of their condition before they are able to independently take care of themselves.

Earlier research by Freyer (2010) and While et al. (2004) referred to the transition of health as process covering the period of time wherein a patient who lives with a certain long-term health condition (e.g. diabetes, cancel, renal, asthma, mental problem), adapts their care procedure before they can be transferred from hospital care to self-care. Transfer of care includes transferring from one general practitioner to another general practitioner, transferring from paediatric to adult care, and transferring from a child-centred to an adult-centred approach (Crowley et al., 2011; Daneman & Nakhla, 2011).

Following Crowley, Wolfe, Lock, & McKee, (2011), S. Field (2014), and Freyer (2010), transitional healthcare involves the transfer process of a young adult moving to an adult setting and self-care. Based on the World Health Organization (WHO), a young adult is defined as being between the ages of 12 and 18 years. However, this range will depend on the practice of the health services in each country. In the United Kingdom, the National Health Service (NHS) defines a young adult as being between the ages of 10 and 18 years. The London Royal College of Nursing guidance suggests that transition care normally takes place in stages and finishes between the ages of 16 and 18 years old (Marape, 2013). However, in certain cases such as distress and lack of family support, the patient will remain in the process up to 25 years old or older (Crowley et al., 2011; S. Field, 2014; Freyer, 2010).

Handling patients with long-term conditions is challenging. As they move from a one setting to another, the analysis of the care plan and how they can be supported throughout the process is crucial (Daneman & Nakhla, 2011; While et al., 2004). A general process of transition is implemented through stages (Marape, 2013; Paone, Wigle, & Saewyc, 2006). The stages are divided into three. At each stage, certain criteria need to be fulfilled by the patients, their family and their practitioner. The criteria are general and suitable for all health conditions. The stages are:

1) Early – Introduction to the transition process. Patient and their family start to be involved with their own care. The target is set.

2) Middle – the patient further understands the transition process. Gather more information and skills, and attempt to manage his/her own care. Discuss previous targets and set new ones.

3) Late – Prepare to leave the transition process. The patient has been independently carrying out his/her own care. Discuss the target and decide the time to start self-care.

At each stage, a patient's readiness towards self-care will be evaluated. One distinguished measurement tool used to evaluate the readiness is the Transition Readiness Assessment Questionnaire (TRAQ) (Sawicki, Lukens-Bull, Yin, Demars, Huang, Livingood, & Wood, 2011). This

tool is a paper-based tool, manually used by the practitioner or paediatrician to determine a patient's readiness towards self-management skills. Patients do not use the tool themselves.

In the Southampton University Hospital Trust (SUHT), a programme called '*Ready, Steady and Go*' [1] was developed based on the three general stages as explained earlier. In the programme, *Ready* corresponds to the early stage, *Steady* to the middle stage, and *Go* to the late stage. The programme is designed for young adults in the paediatric unit, to get through their transition process to live in the adult care unit. With this programme, patients are expected to be more confident about themselves and thus, better able to manage their own condition. The programme has its own survey questionnaire to measure the patient's readiness.

The transition process may take more time depending on the patient's condition, especially when he or she needs more than one physician's attention to self-manage. In this case, support from family, friends and a paediatrician are important (Marape, 2013). Intervention can be done by the patient, the family or the practitioner particularly in terms of time, skills, knowledge, and environment (Crowley et al., 2011; Freyer, 2010). In this situation, additional approaches to support the transition process could help lessen the need for medical intervention. Following Crowley et al. (2011), various efforts were made and one approach implemented was the use of technology in self-management.

3.2.2 Technology implementation in Transition Care

The involvement of technology in a healthcare environment, such as web applications and mobile applications, draws the attention of both health practitioners and researchers. Apart from being a good tool to manage health records, technology could also facilitate the delivery of the transition care process for adolescents (Hieftje, Edelman, Camenga, & Fiellin, 2013; Wilson & McDonagh, 2014). One form of technology implemented is the use of the internet, whereby the management of transition care, such as knowledge transfer, skills development, communication, and survey, is delivered virtually (Girault, Ferrua, Lalloué, Sicotte, Fourcade, & Minvielle, 2015). The application can be accessed using computers and mobile devices. This further encourages the patient, their family and the physician to participate in the process. Another implementation is entertainment technology, such as playful gaming (Hieftje et al., 2013; Thompson, 2012), or on the *play2prevent* website *www.play2prevent.org*, or through gamification (Wilson & McDonagh, 2014). This technology could help the patient and their family to instil ground knowledge and skills for firm preparation. Instead of using surveys, this is a better way of assessing patient motivation, use of techniques and knowledge, and skills development (Wilson & McDonagh, 2014). This indirectly

[1] http://www.uhs.nhs.uk/OurServices/Childhealth/TransitiontoadultcareReadySteadyGo/Transitiontoadultcare.aspx

helps to improve poor management and implementation in the transition programme as indicated by Crowley et al., (2011) and While et al.(2004).

However, little attention has been paid to the issue of how technology can help to significantly improve patients' motivation and support their knowledge acquisition in a transition process. Technology can be more effective when patient's behaviour changes. Research by Hieftje et al. (2013) indicates that 17 of 19 studies, on the application of computer games technology in supporting a healthcare problem for youth, had shown a significant effect in patient behaviour. They claim that the patient implicitly shows their passion towards completing the process. Thus, a promising tool could help increase the success rate of the transition process. As technology develops rapidly, defining a suitable one could be a challenging issue to be resolved.

3.3 Chapter Summary

A game-like experience in gamified application is expected to increase users' motivation and engagement. However, the effect of motivation should be abide by motivation theory. Among motivation theories applied in gamification are; Self Determination Theory (SDT) and the ARCS model of motivation. These motivation theories will show how a game element could serve as a motivational element in a gamified application. A gamified application can be beneficial to healthcare domains such as the transitional care process. The process is a period of time taken to prepare the patient before shifting him or her from hospital care to a setting of self-care. It takes years to complete the transition process. Patients in a transition process found it difficult to maintain their involvement in the process. Technology could prove to be a good intervention in healthcare as it could help to create self-motivated individuals. One technological approach can be the use of the internet, a game, and gamification. A gamification could be a way in which a patient can be supported to learn about their condition in a transition process with well-defined but 'fun' activities within a gamified application.

Chapter 4: The Transitional Anthropomorphic Gamification (TAG) Framework

Chapters 2 and 3 discussed the research related to anthropomorphism, gamification and transitional healthcare. This chapter examines related problems that emerge when considering the use of anthropomorphic interfaces in gamified application for improving patients' motivation in a transitional healthcare process. Hence, this chapter develops and proposed a framework for the use of anthropomorphic interfaces in gamified application for transitional healthcare.

4.1 Relationships and Gaps

The application of an anthropomorphic interface in gamification for transitional healthcare is mainly aimed at motivating and engaging a patient with their transitional healthcare process. This research first explores the relationships between anthropomorphism, gamification and transitional healthcare, followed by an explanation as to how the gaps between them may be bridged (see Figure 4-1). Of particular concern, is determining the gamification of anthropomorphic interfaces for the transitional healthcare application for patients with health conditions.

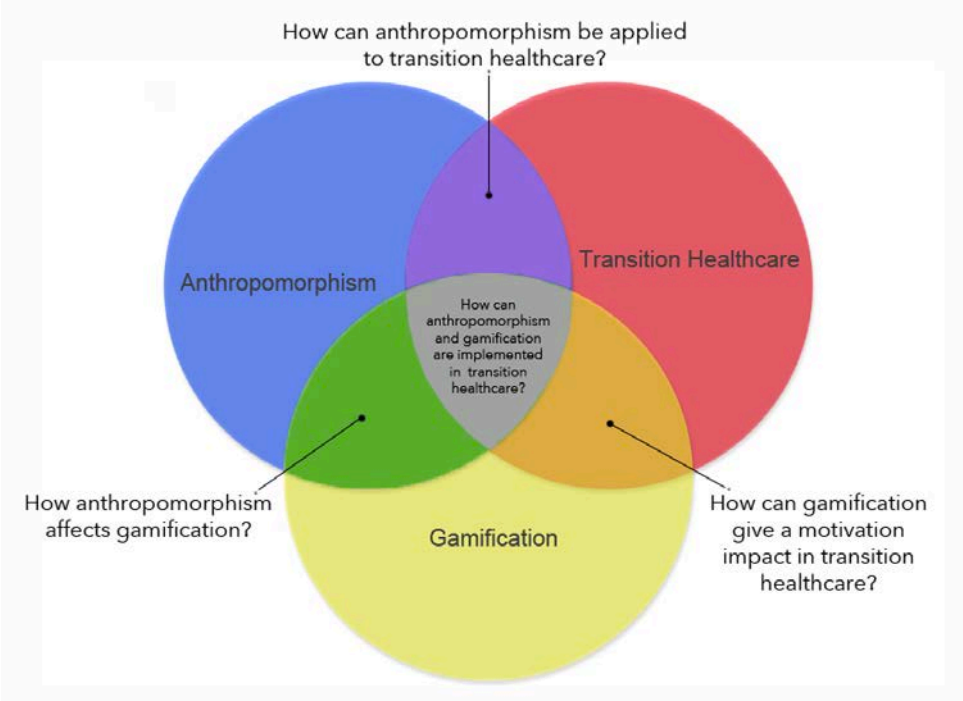


Figure 4-1 Triangulation Maps

4.1.1 Anthropomorphic Interface in Gamified Applications

Chapter 3 discussed the game elements in gamification, and outlined several possible uses. One was the use of an avatar as the game element. The use of an avatar in gamification is generally involved with personalisation and identification, in which players are able to create their own character to represent themselves in the game setting. Gamifying an avatar involves the avatar's modification or upgrading based on the level or points earned in the game. The player can modify their avatar by adding more features or upgrading it to a more 'attractive' avatar. For example, a study by Kuramoto, Ishibashi, Yamamoto, & Tsujino (2013) used an avatar as a reward system in their games. In the game, the player (a commuter) was able to change their avatar personalisation after a certain amount of time had been accumulated whilst travelling on public transport. Another example was a study conducted by Otake et al. (2014), who used an avatar as a motivation factor in games. In the game they used, the player's avatar was changed according to the experience points that they gained while practising their orchestral instrument. In Barata, Gama, Fonseca, Gonçalves, & Jorge (2013), the gamification of avatars in the *AvatarWorld* (the students' gamified learning experience application) can be modified according to the students' achievement in the learning environment. In those examples, the avatars were customised based on the points earned while playing the game, which served as either a motivational factor or a personalisation tool.

Notably, these studies of Barata et al. (2013), Kuramoto et al. (2013), and Otake et al. (2014) showed that the gamification of anthropomorphic interfaces dominated by the use of avatars, which substituted a human-like representation. However, in exploring the uses of anthropomorphic interfaces in computing (Chapter 2.1), there are other degrees of anthropomorphic interfaces, such as ECAs and abstract character, which have been hardly explored in the context of gamification. Additionally, the anthropomorphic interface will be more effective when designed with a trustworthy and preferable element (see in Chapter 2.3). According to Lugrin, Latt, & Latoschik, (2015), the degree of realism for a trustworthy avatar, including appearance (presence) and behaviour (responses), is elusive and is still an open research question. Therefore, further studies are needed to explore the use of other anthropomorphic interfaces.

4.1.2 Anthropomorphic interfaces in Transition Care application

Previous studies have shown a positive impact on the implementation of anthropomorphic interfaces for several medical purposes. For example, Van Vugt, Konijn, Hoorn, & Veldhuis (2009) used an anthropomorphic interface as an advisor for controlling and monitoring patients' weights. This was perceived by patients as a trusted weight advisor. An avatar that impersonates a nurse to

communicate a patient's healthcare information before the patient is discharged from the hospital (Bickmore, Pfeifer, & Jack, 2009). Patients could measure how healthy or unhealthy they were by interacting with their avatar (Schmeil & Suggs, 2014). These implementations of anthropomorphism in healthcare were based on the avatar. The avatar was perceived as positive because of its similarity to a human presentation and it was pleasant to communicate with. Thus, it could provide a more trustworthy interface. The other anthropomorphic interface designs, such as ECAs and abstract characters, could also have a positive impact on patients' motivation and engagement, and may be preferable to the patient. Even though anthropomorphism has been widely applied in many healthcare application, its application in transitional care in health has not been tested.

4.1.3 Gamification for Transition Healthcare

In the transitional health care process, there is a guideline and plan used by paediatricians to measure a patient's readiness. For example, the Transition Readiness Assessment Questionnaire (TRAQ) (Sawicki et al., 2011), and a questionnaire for the *Ready, Steady, Go* programme. Offering additional tools that could be used to support the patient in learning to self-manage, may increase their motivation and engagement in the transition process.

As discussed in Chapter 3.2.2, the introduction of technology could be helpful. One method is through gamification. Gamification for healthcare is getting more attention lately. However, in the transitional care process, there is not much exploration of gamification. One recent study by Wilson & McDonagh (2014) proposed a gamification model for transition care checklists. Their models proposed several game elements for the checklists such as points, badges, levels, and a Leaderboard. A patient received 100 points when they achieved a given task. Early achievement will earn additional 600 points plus with more bonus points. A trophy and badge are awarded when certain skills are gained. A Leaderboard will show all the patients' achievements throughout the process. This gamification model has too many incentives as the key to motivation. As Hamari et al., (2014) and Mekler et al., (2013) argued, too many extrinsic motivations (such as points and rewards) will decrease the player's intrinsic motivation. Moreover, Wilson's gamification model does not explicitly show how a patient could learn or could gain knowledge in a transition process. Thus, a comprehensive gamified application should be designed for supporting the patient to learn and self-manage in the transition process.

However, this study is not about motivation alone, and it can be argued that patient motivation may vary throughout the transition period. The transitional care process will last 8 to 10 years and, as the patient is going through the process, introducing more attractive elements

could be helpful to motivate them to learn about their condition during the transition process. Thus, confirming the usefulness of gamification for transitional healthcare remains a challenge.

4.2 Bridging the Gaps

This research triangulates anthropomorphic interfaces, transitional healthcare, and gamification. Identifying gaps for each of the areas helps to connect the ideas for this research. The research gaps are;

i. Current anthropomorphic interface application in gamification focuses mainly on avatars, as its game elements (section 4.1.1). Anthropomorphic interfaces offer different degrees of human-like designs. However, other degrees of anthropomorphic interfaces, such as ECAs and abstract characters are yet to be established in computer applications. Exploring the different degrees of anthropomorphic interfaces may help show how anthropomorphic interfaces could be applied in a gamified application. The research also argues that the anthropomorphic interface will be more effective when designed with a trustworthy and preferable element.

ii. A gamified application typically uses points, badges, levels, and a Leaderboard as its main claim to the concepts of gamification and its motivational effects in a gamified application. Discovering other combinations of game elements, such as the different degrees of anthropomorphic interface, could see the potential of gamification and its motivational influence, in particular when applied into transitional healthcare applications.

iii. The anthropomorphic interface has various uses in a healthcare application (as discussed in section 4.1.2.). However, when investigating their use in a transition care application, additional exploration is required. In the transitional care application, introducing additional tools such as a gamified application may help the patients to learn more about their condition and may help to maintain the patients' motivation throughout the process. When applying different degrees of anthropomorphic interfaces in gamified application, it may also have an effect on the transitional care process.

iv. Both anthropomorphic interfaces and gamification offer a motivational effect on human and computer interaction. Confirming the effects in line with motivation theory will further support the argument in this research.

The gaps being addressed here encouraged an investigation of how the different degrees of anthropomorphic interface and its elements applied in a gamified application could motivate patients to learn about their condition in a transitional care process. Thus, creating a suitable framework may help to address the problem. This framework is presented in the next section.

4.3 The Framework Development

Synthesizing the research is crucial to developing a new framework. The framework is based on problems raised by each of the proposed research areas. For that, the process is divided into three phases, which are illustrated in Figure 4-2.

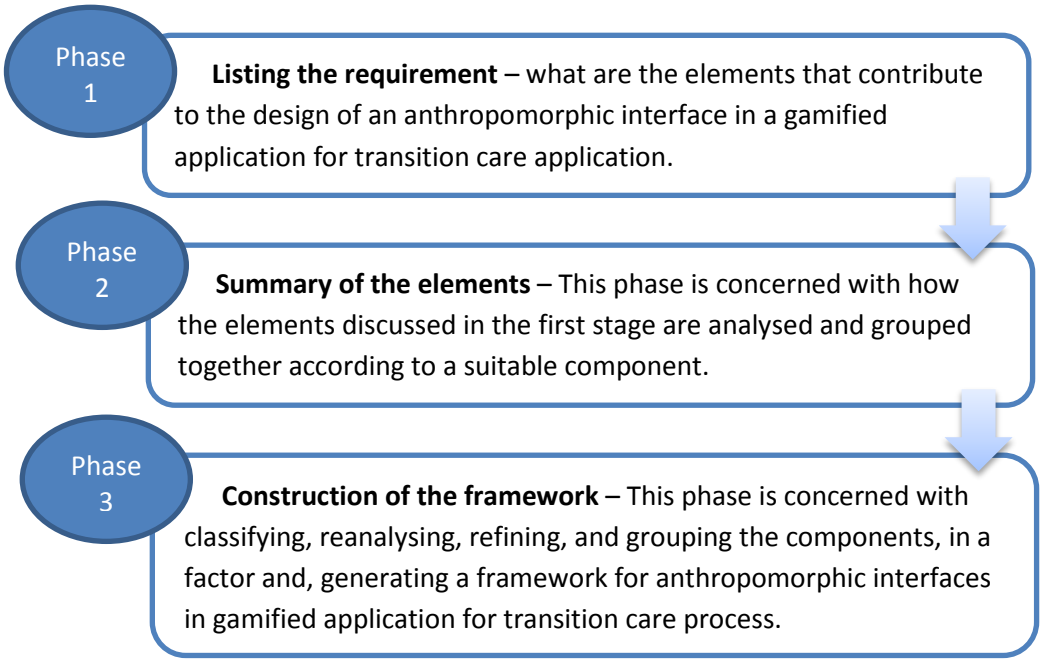


Figure 4-2 Phases in Framework Development

4.3.1 Phase 1: Listing the requirements

In developing the framework, the first phase is to list out all the components and elements related to anthropomorphic interfaces in gamified application for transitional healthcare. These components and elements are analysed and extracted from the discussions in Chapters 2, and 3. The process of analysis questions what the basis of the degree of anthropomorphism is, what types of anthropomorphic interface element are needed, what game elements should be used for gamification, and what are the requirements for a transitional care gamified application. Chapter 3 discussed gamification as a motivation affordance, while Chapter 4.1 linked the gamification of anthropomorphic interfaces to motivation. Anthropomorphic interfaces and gamification could have a great effect on a users' motivation. This motivation effect also needs verification. Therefore, in this phase, six issues were analysed;

First, anthropomorphic interfaces vary in their portrayal of human-like qualities. Departing from the research on anthropomorphic interfaces in Chapter 2.1, the degree of anthropomorphic interface can be described by different designs, for example; 1) more human-like - avatar or a caricature of human, 2) medium human-like - interface agent either a mix design between human

and animal or a mix design between human and other object, and 3) less human-like – an abstract character that may be presented in any form other than in types 1 and 2. Thus, the anthropomorphic interfaces will be based on these types of designs.

Secondly, anthropomorphic interfaces should portray a trustworthy and a socially present element. These elements were discussed in Chapter 2.4 and 2.5. Based on previous research, the anthropomorphic elements were categorised as,

1) Social response towards a trustworthy anthropomorphism and
2) The element of a social presence.

There are a total of eight elements of social response and four elements of social presence. Social response consists of eye contact, facial expression, gesture, posture, voice instruction, flattery effect, emotion, and intelligence. Social presence consists of gender, ethnicity, age, and facial attractiveness. From the previous research listed in Table 4-1, the research conducted examined several anthropomorphic elements, whereby in each subject of research there were elements that supported or did not support, as well as elements that were suggested for future enhancement. The elements that were supported indicated that they were consistent and thus, should be implemented in any design of anthropomorphic interfaces. For the elements that were not supported and suggested future enhancement, a confirmation study should be conducted to verify them. Thus, the elements to be further verified are gesture, posture, voice for instruction and flattering effect, intelligence, and gender.

Third, the accessibility features discussed in Chapter 2.6 will also be taken into consideration conforming to the UAAG. The accessibility features will provide an alternative access point to the anthropomorphic interfaces. However, the features will not be suitable for users with specific disabilities like hearing or visual impairments. It aims to test users who have a mobility problem.

Fourth, the list of game elements was discussed in Chapter 3.1.1. Previous studies show that among the game elements; points, badges, levels and a Leaderboard were among the common elements used in gamified applications. Table 4-2 listed previous research studies in gamification. The utilisation of other game elements has been overlooked. Other than the points, badges, levels, and a Leaderboard, different combinations of game elements need to be explored as well. However, the selection of game elements depends on the issue addressed. The implementation of game elements is based on the context of transition care, which will be applied in this research.

Table 4-1 Summarisation table for Anthropomorphism Element

	Anthropomorphism Element							
Categories / And Elements / Research Studies	Social Responses through Trustworthiness (pages: 15-16)				Social Presence (pages: 16-17)			
	non-verbal behaviour: 1) eye contact 2) facial expression 3) gesture 4) posture	Voice 1) Instruction 2) Flattering effect	Emotion	Intelligence	Gender	Ethnicity	Age	Facial Attractiveness
Cowell & Stanney (2005)	✓ (1/2) ‡ (3/4)				×	✓	✓	
Forlizzi, Zimmerman, Mancuso, & Kwak (2007)				✓	✓			
Gong (2008)	✓ (2)	‡						
Lee (2010)		✓ (2) ‡ (1)						
Mumm & Mutlu (2011)		✓ (2)						
Power, Wills, & Hall (2002)				✓				
Catrambone, R., Stasko, J., & Xiao, J. (2002)				✓				
Pereira, Prada & Paiva (2014)				✓				
Złotowski et al. (2014)			✓	×				
Beck, Stevens, Bard, & Cañamero (2012)			✓					
De Angeli & Khan (2007)					✓	✓		✓
Qiu & Benbasat (2010)					×	✓		✓
Pratt, Hauser, Ugray, & Patterson (2007)						✓		
Spence, Lachlan, Spates, Shelton, et al. (2013)						✓		
Spence, P. R., Lachlan, K. a., Spates, S. a., & Lin, X. (2013)						✓		
Khan & Sutcliffe (2014)								✓
Seung-Chul Yoo, Jorge F., Mibette E. (2015)							✓	
Park Jaram, Barash, Fink & Cha (2013)			✓			✓		

✓: conducted and supported study ‡: further suggestion × : conducted but not supported

Table 4-2 Summary table for Game Elements used in gamified applications

Game Elements / Research Studies	Point	Badges	Leaderboard	Levels	Storyline	Progression	Feedback	Avatar
Wilson & McDonagh (2014)	✓	✓	✓	✓				
Otake et al. (2014)	✓	✓	✓	✓				✓
Barata et al. (2013)	✓		✓		✓	✓		✓
Ziesemer et al. (2013)		✓				✓		
Kuramoto et al. (2013)	✓	✓	✓	✓				✓
Mekler et al. (2013)	✓		✓	✓		✓		
Domínguez et al. (2013)	✓	✓	✓	✓		✓		
Cheong et al. (2013)	✓		✓	✓			✓	

✓: Game Elements that investigated in the research

The use of anthropomorphic interfaces was mostly based on the design of the avatar. The avatar is one of the game elements identified in Chapter 3.1.1. A range of anthropomorphic interfaces had not been utilised in previous research, so the variations proposed by this research need to be assessed. Previous applications of avatars in gamified applications were discussed in section 4.1.1. The avatars were either a player's representation or used as a strategy in games where changes were possible depending on levels reached within a game. This research defined how an anthropomorphic interface is applied in a gamified application. This could be as an element of personalisation or user identification.

Fifth, there are two motivation theories discussed in Chapter 3.1.2; 1) Self Determination Theory (SDT) and 2) the ARCS (Attention, Relevance, Confidence, and Satisfaction) model. These theories have been applied to verify the effect of the gamified application on a player's motivation. Using the ARCS (Keller, 1987), the motivational effect is assessed by getting attention, establishing relevance, gaining confidence, and having satisfaction over the learning process. However, in SDT (Ryan et al., 2006), the theory shows that having the sense of one's own control (autonomy), ability to make changes (competence), and any relation to surroundings (relatedness), have an impact on experiences, decision, and behaviour. The SDT has been widely applied and confirmed as a significant concept in the gamified application (for example in Cheong, Cheong, & Filippou (2013), Domínguez, Saenz-De-Navarrete, De-Marcos, Fernández-Sanz, Pagés, & Martínez-Herráiz (2013), and Mekler, Brühlmann, Opwis, & Tuch (2013)). The ARCS model has rarely been applied to a gamified application because in previous studies, assessing a player's motivation to learn was not the main purpose of using a gamified application. Thus, the adoption of the ARCS model for a gamified application remains a challenge. This research proposes the

application of the ARCS model to confirm the motivational effect on a transitional care gamified application.

Finally, the issues facing transitional care requires further attention. Transition care aims to guide the patient throughout their transition period (discussed in Chapter 3.2.1). Based on the discussion, the technology implementation in the transitional care process is expected to help patients survive their condition. Therefore, the proposal is to implement items defined in Phase 1 and 2 for the transitional care process. To this end, defining a requirement to employ a gamified application for transition care process is needed. The transition care process is conducted in stages. These stages differentiate the level of learning the patient should concentrate on. The stages are early, middle, and late. This stages are also known as ready, steady, and go as adopted in the Ready, Steady, Go programme explained in Chapter 3.2.1.

The *Ready, Steady, Go* transition process (see in Chapter 3.2.1) normally involves young adults, age from 11 to 18 years. However, people in the *Ready, Steady, Go* transition can be up to 25 years old. The age ranges varies depending on a patient's health condition. Defining the age range will inform a suitable design for a transition care gamified application. This suitable design will implicitly help to understand the motivational effects of gamified applications for transitional healthcare.

4.3.2 Phase 2: Summary of the elements

In phase 2, each element identified in Phase 1 is gathered, refined, and then, grouped into a suitable component. Table 4-3 shows the summary of the refined elements. The research themes were the issues discussed in Phase 1. Based on the themes, the identified elements were grouped into components. This summary helps to focus on which components are important as the groundwork of the framework.

Table 4-3 Summary of identified elements for the framework

Research themes	Discussed Components	References
Type of anthropomorphic interfaces in computer application	Lifelike character (more human-like) and iconic character (less human-like)	Catrambone et al. (2002)
	Human-like (more human-like – avatar), cartoons (medium human like), and Icon (less human-like)	Power et al. (2002)
	Avatar (more human-like – avatar), agent (medium human like), no image	Nowak & Biocca (2003)
	Human-like (more human like), a shape (less human like)	Kao & Harrell (2015)

	Human (less human like), fantasy (medium human like), animal, and humanoid (less human like)	Mull et al. (2015)
	Machine-like (medium human like), cartoon-like (medium human like), human-like (more human like)	Lugrin, Latt, & Latoschik (2015)
Elements of Anthropomorphic interfaces	- Social presence - Social response through trustworthiness	Refer to list of references in Table 4-1
Game elements commonly applied in gamified application	Game Elements e.g. Points, Badge, Level, a Leaderboard, Progression	Refer to list of references in Table 4-2
Motivation theory in accordance with the effect of game-based learning	The ARCS Model of Motivation	Hamzah & Ali, (2014) Hung, Lee, Chao, & Chen, (2011) J. T. Kim & Lee, (2012) Proske, Roscoe, & McNamara, (2014)
Elements of motivation for young adults	Relevant elements for young adults	R. Brewer et al. (2013), Proske et al. (2014) Punch, 2002; Wilson & McDonagh (2014)
Requirement for Transition healthcare	Stage in transition	Marape (2013), Sawicki, Lukens-Bull, Yin, Demars, Huang, Livingood, & Wood (2011) Wilson & McDonagh (2014)

4.3.3 Phase 3: Construction of the framework

The construction of the framework is founded on previous research findings and established theories relating to anthropomorphic interfaces, gamification, motivation, and transitional healthcare. In this phase, the proposed framework is constructed for anthropomorphic interfaces in gamified applications for transitional healthcare. The elements and components identified in Phases 1 and 2 were collected, analysed for recurring and similar components, refined and re-analysed against the need for transitional healthcare, and then summarised into a constructive framework. Following the summary, the research themes were categorised as a factor and the discussed components were grouped and named as components of the framework.

The framework suggests that anthropomorphic interfaces in gamified applications for transitional healthcare can be determined by six factors and fifteen components. Table 4-4

presents the classification of the factors and its related components for inclusion in the proposed framework. The detailed descriptions of these six factors are presented in the next section.

Table 4-4 Classification of the Factors and Components in the proposed framework

Research Themes (refer Table 4-3)	**Factors in Framework**	**Discussed Components (refer Table 4-3)**	**Components in Framework**
Type of anthropomorphic interfaces in computer application	**Degree of Anthropomorphic Interfaces**	- more human-like (avatar), - between avatar and agent, - medium human-like (interface agent), - between agent and abstract, - less human-like (an abstract character)	**Avatar,** **Human Cartoon,** **Interface agent,** **Hybrid Character,** **Abstract character**
Elements of Anthropomorphic interfaces	**Elements of Anthropomorphic interfaces**	Social presence Social response	***Social Responses*** (eye contact, facial expression, gesture, posture, voice instruction, flattering effect, emotion, and intelligent), ***Social Presence*** (gender, ethnicity, age, facial attractiveness), *Accessibility*
Game elements commonly applied in gamified application	**Game elements in gamification**	Points Badge Level Leaderboard Progression	**Points,** **Badge,** **Level**, **Leaderboard** **Progression**
Motivation theory in accordance with the effect of game-based learning	**Motivation Theory**	ARCS Model of Motivation	***ARCS theory of motivation***
Requirement for Transition healthcare	**Transition Healthcare**	Stage in transition	**Three stages** involved: Early, Middle, and Late
Elements of motivation for young adult	**Motivation Element for young people**	Relevant elements for young adults	***Motivation elements*** for young people aged 11 to 25

4.4 The Proposed Framework

The proposed framework is derived from the development phases discussed in section 4.3. The Framework for ***A***nthropomorphic interface affects in ***G***amification for ***T***ransitional care (TAG) is based on the six suggested factors, which are: 1) degree of anthropomorphism, 2) the elements of anthropomorphism, 3) the game elements in gamification, 4) motivation theory, 5) transition healthcare, and 6) motivation effect on young people.

Each of the factors is described below;

1) Degrees of anthropomorphic interface

Different designs of human resemblance for an anthropomorphic interface include;

- An Avatar - representing very human-like features.
- A human cartoon - represented by a human as well, but resembling a cartoon character with big head, a small body or a heroic character such as Super Mario.
- An interface agent - a design of mixed human and animal features like a Sonic Hedgehog.
- The hybrid character - a representation of a human-like design within animal features such as a dog, a bird, a horse, or a representation of human-like design in real object such as Angry Birds, Paperclip (Microsoft) and racing car avatars.
- An abstract character - the representation of a human-like design within an abstract form such as a smiley face, or an alien figure.

Suggested types of anthropomorphic interface are found in Figure 4-3.

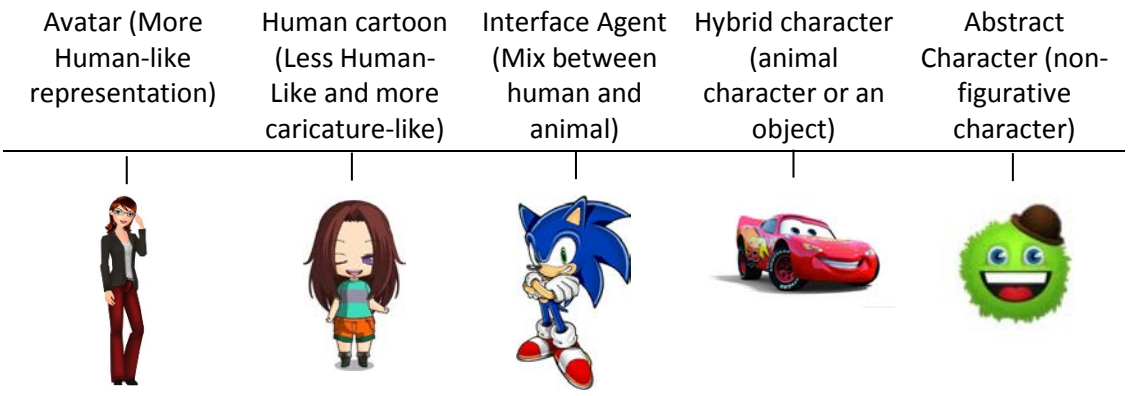


Figure 4-3 Type for Anthropomorphic Interface

2) Elements of the anthropomorphic interface

This factor will identify the characteristics of an anthropomorphic interface. The characteristic has two main elements, social responses and social presence. The social responses element consists of eye contact, facial expression, gesture, posture, voice instruction, flattering effect, emotion, intelligence. Whereas, the social presence element consists of gender, ethnicity, age, and facial attractiveness. All the elements in social

responses and social presence were based on previous research that has been summarized in Table 4-1. Another element of the anthropomorphic interface that can also be included within this factor is accessibility assessment.

3) Game elements in gamification

This factor will identify elements based on process requirement by the transition care process. Based on previous research in gamification summarized in Table 4-2, the game elements suggested are badges, levels, points, progression, and a Leaderboard.

4) Motivation theory

This factor will identify the motivation theory that fits this study. The ARCS model was applied because the ARCS model could be suitable for assessing the motivation effect on learning process. Besides, there is little application of the ARCS model in a gamified application. Four elements based on the ARCS model will be used to assess motivational effects. There are Attention, Relevance, Confidence, and Satisfaction.

5) Transition healthcare process

This factor defines the stages involved in the transition care process. Stages are defined in Chapter 3.2.1 as early, middle, and late stages.

6) Motivation for young people

This factor will define the motivational elements for youth category which are relevant to the transition process. These young people are aged between 11 to 25 years old.

To conclude, Table 4-5 listed all the factors and components suggested for each of the factors in the TAG framework. Based on the table, the factors of the proposed framework are illustrated in Figure 4-4. The framework is presented in the design of puzzle. The puzzle is meant to symbolize that each research gaps or problem statements for the application of anthropomorphic interfaces in gamification for transitional healthcare has to be resolved as a whole. Each pieces of the puzzle represents one factor. These factors have to be arranged, combined, and built into a single reference framework. It is understand that, the factors in this framework are specific to the implementation of anthropomorphic interfaces in a gamified application for transitional healthcare. If one of the factors changed or is replaced, the framework will be no longer serve its purpose. Thus, it will be beyond the context of research. Any extension to the framework or other utilisation in the healthcare setting should be considered for future research.

Table 4-5 Factors and Components in the TAG Framework

No.	Factors	Components
F1	Degree of anthropomorphic interface	*Avatar, Human Cartoon, Interface agent, Hybrid Character, and Abstract character*
F2	Elements of anthropomorphic interface	*Social Responses* (eye contact, facial expression, gesture, posture, voice instruction, flattering effect, emotion, and intelligent), *Social Presence* (gender, ethnicity, age, facial attractiveness), *Accessibility*
F3	Game elements in gamification	*Rewards, Badges, levels, progression, the leaderboard*
F4	Motivation theory	*The ARCS theory of motivation*
F5	Transition healthcare process	Three stages involved: *Early, Middle, and Late*
F6	Motivation for young people	*Motivational elements* for young people

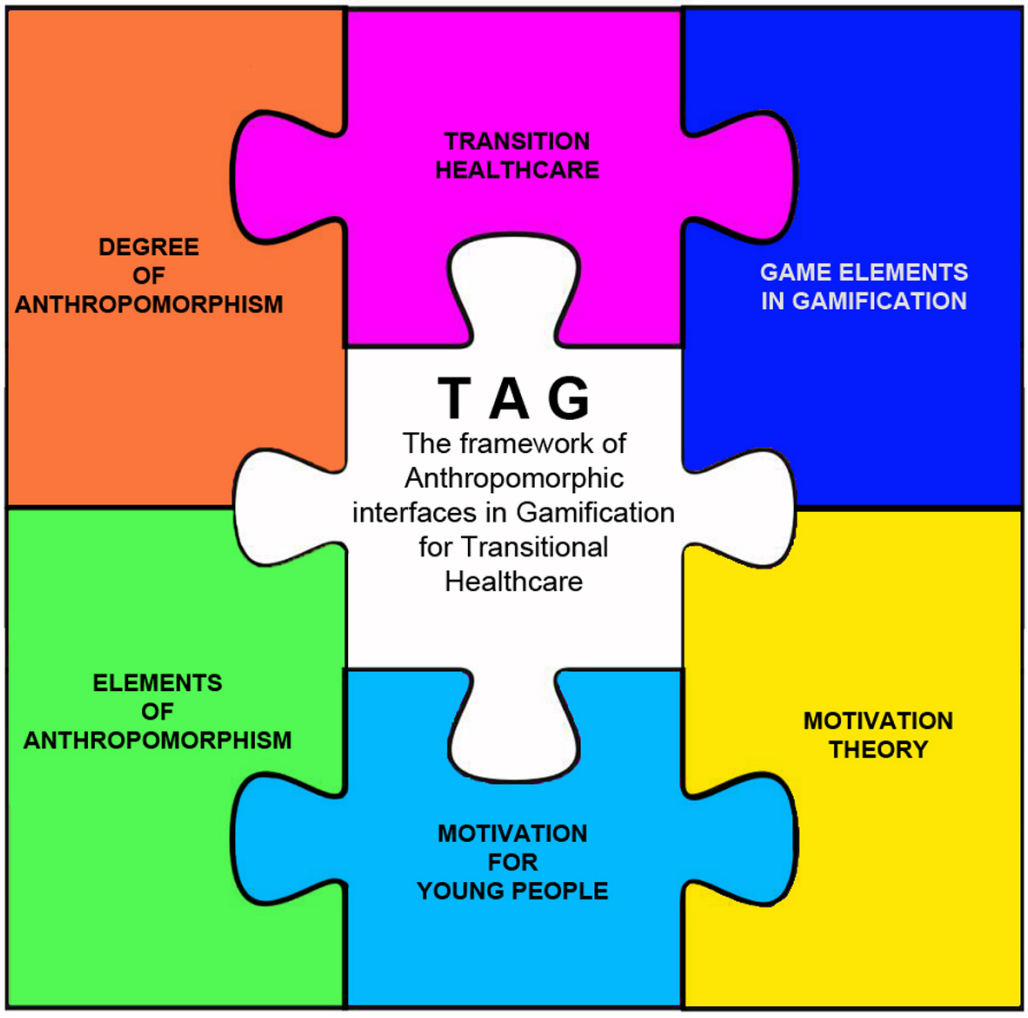


Figure 4-4 the Proposed Framework

4.5 Chapter Summary

A review and a discussion of anthropomorphic interface research, gamification research, and transition healthcare research have informed the development of the framework for anthropomorphic interfaces in gamified applications for transitional healthcare. The conjecture of this research is that different degrees of anthropomorphic interface should be applied in gamification for transitional healthcare. As a consequence, the development of a framework is required for this study. The framework was developed over three phases. The first phase was listing all the elements related to anthropomorphic interfaces, gamification, and transition care applications. The second phase was concerned with how to refine the elements discussed in phase 1, summarising the research issues into themes, and grouping the elements in the research theme according to their suitable component. The third phase was concerned with generating the factors and components for inclusion in the framework. As a result, the framework for anthropomorphic interface (**A**) in gamification (**G**) for transition healthcare (**T**) was proposed. Shortened to ***TAG***, its factors include;

1) The degree of anthropomorphic interface,
2) The elements of anthropomorphic interface,
3) Game elements in gamification,
4) Motivation theory,
5) Transition healthcare, and
6) Motivation for young adults.

The proposed framework therefore needs verification and confirmation. Once the framework has been confirmed, further validation of its use and its possible application are explored and examined. Next, the research methodology applied to further this research is outlined.

Chapter 5: Research Methodology

This chapter discusses the method used to carry out the body of this research. Further research should be conducted to confirm the framework proposed in Chapter 4.4, validate its use and apply it in the context of this research. This is in line with the research objective in Chapter 1.2, where the research attempted to define;

1) A suitable framework for the application of anthropomorphic interface in gamification for transitional healthcare,
2) An instrument to measure the extent of anthropomorphic interfaces in a gamified application for transitional healthcare in informing the users about their health,
3) A guideline that can be used as a benchmark for a gamified application in transitional care.

In order to provide appropriate conclusions, a suitable research methodology had to be applied. Therefore, this chapter explains the research methods considered, the rationale for the chosen method, and the application of the chosen methods applied in this study. The explanations presented in the following section are; the research paradigm, the methodological approach, the design, the technique for data collection, the techniques for data analysis, and the study's ethical considerations.

5.1 Research Design

The research design refers to the knowledge assumption to seek an understanding about the research and how the research should be investigated (Creswell & Plano Clark, 2011; Saunders, Lewis, & Thornhill, 2009). Identifying which research design to follow will gives the researcher a logical method to carry out the research. In general, there are three research designs – quantitative, qualitative, and mixed method.

i. Quantitative Research

Basically, quantitative-based research views a study objectively and is dependent on statistical data to determine the outcome of the study. The research is often designed with structured and close-ended questions, to avoid researcher biases (Creswell, 2009). Quantitative research is adopted for confirming existing information rather than exploring a new idea. Among the strategies involved in quantitative study are the controlled experiment and survey research (Creswell, 2009; Easterbrook, Singer, Storey, & Damian, 2008). A large number of participants are required to represent the population.

ii. Qualitative Research

Qualitative based research allows for the acquisition of in-depth knowledge and views based on a specific focus group or a particular situation (Creswell, 2009). It enables the discovery of new information and helps to further explore the current situation. Qualitative strategies can be in the form of interviews, photographs, notes, conversations and recordings. The data from qualitative research will be subjected to the researcher's interpretation. Here, there is the notable possibility of research bias (Creswell, 2007; Sekaran, 2013). Moreover, conducting and analysing a qualitative research study is more time consuming. The number of respondents required for this setting is not predetermined, but should be a reasonable sample to ensure validity for the data obtained.

iii. Mixed Method Research

Mixed methodology combines quantitative and qualitative research in acquiring a profound understanding of the research scenario (Creswell, 2009; Warfield, 2010; Zachariadis, Scott, & Barrett, 2013). It is believed that mixed method research can offset possible flaws when exclusively quantitative or qualitative methods are adopted (Creswell, 2009). The combined approach helps discover new information as well as confirm existing knowledge. In information technology, mixed methods may achieve a more reliable outcome and will improve the validity of a study (Bliss, 2003; Warfield, 2010). The mixed method allows for the triangulation of the data obtained, making the conclusions more robust.

Previous research conducted on anthropomorphism or gamification for the healthcare setting had applied more or less a similar research design. A study by Bickmore, Pfeifer, & Jack (2009) about a virtual nurse for hospital discharge, and Høiseth & Giannakos (2013) about health games for toddlers, undertook qualitative research in their study. They used interviews to gain insight into the participants' perspectives and experiences related to the context of the study. They believed, from the interviews, that the participants had the opportunity to openly express their feelings and opinions. An experimental study by Van Vugt, Konijn, Hoorn, & Veldhuis (2009) explored the effect of a trustworthy e-health advisor by using a questionnaire to disseminate the participants' opinions. Furthermore, a study by Sah & Peng (2015) used a questionnaire to measure a participant's behaviour outcome resulting from the effect of anthropomorphic cues in a healthcare website. Both studies employed quantitative methods for their studies. All of the data were analysed and refined into statistical information to provide meaningful conclusions. The mixed method research applied by Durga et al. (2011) and Karadimitriou & Roussou (2011), used interviews, observations, and questionnaires to obtain data from a long-term study. An interview was conducted to obtain the participants' experiences and observation was used to study the participants' reactions and change in behaviour over a period of time. A questionnaire

was used to collect the participant's views about the task that had been given to them. By adopting a mixed method, the data from interview, observation, and questionnaire were complementary. Thus, the study obtained a wide range of data.

All research designs have their own requirements. In any of the research designs, understanding the scenario of the study and how the aims can be achieved, helps with the choice of research design that should be adopted.

5.1.1 Rational for choosing a research design

In this research, the research questions were developed based on the gaps in previous literature. From there, research is further explored, built up and formed around discussions, assumptions, actions, and thoughts. Acquiring knowledge with more than one specific research design could help the researcher answer the research question. Based on the research questions listed in Chapter 1.2, this research employed a mixed method design. This is justified as follows;

i. The first research question aimed to provide a suitable framework for the application of anthropomorphic interfaces in a gamified application for a transitional healthcare process. When the framework was developed, it was deemed necessary to further explore to confirm the significance of each of the factors and components identified in the framework. To do so, exploratory and descriptive studies adopting mixed methods were chosen. This is because the variation of data from different perspectives relating to research, personal experiences, and practical approaches could lead to a greater validity. Moreover, when researching interdisciplinary studies – the anthropomorphic interface (HCI), gamification (game), and transition care (health), it was deemed insufficient collect data from a single method, be it qualitative or quantitative (Creswell & Plano Clark, 2011). Thus, adopting a mixed method design could support and strengthen the claims made in this research.

ii. The second research question concerned the validity of the use of the framework created and confirmed in the first research question. One of the uses of the framework is to provide an instrument to measure the extent of anthropomorphic interfaces in gamification applied in games, in informing the patients about their transition care. The instrument is presented in Chapter 7 and Chapter 8. This research adopts a quantitative design to validate the instrument. In order to obtain participant's opinion about the measuring items, the use of a questionnaire in an interview, survey, and experiment was considered suitable for testing and validating the developed instrument, in particular, to look at the relationships between measuring items, and to establish the validity of each item in the instrument.

iii. The third research question looks at the applicability of the framework, it is thus, a guideline to assist practitioners and researchers in developing a gamified application for transitional healthcare by featuring the anthropomorphic interfaces. This guideline will then require verification (presented in Chapter 9). This research adopts a qualitative design. To find and ensure the usefulness of an intervention such as a guideline, it is advisable to obtain an expert's opinion using a focus group discussion in order to look at the strengths and weaknesses of each item in the guideline (Sekaran, 2013).

To practically apply the research design, the next section explains the approach to the design.

5.2 Research Approach

Seeing as the mixed method design was chosen, this research approach section explains the details of how the chosen research designs were adopted. The explanations for all approaches are as follows;

5.2.1 Triangulation

Triangulation uses multiple methods, measurements and perspectives in order to solve a research problem in the same context of study (Jick, 1979; Zachariadis et al., 2013). The mixed approach in triangulation is to offset any bias or weaknesses when using a single method (Jick, 1979; Zachariadis et al., 2013) and thus improve the validity of the research outcomes. The triangulation methodology applied is a combination of theoretical aspects (the proposed framework) and the practical approach (the way data are collected to support the framework). The triangulation method is suitable for exploratory and confirmatory studies, where data and theory are mixed, by comparing, integrating and interpreting (Creswell, 2009; Warfield, 2010; Zachariadis et al., 2013). At the end, the same pattern of understanding will be gathered. Employing triangulation methodology thus helped in confirming the proposed framework.

5.2.2 Sequential procedure

In conducting mixed method research, there are two types of procedures that can be used to conduct a study – sequential and concurrent (Creswell, 2009). A concurrent procedure will conduct both quantitative and qualitative studies simultaneously. A sequential procedure will conduct the quantitative and qualitative study in a particular order, either using the sequential explanatory strategy (the quantitative study will be conducted first, followed by the qualitative study) or the sequential exploratory strategy (the qualitative study will be conducted first, followed by the quantitative study).

As the emphasis is to confirm the suggested framework, the foundation of the framework has to be further explored to understand its importance and then empirically expand the finding. In such a case, the sequential exploratory strategy is deemed appropriate. According to Creswell (2009), the sequential exploratory strategy is suitable when the researcher is developing a new instrument in particular, if the researcher wants to discover what is available, and support the existing implementation with statistical data. Thus, a sequential procedure implementing an exploratory strategy was chosen for this study. The expert interview was the method applied for qualitative study, explained in section 5.3.1. The questionnaire survey was the method applied for the quantitative study, explained in section 5.3.2.

5.2.3 Pre-test

The pre-test is a preliminary study that pre-tests the instrument or questionnaire before it is used in an actual study (Creswell, 2009). This is conducted by means of administering the developed items to a prospective sample. The pre-test will simulate a test in order, to pre-identify any early problems and anticipate the prospects for a successful outcome (Saunders et al., 2009). It is also used to determine beforehand if the instrument is valid and has an acceptable level of reliability (see in Banks & Bowman (2016), Dwivedi et al. (2006), Fu, Su, & Yu, (2009) and Karadimitriou & Roussou (2011)). The pre-test will enable constructs or questions to be refined if necessary. Moreover, the initial data analysis will ensure that the data collected from the actual test will allow the research questions to be answered (Creswell, 2009). Therefore, this study employed a pre-test, and the method by which it was conducted is explained in section 5.3.2.

5.2.4 Instrument Validation

A newly created instrument requires validation to ensure that it measures the underlying concept it is meant to measure. Following Creswell (2009), Saunders et al. (2009) and Sekaran (2013), to assess an instrument's validity, three types of validity tests are used; content validity, construct validity, criterion validity.

i. Content Validity

A content validity test looks at the extent to which a construct adequately reflects the subject that it intends to measure (Creswell, 2009; Sekaran, 2013). In this research, a content validity test is conducted to see if the measurement items in the questionnaire adequately cover the research concept. A content validity test is usually conducted at an early stage, especially when using a newly developed questionnaire. It is based on the subjective judgement of experts in the context of the research problem and is also seen as a cost effective technique, considering the time and

the people involved in the study (Creswell, 2009). By employing experts in the field, only a small number of people are required, reducing the amount of time needed.

In previous research by Banks & Bowman (2016) and Dwivedi, Choudrie, & Brinkman (2006), a content validity test was conducted to inspect the importance and suitability of each item in their instrument. The inspections were conducted with experts, who have experience relevant to the study. During the inspection, experts gave their comments in terms of the language, sequencing, use of words (confusing, repetitive, and too broad), the unnecessary items (question is too common, or out of context), and the scales of appropriateness. The assessment of the content's validity will enable the researcher to make necessary amendments to their instrument prior to the actual study. For the process of validation as well, it may help to reduce errors and helps to strengthen the instrument. Thus, the inspection method will be applied to conduct the content validity in this research. It will be explained in section 5.3.3.

ii. Construct Validity

The construct validity test assesses to how well the data obtained from the use of instrument demonstrates the theories being tested (Sekaran, 2013). In this research, a construct validity test is conducted to examine whether the constructs (the measurement score) meet the purposes for which they are used in practice (according to the scale/domain). Furthermore, the validity will statistically demonstrate that the items represent a particular construct and thus, could suggest both theoretical construct and statistical result into a newly validated instrument. Previous research such as validating a new gameplay instrument (Fu et al., 2009), user engagement instrument (Brockmyer, Fox, Curtiss, McBroom, Burkhart, & Pidruzny, 2009; O'Brien & Toms, 2010; Wiebe et al., 2014), and avatar instrument (Banks & Bowman, 2016) employed the exploratory factor analysis and the reliability test to validate their research instrument. With statistical support, the theoretical construct then suggested a new usable instrument, for the context of study. Thus, to conduct a construct validity test, a validation test is devised, considering within and between subject designs explained in section 5.2.5.

iii. Criterion Validity

Generally, a criterion validity test is concerned with differentiating individual scores based on predicted or expected criterion which can be explained by either conducting concurrent or predictive validity (Saunders et al., 2009; Sekaran, 2013). Concurrent validity will look at the individual scores for which criterion are known to be dissimilar at a specific time. Meanwhile, predictive validity will demonstrate whether the instrument is able to differentiate predicted future conditions. Previous research in computers and games mainly established predictive validity rather than concurrent validity; for example, to compare the differences between overall

scale score (game enjoyment) and criteria scale (learning experience by playing games) (Fu et al., 2009), to predict a user's engagement instrument towards game performance (Wiebe et al., 2014), and to test the assumption on the importance of various gameplay elements towards the player's gameplay motivation (Banks & Bowman, 2016). This predictive validity test was conducted as an additional confirmation to further validate if the instrument can be practically used. Thus, to conduct the criterion validity test, the data collected for the construct validity test will be further analysed.

5.2.5 Within-Subject Design vs Between-Subject Design

'Within-subject design' and 'Between-subject design' are empirical evaluations designed for use in an experiment for comparing two or more conditions under treatment (Creswell, 2009). A within-subject design describes to a study design where each individual (a subject) in an experiment experiences or tests all of the conditions under treatment, but when an individual tests only one of the conditions, it is known as a between-subject design. Both designs are intended to compare two or more different conditions (see study by Cowell & Stanney (2005), Fu et al. (2009), and Mekler, Brühlmann, Opwis, & Tuch (2013)), or two or more different subjects (see study by Li, Forlizzi, Dey, & Kiesler, (2007) and Murano & Holt (2011b)). In some cases, it is not about comparison across conditions, but rather to have multiple outcomes for each subject (see study by Dahl & Kraus (2015) and Macvean & Riedl (2011)) and to get the level of consistency of individual preferences across conditions (Blanco, Engelmann, & Normann, 2011).

The implementation of both designs is subject to the research questions. The experiment conducted in this research would like to seek the level of consistency of individual preferences and to obtain multiple outcomes from each subject. For that reason, within-subject design was chosen. With the design, each subject has a control over all conditions and thus, will reduce the effect of individual differences. However, when conducting a within-subject design, there is the possibility of having a carry-over effect (Dahl & Kraus, 2015). The carry-over effect is an effect that occurs when the first test influences how the second test is carried out. In this case, the participants advance themselves. They learned from the first test and got hints for the second test, so their tasks become easier. This situation will introduce a learning bias in the study. To avoid the bias, a crossover design method is suggested and this method is explained in section 5.3.4.

5.3 Method of data collection

According to Creswell (2009), a research method is a strategy that provides a particular direction for the processes in a research design. The following describes the research methods applied in

this study. All of the methods were used based on the research design and its suitability in addressing the questions of investigation.

5.3.1 Interview

When interviewing experts, information was gathered either individually or in a group. In groups there was more open discussion with the researcher, who guided the proceedings. Individual interviews were more focused and were a one-on-one guided discussion between the researcher and an expert (Creswell, 2009; Sekaran, 2013). The individual interview allowed the participant to directly express their own individual views, whereas in the group interview, ideas emerged based on one another's thoughts. This situation affected how each participant conveyed his/her view. For individuals and groups, the same guided and semi-structured questions were used.

In this study, semi structured interviews were conducted face-to-face or online. Semi-structured interviews give an opportunity for the expert to speak their mind with their own structures of preference based on the professional and personal experiences of the subject (Creswell, 2007; Saunders et al., 2009). This situation helps to expand the researcher's understanding and disclose different points that were missed or overlooked beforehand. Details about the interview conducted are explained in Chapter 6.1.2.

5.3.2 Survey

A survey is used to empirically gather information about samples' opinions, behaviour, trends, and the impact of the experiment under scrutiny (Creswell, 2009). According to Sekaran (2013), in surveys, data can be collected with a self-administered questionnaire, interview, and structured observations. The survey can be conducted using online survey tools (i.e. *SurveyMonkey*, Google Forms, *iSurvey*), or be paper-based. A survey question has to be designed carefully, kept simple, and avoid technical terms (Sekaran, 2013). This would help get responses pertaining specifically to the context of the study, without making it too difficult to understand. Usually, a survey was employed to get a large amount of data within a short period of time and when the availability of prospective participants varied places and time zones. In this research, a self-administered questionnaire using online tools was employed in the confirmation of the proposed framework, and in conducting the pre-test and the validity test. A paper-based questionnaire was used to obtain the expert's opinion during the content validity study.

In developing an item for a survey, Likert scales were used to obtain participants' responses concerning their opinion, belief, and attitude on the described items (DeVellis, 2017). There is no specific theory for choosing the right or the best length of scale. Many studies on human-computer interaction and games choose one depending on the suitability of the question and the

objectivity of the instrument (for exmple, Li et al. (2007), O'Brien & Toms (2010), Pedreira et al. (2015), and Wiebe et al. (2014)).

In general, a 5-point Likert scale is used in the research because it provided just enough choice, are straightforward, and are manageable for the participant (DeVellis, 2017; Johns, 2010). It will also result in an increase of response rates and response quality (Revilla, Saris, & Krosnick, 2014). Alternatively, a 7 or 9-point Likert scale provides a wider selection of responses however, these selections have a small variation of option (Johns, 2010; Revilla et al., 2014). This may lead to confusion and a misinterpretation. Whereas, a 4 or 6-point Likert scale, obliges the participants to choose either agree or disagree, or important and not important. This type of scale will eliminate the undecided or uncertain options that participants might encounter in giving their responses (Revilla et al., 2014). Thus, for that reason, survey questions in this research employs a 5-point Likert type scale ranging from 1- strongly disagree to 5- strongly agree and from 1- not important to 5- very important.

All of the details for conducting these surveys are explained in Chapter 6.1.4 for confirmation of the framework, and Chapter 8 for the content validity, pre-test, and the validity test. The development of the questionnaire survey for framework confirmation is explained in Chapter 6.1.1.2, and the instrument development is explained in Chapter 7.1.

5.3.3 Inspection method

In human and computer studies, inspection techniques are a method applied to inspect any usability problem in websites or online applications (Hollingsed & Novick, 2007). One of the well-known methods in inspection techniques is the heuristic evaluation. The heuristic evaluation involves a small group of usability experts. The experts will evaluate the application interfaces based on a guideline, stating exactly where the problems are and the severity of the problems. According to Nielsen (1992), employing an expert will provide a more thorough and quicker review at an early stage of development. Recognizing this inspection technique, it is appropriate to the nature of study to conduct the content validity test. Experts were asked to inspect the questions in the instrument according to the framework of this study. The details about conducting the inspection are presented in the content validity study in Chapter 8.1 and the confirmation of guideline in Chapter 9.

5.3.4 Crossover Design

Crossover design is a method used to mitigate the carryover problems and balance any learning effect when carrying out a given task (Dahl & Kraus, 2015; Kumar, 2011). In a crossover design, all participants or subjects will be tested under all conditions, but the order of testing is interspersed

between the conditions (Kumar, 2011). For example, there are two participants (P1 and P2) tested under condition A and B. In the first round, the P1 is tested under condition A, and the P2 is tested under condition B. In the second round, the participants and conditions are swapped, P1 is tested under condition B and P2 is tested under condition A. This research will implement the method for conducting the validation experiment using this crossover design. The details are presented in Chapter 8.3.

5.4 Research Sample

Collecting data requires an acceptable sample size and a suitable sample of population to appropriately summarize the result and conclude the claim made in a research. The research sample explains how the sample size is determined and who the participants of this study will be.

5.4.1 Determination of the sample size

The sample size has to be determined prior to conducting a study. In a qualitative design such as interviews, the sample size requirement is based on the saturation of data. According to Saunders, Lewis, & Thornhill (2009, p. 345), when no new data emerges, the data has reached saturation level. Thus, additional interviews are not necessary. However, for data saturation and variability of data, the determination of sample size is based on the type of sampling used in a study (Onwuegbuzie & Leech, 2007). For example, to sample a heterogeneity objective, Onwuegbuzie & Leech (2007) suggested having six to eight interviews per homogeneous sample and twelve to twenty interviews when looking for a maximum variation of the data. Meanwhile, according to Nielsen (1992), either a minimum of five experts, a novice, a regular specialist or a double specialist, are required to find an average proportion of the problems in heuristics evolution. Therefore, this view of sample size becomes the basis for acquiring expertise in this research.

For a quantitative design, the sample size can be determined by manipulating the statistical power of analysis. According to Cohen (1992), three variables have to be considered to get the sample size; the significance criterion (α), the effect size (ES), and statistical power (1-β).

The alpha (α) is a value that represents the maximum risk of mistakenly committing a *Type I* error (rejecting a true null hypothesis). Also, the alpha is a consideration of the level of significance for an experiment (Creswell, 2009). There are three α values that can be used; 0.01 (confidence level at 99%), 0.05(confidence level at 95%), and 0.1(confidence level at 90%). The smaller the value, the lower the risk of committing a *Type I* error. The effect size refers to the degree of null hypothesis to be false and the effect size is indexed by the differences between the

null hypothesis and the alternative hypothesis (Cohen, 1992). The effect size explains the differences in the means between the investigated groups and the control condition/group as stated in the standard deviation (Creswell, 2009). Cohen (1992) suggested, .80 to represent a large effect size, .50 for a medium effect, and .20 is for a small effect, in which the medium effect is considered as acceptable to observe effects in various fields. When effect size is .50, the means differ by one-half of the standard deviation.

The statistical power (1 – β) is the probability of not rejecting the null hypothesis when it is false (the *Type II* error). According to Cohen (1992), for general use, the specification for power is .80, where β = .20. For a study that will be looking at an acceptable effect of study for two independent means, the alpha (α) value will be defined at .05, power (1 – β) is .80, and the effect size value at .50. Using the *G*Power* application indicates that the minimum sample size is 26.

Following the central limit theorem, for a significance test, a sample must be large enough to assume that the data is approximately normally distributed (A. Field, 2014). A large sample size varies depending on the type of statistical test being used. Based on Field, a minimum sample size of 30 is assumed to be enough to produce an approximately normal distribution. Moreover, to produce a significance test with an assumption of normal distribution, and less risk of committing *Type I* and *Type II* error within an acceptable effect, a minimum sample size of 30 will serve as guidance in recruiting a participant for conducting the quantitative method of this study.

5.4.2 Recruitment of participants

The recruitment of a participant is based on the purpose of the research. They have to be matched with the participant criteria that were set in the study. In this study, the main participation criterion is to be 18 years old or above, and are selected randomly. The other criterion is based on the type of study conducted in this research. The details of this information will be explained in each of the studies conducted for this research.

5.5 Data Analysis

The method for analysing the data obtained followed the research approach chosen in this research. For the qualitative design, thematic analysis was chosen to analyse the interview data and for the quantitative design, this research used the statistical analysis including the t-test, reliability test, correlation test, the exploratory factor analysis, and mixed-design ANOVA.

5.5.1 Thematic analysis

Thematic analysis is one of the techniques used to analyse interview data. The technique helps explore the interview data based on the selected 'theme', from the research question (Silver & Lewins, 2014). It shapes the interview data with certain patterns of answers and views (Braun & Clarke, 2006). The thematic process, which is the development of themes to analyse the data can be conducted in two ways, the deductive approach or the inductive approach (Braun & Clarke, 2006; Silver & Lewins, 2014). Theme development using a deductive approach is based on the theoretical aspect and is determined prior to the analysis process. Whereas, in the inductive approach, the themes are developed based on the content of a dataset and are structured while reading and interpreting the dataset. When both approaches are applied together, it is called abductive approach (Silver & Lewins, 2014). A method to analyse the interview data followed the chosen research design, which is the exploratory descriptive design. These processes are subject to how the data is interpreted by the interviewer. The interviews were transcribed and analysed using the NVIVO application.

5.5.2 Statistical analysis

In analysing the quantitative data, the IBM SPSS tool was used to obtain the statistical analysis of the collected questionnaire. Statistical analysis helps to provide a significant relationship between the tested variables. To analyse the data, several methods of analysis were employed. These included frequencies, descriptive, t-test, correlation, reliability, and exploratory factor analysis.

The frequencies and descriptive analysis methods were used to see the distribution of respondents and variables (Hair, Anderson, Tatham, & Black, 2009). To explore the data, the t-test is used to understand the interrelationships among variables in the tested set (Hair et al., 2009). The exploratory factor analysis (EFA) was used to explore the interrelationships and summarize the patterns of correlations among the observed variables (Hair et al., 2009; Tabachnick & Fidell, 2007). The reliability test was performed to determine if the measurement items consistently reflected the construct being measured (A. Field, 2014). For this, Cronbach's alpha will be calculated to measure the internal consistency of a scale (Hair et al., 2009). The correlation is calculated to obtain the strength of the relationship between the constructs or the measurement of items in a study (A. Field, 2014; Tabachnick & Fidell, 2007). The application of these analyses will be explained in detail in the sub-chapter on data analysis in Chapter 6 and 8.

5.6 Research Ethics

It is important to obtain the approval of research ethics from a research committee before conducting any study. This is to ensure that all the research conducted is ethically appropriate and in accordance with the standards designated by the research committee. For this study, the research was granted ethical approval from the Ethics and Research Governance Committee of the University of Southampton.

- For the confirmation of the research framework, the ethics approval number is ERGO/FPSE/16577;
- For the validation of metrics, the ethics approval number is ERGO/FPSE/23003;
- For the conducting of a pre-test, the ethics approval number is ERGO/FPSE/23632; and
- For the conducting of the validation test, the ethics approval number is ERGO/FPSE/24333.
- For the conducting of a validation test of the guideline, the ethics approval number is ERGO/FPSE/27646.

Generally, all participants were informed about the study beforehand. Consent was obtained from all participants when they agreed to participate. Their participation was voluntary and if they no longer wished to participate in the study, they could withdraw at any time. The participants were also assured of the anonymity and confidentiality of the data. All of the collected data would be destroyed at the end of the study.

5.7 Chapter Summary

The methodology chapter addressed the research foundations of this research, allowing for an appropriate answer for the research claim in this research. For that, this chapter mainly explained the research design, research approach, research methods, data analysis, and research sample. The explanation includes what is available and why the particular methodology is chosen for this research. To summarise;

- The research design applied in this research is based on the research questions. For this purposed, a mixed method design is chosen.
- The approaches to the research design are;
    - The mixed method adopted was that of triangulation, and using sequential exploratory procedure in conducting a mixed method for confirming the framework,
    - A content validity, a pre-test, and a within-subject design for validating the instrument,
    - An inspection method in a focus group discussion for validating the guideline.

- To collect data in this research, several data collection methods were chosen. These include interviews, surveys, the inspection method, and a crossover design.
- The techniques used to analyse the data collected for this research were thematic analysis and statistical analysis.
- Data collection also requires an adequate number of participants and suitable criteria for participation to enable the conclusiveness of the research findings. The minimum sample size for conducting an interview was 5 and for conducting a questionnaire survey, was 30.
- In any research, ethical consideration is important to ensure that all the research conducted is ethical and complies with the set standards.

Based on the summary, Figure 5-1 illustrates the methodology applied in this research. The implementation of all the research approaches and research methods addressed in this chapter are explained in detail in other chapters and refer back to this chapter (i.e. Chapter 7, Chapter 8, and Chapter 9).

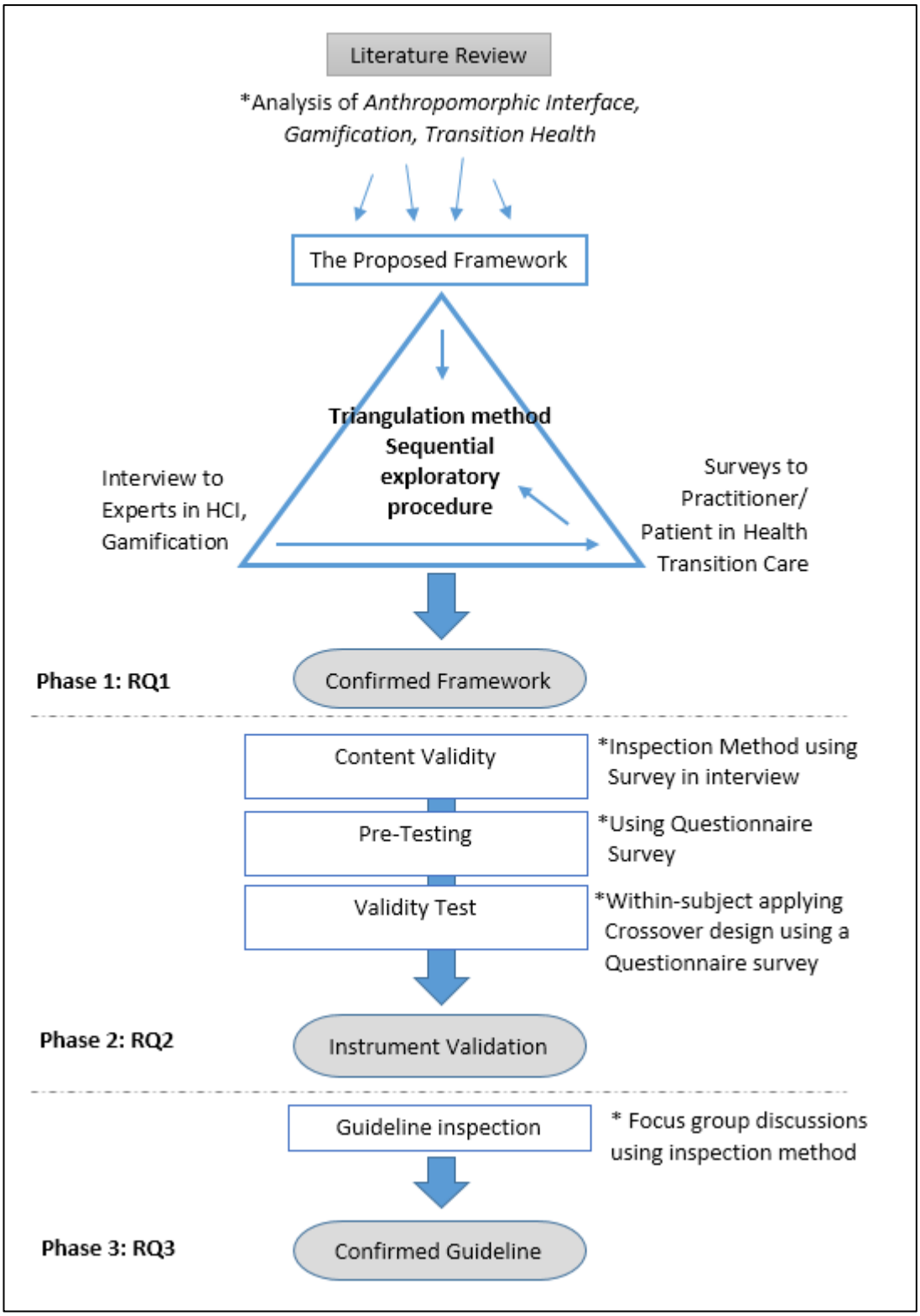


Figure 5-1 Methodology structure applied in this study

Chapter 6: Confirmation of the Transitional Anthropomorphic Gamification (TAG) Framework

The research in Chapters 2 and 3 were consolidated and synthesized, was then used to develop a framework that supported transitional gamified applications emphasizing the anthropomorphic gamification. Chapter 4 proposed a framework and described the framework's development process, detailing factors and components related to TAG in gamified applications.

This chapter will demonstrate the confirmation of the proposed framework. The development of interview and survey questions, methodology, and the procedure for data gathering were explained in section 6.1. Section 6.2, presents the findings from interview and surveys' results. Followed by an analysis of the findings and results in section 6.3, leading to the confirmation of framework in section 6.4.

6.1 Confirming the TAG framework in gamified applications

There could be other important factors that may need to be considered, and therefore may lead to customisation in the framework. A mixed method approach, employing interviews and surveys was applied to answer the following questions;

1- What key factors determine the use of anthropomorphic interfaces within gamification?
2- How important are these factors in determining the user's motivation for the transition health care application?

6.1.1 Development of Questions

Questions were constructed based on the factors and components of the proposed TAG framework. There are 6 factors and 15 components in the framework. To explore the framework, questions are developed in section 6.1.1.1 and 6.1.1.2 for each of the factors.

6.1.1.1 Interview questions

The nature of the interview questions for this study are exploratory. To design the question, information to explore each of the factors was identified. A map between the factors, the objective to achieve, and its related questions were developed. This information is presented in Table 6-1.

The interview does not gather personal information. However, individuals were asked about their research background, current research study and research interest. This was to confirm that their expertise is suitable to the context of the study. Furthermore, by asking about their research background, the researcher realized that experts had different insights related to the research problem in question.

Table 6-1 Interview questions

Factors in the Framework	***Objective***	***Questions***
General	*To scan the respondents' background*	▪ *Can you describe your professional and personal experience related to this topic?*
F1) Degree of anthropomorphic interface	*To identify type of human characters in a game/application that affected the respondent*	▪ *Can you name a character of human representation that may affect you the most?*
F2) Elements of anthropomorphic interface	*To explore the types of human characteristics in the character*	▪ *Should the avatar character be designed with the specific appearance and behaviour characteristic of a human?* o *If YES, What are the characteristics?* o *Or If No, Why Not?*
	To identify the needs of accessibility options	▪ *In health apps like diabetes or kidney transplant, users are vulnerable at a certain level of their condition. Should any accessibility issues taken into account?*
F3) Game Elements	*To explore type of reward systems and its applications in healthcare apps*	▪ *What do you think of reward systems in games?* ▪ *How do you find the use of gamification in a healthcare application?*
F4) Motivation Theory	*To find types of motivational theory applied for gamification*	▪ *What theory of motivation do you think may support the gamification?*
F6) Motivation for young adults	*To explore character's effect in healthcare application*	▪ *What do you think about the effect of incorporating a character into a healthcare application?* ▪ *In what ways do you think gamification can improve a young adult's motivation?*
F5) Transition healthcare process	*To find what is transition health*	▪ *Can you explain what transition healthcare is?*
	To collect type of games/applications available for transition	▪ *What sort of games do you think are suitable for Transitioning Care?*
	To explore the effect of characters for transition	▪ *What do you think of having a human character like an avatar, incorporated into a game for the transitional healthcare setting?*

6.1.1.2 Questionnaire Survey

The survey questions were designed based on two things,

1) the objective of the questions for each of the factors and
2) the additional questions arising from the interview session.

For that, a map between the factors, the objective of the questions, and the related additional questions arising from the interview session were developed. This information is presented in Table 6-2. Note that, in this survey, motivation theory was not surveyed because the questions about the theory were deemed unsuitable for the participant in question. However, a question about how games can affect participants' motivation was asked.

Table 6-2 Mapping surveys' questions

Factors	Objective of the Question	Additional Questions (arising from interviews)	Question No. in the survey
F1) Degree of anthropomorphic interface	To find the type of anthropomorphic interface most affective in games by users	Reason for choosing the type of anthropomorphic interface	Section 3 Q2.6 and Q2.7
F2) Elements of anthropomorphic interface	To find the agreement of anthropomorphic interface: 1- Element of social responses 2- Element of social presence	The relation of social response and social presence towards human behaviour	Section 4 Q3.1 and Q3.2
F3) Game elements in gamification	To find the choices of reward in games To find acceptance of the concept of the Leaderboard	Type of game people choose or like to play	Section 3 Q2.1 to Q2.4
F5) Transition Process	People's age range in transition process to reflect stages based on the ready, steady, go programme	1- Type of health condition 2- Problem in the transition 3- Involvement of technology in the transition process	Section 2 Q1.1 to Q1.4
F6) Motivation of young adults	To find the motivation effect for health improvement	1- Motivational effect on gamification 2- Motivational effect of the anthropomorphic interface	Section 3 Q2.5

The surveys' questions were developed in four sections. The types of questions used are multiple response questions, a 5-point type of Likert scale which requires participant to convey

their inclination according to the question, and fill in the blank questions which allow the participant to answer the question based on their condition.

Each of the sections is explained as follow;

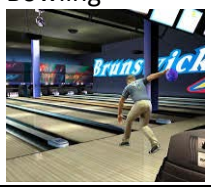
- Questions in the first section cover demographics; gender, age, and type of health condition or experiences. Age was asked to ensure that the respondents were 18 years old or older. To analyse the distribution of participants they survey asked for their gender and their type of health condition.
- The second section covers transition information such as; how long they have undergone their transition and in what age range the transition normally took place. This part refers to the transition healthcare process within the framework.
- The third section covers experiences in playing games, what type of games they are playing and their character preferences and rewards for playing games. This part refers to the game elements and the motivational effect within the framework.
- The last section covers the perspectives of self-representation in games especially characteristics and behaviours. This part refers to the degree of anthropomorphic interface and elements of anthropomorphic interface within the framework.

The surveys questions are shown in Table 6-3 where they are remapped to include the factors in the framework too, to show the rationale for each question and its relationship to the factors.

Table 6-3 Survey Questionnaire

Factor in Framework	**Questions**
Transition healthcare process (F5)	1.1 How long have you suffered with your health condition? _____ (years) 1.2 Age range when you started the process of transferring your health condition from hospital care to self-care? _____ 1.3 Any problem you have encountered during the transition period: ☐Lack of information about medication/condition/process ☐Confusion about medication/condition/process ☐Readiness for own care ☐Individual Support ☐Others: _____ 1.4 The involvement of technology such as online health applications or mobile apps, in managing your health awareness is very useful. Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree

Game elements in gamification (F3)	2.1 Do you play games? YES | NO 2.2 What kind of games you are playing?

☐Final Fantasy 	☐PGA Tour Golf 	☐Angry Bird 	☐Clash of Clans 
☐Dragon Warrior 	☐Counter-Strike 	☐Sonny the Hedgehog 	☐FarmVille 
☐Warcraft 	☐Need for Speed 	☐Brunswick Bowling 	☐Doom 
☐Chess 	☐Candy Crush 	☐Monopoly 	

*picture were taken from google image

Game elements in gamification (F3)	2.3 Element of rewards that mostly grabs your attention when playing a game?

☐Points 	☐trophy 	☐Badge 	☐Stars 

*pictures were taken from google image

Game elements in gamification (F3)

2.4 Leaderboard in games. (tick where appropriate)

Leaderboard items in game.	***Strongly Agree***	***Agree***	***Undecided***	***Disagree***	***Strongly Disagree***
You like the ability to share and show your status publicly?					
You like the ability to share and show your scores publicly?					
You like the ability to share and show your progress publicly?					

Motivation for young adult (F6)

2.5 Motivation Elements (tick where appropriate)

Motivation Elements	***Strongly Agree***	***Agree***	***Undecided***	***Disagree***	***Strongly Disagree***
Playing games should be fun					
Playing games should be compulsive					
Playing games should be rewarding					
Playing games should help me to improve my health					
Playing games should be engaging					
Playing games should be with teams					
Playing games should be an individual effort					
Playing games can be both team led and individual					
Playing games with characters rather than humans is fun					
Playing games helps me to release stress					
Playing games helps me to lose myself					

Degree of anthropomorphic interface (F1)

2.6 Choose three (3) type of characters in game that effect you the most OR kind of characters in game you like it to be in the games.

☐Zombie in 3D	☐Real 3D human	☐Animal in 2D
☐Non-figurative character in 2D	☐Animal in 3D	☐Human Cartoon in 2D
☐Non-figurative character in 3D	☐Alien in 2D	☐Mix Human & Animal in 2D

<table>
<tr><td>Degree of anthropomorphic interface (F1)</td><td>2.7 You choose the character in question 2.6 because?
(Tick three most important to you. You may include your own other category within the three if that is important to you)
☐I like it and It may represent myself virtually
☐I feel more comfortable to interact with
☐The character’s appearance perceive attractiveness
☐The character(s) is convincing
☐The character is funny
☐Others: _____</td></tr>
<tr><td>Elements of anthropomorphic interface (F2)</td><td>3.1 Give your opinion according to the following scale;
<table>
<tr><th>The character design should;</th><th>Very Important</th><th>important</th><th>Moderately Important</th><th>Slightly Important</th><th>Not Important</th></tr>
<tr><td>have an eye contact</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>portray facial expression with happiness, surprise, anger, fear and sadness</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>show body motion</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>display body position</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>mimic human dialogue</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>offer praise or pleasurable feedbacks</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>provide gender selection</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>have around the same age as yours</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>provide a variety of skin colour</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>possess a good looking appearance</td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Elements of anthropomorphic interface (F2)</td><td>3.2 Please give your opinion according to the following scale;
<table>
<tr><th>Based on your opinion in Question 3.1</th><th>Strongly Agree</th><th>Agree</th><th>Undecided</th><th>Disagree</th><th>Strongly Disagree</th></tr>
<tr><td>A character that reliably exhibits human behaviour</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>A character that exhibits Intelligent human behaviour</td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
</table>

6.1.2 Research Methodology of confirming the TAG

Considering the first research question (see Chapter 1.2), an exploratory descriptive research design was chosen because the design would help to further explore the concept of anthropomorphism, gamification and the processes of transitional healthcare. Furthermore, the design also helps to describe important factors associated within the framework.

6.1.2.1 Research Design

A mixed method research design was chosen to confirm the proposed framework. The reasons for choosing this design are explained in Chapter 5.2.1. The mixed method adopted was triangulation, as shown in Figure 6-1. The purpose for adopting a triangulation method was the nature of the exercise, which needs both objective and qualitative approaches to gauge feelings and emotions related to the topic, as well as providing rigour. The TAG framework is confirmed by the results of the triangulation of the proposed framework, the experts' reviews, and the surveys from the practitioners and patients in transitional healthcare.

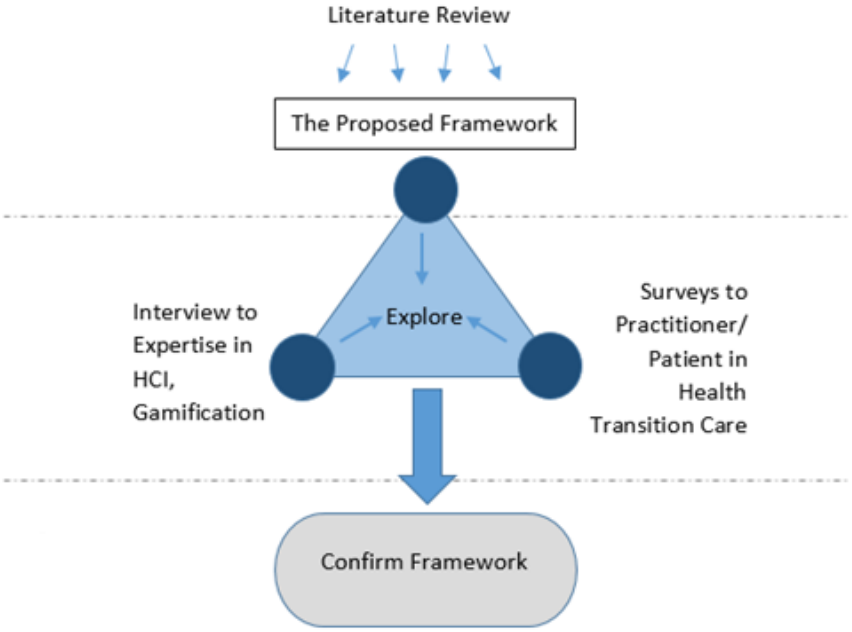


Figure 6-1 Overview of the triangulation methodology

6.1.2.2 Data gathering procedure

In employing the mixed methods design, sequential procedures (see Chapter 5.2.2, were applied to collect data from the experts' interview and from the surveys.

6.1.3 Interview

This research applied a semi structured individual interview conducted face to face and via Skype. Individual interviews were used because due to time difference and respondent availability constraints. A total of 15 experts were interviewed. They were experts in various areas of HCI – such as interaction design, user interfaces, interactive application, aesthetic, and persuasion, and also in the area of games, gamification, health, and health transition care. The experts were selected based on their interest, related publications, previous experiences, and current involvement in the research area. They are academic staff, researchers, and PhD students in the United Kingdom, the University of Malaysia Sabah, and doctors from the Southampton General Hospital. Fifteen individuals were interviewed to reach the point of data saturation. According to Saunders, Lewis, & Thornhill (2009, p. 345), when no new data emerges, the data has reached saturation level. Thus, additional interviews were not necessary. The following Table 6-4 shows the respondent's background.

Table 6-4 Respondent's Background

ID	STATUS	AREA
Category 1 (HCI & Gamification)		
1A	*Academic & Researcher*	*Multimedia (gaming, HCI, animation)*
1B	*Academic & Researcher*	*Usability engineering*
1C	*Academic & Researcher*	*Gamification & HCI (user interface)*
1D	*Academic & Researcher*	*IS for learning and games*
Category 2 (HCI, Gamification, Healthcare)		
2A	*Academic & Researcher*	*Gamification, healthcare and design interface.*
2B	*Academic & Researcher*	*Interaction design, user experience, healthcare and gaming.*
Category 3 (HCI & Healthcare)		
3A	*Academic & Researcher*	*HCI (aesthetic) & into Health*
3B	*Academic & Researcher*	*persuasion interaction, games in psychological perspective*
3C	*Academic & Researcher*	*Interaction design, healthcare*
3D	*Academic & Researcher*	*HCI, Anthropomorphism & Application, Learning*
3E	*Academic & Researcher*	*Interaction design & healthcare*
Category 4 (Games/Gamification & Healthcare / Health Transition Care)		
4A	*Hospital Consultant*	*Health transition & interested in interactive application*
4B	*PhD Student*	*Games & Healthcare*
4C	*Researcher*	*Health transition & interested interactive application*
4D	*Hospital Consultant*	*Health transition & interested in interactive application*

6.1.3.1 Piloting the Interview Questions

The questions developed in sections 6.1.1.1 were piloted with four people before they were used for the interview. Two people were from the games research group and another two were from the health science research group, at the University of Southampton.

Piloting the questions was important in order to determine a question's suitability and to look for any other questions that were overlooked in order to elicit better information related to the framework (Saunders, Lewis, & Thornhill, 2009). By piloting, the researcher could help control biases related to the questions asked in the interview. Through piloting, some questions were added and rephrased in terms of grammar and its relevance and utility to the study. From the piloting;

1. The question about accessibility issues and the theory of motivation were added,
2. The term transitioning programme is not exactly there yet. Instead, it was suggested to focus the question into the processes of transition. Thus, 'transitioning programme' was rephrased into 'the processes of transition',
3. To use the word 'avatar' as an example instead of using only the word 'character'.

Table 6-1 presents the final version of the interview questions.

6.1.3.2 Procedures for Conducting Interviews

Respondents were invited to take part by email. Once they agreed to participate, the time and location of the face-to-face interview, or the time of the Skype call was arranged. In each interview, the respondent was asked to read a research information sheet, generally explaining the purpose, scope and the research contribution. The respondent was also made aware that no personal information would be used in the analysis or the publication. Each respondent was identified by a code name. The respondent was assured that their data confidentiality would be preserved and would be treated carefully. Once the respondent clearly understood the research, they were requested to sign a consent form. The researcher then started the interview. The interview questions were semi-structured questions. During the interview, the respondents were not informed or shown the developed TAG framework.

The interviews lasted between thirty minutes to an hour and the interviews were recorded with consent, unless some respondents felt uncomfortable (4 interviewees). At the end, each respondent was thanked for their time and involvement. These procedures were in-line with the research ethics approved for this study (see the research ethics sections in Chapter 5.6).

6.1.3.3 Method used to analyse the interview's data

A thematic analysis as explained in Chapter 5.5.1 was adopted to analyse the data obtained from the expert interviews. For the purpose of analysis, the theme was developed using the abductive approach. In this approach, the themes were predetermined based on the proposed framework before the analysis was done. Then, while reading and analysing the data, the themes that emerged, were combined or dissected. A total of 15 interviews were transcribed and analysed using an NVIVO application. Following Braun & Clarke (2006) and Saunders et al. (2009), the steps to analyse the interview were as follow;

Step1) Prepare the data for analysis – Transcribe the interview. Format the text into different headers for ease of referencing.

Step2) Predetermine themes – Develop the initial themes according to the framework.

Step3) Reading and annotation –

- Read and re-read the text.
- Identify specific segments in text
- Open coding and annotate any significant text.

Step4) Sort the text into themes –

- Query coding and connect / combine the text related pattern into themes
- Identify texts without themes and create new themes for them
- Delete pre-determined themes that are not related

Step5) Finalizing the themes – a final check to develop the themes and finalize the findings.

6.1.4 Survey

For the survey, an online self-administered questionnaire was used to empirically gather the information. Results from the survey were used to support the arguments of the framework and then, further confirmed the proposed framework. All the participants were above 18 years old and were either;

1) Living with certain health condition and has been going through the transition process,
2) Practitioners (the doctors) involved with the transition processes,
3) The parents of patient that living with certain health condition.

Based on the sample size determination for quantitative research in Chapter 5.4.1, a minimum sample size of 30 was followed. Therefore, the survey was applied to a sample size of 33 participants.

6.1.4.1 Piloting the Survey

The questionnaire went through a piloting process. The process was conducted with two people in the games research and two people in the health science group working together in the game project. The piloting process was examined from different perspectives to validate the question's suitability for games and healthcare practice. Following the pilot process, the comments were as follows;

- The participants were expected to be very sensitive about their condition and may have less self-confidence, so words and pictures were chosen carefully.
- Questions were rephrased to avoid technical terms (refer to question 2.4 and 3.1) and if the questions could be confusing (refer to question 3.2).
- Asking what type of method for measuring transitions outcomes was thought not to be necessary as it may lead to assessing the method rather than knowing what methods are available. (question was removed)
- Questions about type of games (refer to question 2.2) and reward element (refer to question 2.3) were added with pictures and one question about the Leaderboard was divided into three different questions.
- Existing motivational questions were replaced and added with some new elements (refer to question 2.5).
- Instead of using open text to ask about type of preferred character in the game, a list of options was provided (refer to question 2.6).
- The arrangement of Likert scale was put into table forms.

The final version of the survey questions is presented in Table 6-3.

6.1.4.2 Procedure for Survey

Potential participants were identified via:

i. A network of friends,
ii. Through the diabetes research forum, based in the United Kingdom (http://www.diabetes.co.uk),
iii. Through the kidney patient forum, based in the United Kingdom (http://www.kidneypatientguide.org.uk/forum/viewforum.php?f=2).

For a participants identified through friends, he/she was approached personally, either face-to-face, via personal messaging on Facebook, or via email. They were briefed about the research background and were given a sheet of related information for their reference. Once the participants understood and agreed to join, they were given a link to the online questionnaire

(http://goo.gl/forms/pEsxZiyg18). To reach members of diabetes forums, a research request was sent to the forum administrator for approval. Once approved, the request was posted in the forum and available for people active in the forum to participate in the survey.

Appendix G shows screenshots from the forum. For this, the same online questionnaire link was used. The questionnaire provides a drop down option for consent. Every participant was required to give his or her consent prior to answering the questionnaire. They were expected to complete the questionnaire within fifteen minutes at most. Participants were thanked for their involvement at the end of the questionnaire.

6.1.4.3 Method of Analysis

By using the IBM SPSS tool, data collected from the survey were analysed as per their frequencies, descriptive, and t-test. The reasons for employing these methods of analysis were explained in Chapter 5.5.2. However, for this research, frequencies and a descriptive analysis were used to find the distribution of the collected data and t-test were used to find the significant difference of participants' agreement on the motivational effect of the anthropomorphic interface and on the characteristics of the anthropomorphic interfaces.

6.2 Findings and Results of the confirmation study

Section 6.2.1 presents the findings from expert interviews and section 6.2.2 presents the results from the survey. The discussions of the findings are then presented in the section 6.3.

6.2.1 Interview Findings

Findings from the expert interview were structured into two parts, which were the experts' demographics and analyses of the interviews.

6.2.1.1 Respondents Demographic

The 15 respondents involved in the interview are experts from areas of expertise related to this study. Table 6-4 summarizes their background and Table 6-5 shows the interview settings. The respondents were divided into four categories;

1. Four experts represent the HCI and gamification perspective,
2. Five experts represent the HCI and healthcare perspective,
3. Four experts represent the games and health transition perspective,
4. Two other experts reflect the HCI, gamification and healthcare perspective.

Table 6-5 Interview setting

ID	DATE	FORMAT	LENGTH	METHOD
1A	*29/07/15*	*Structured*	*30 minutes*	*Concurrent Notes*
1B	*01/09/15*	*Structured*	*35 minutes*	*Concurrent Notes + Audio Recording*
1C	*27/07/15*	*Semi Structured*	*30 minutes*	*Concurrent Notes + Audio Recording*
1D	*04/08/15*	*Semi Structured*	*40 Minutes*	*Audio Recording*
2A	*3/08/15*	*Semi Structured*	*40 Minutes*	*Concurrent Notes + Audio Recording*
2B	*20/08/15*	*Semi Structured*	*40 Minutes*	*Concurrent Notes + Audio Recording*
3A	*29/07/15*	*Structured*	*30 Minutes*	*Concurrent Notes + Audio Recording*
3B	*14/08/15*	*Semi Structured*	*40 Minutes*	*Concurrent Notes + Audio Recording*
3C	*14/08/15*	*Structured*	*20 minutes*	*Concurrent Notes + Audio Recording*
3D	*10/08/15*	*Semi Structured*	*40 Minutes*	*Concurrent Notes + Audio Recording*
3E	*17/08/15*	*Semi Structured*	*35 Minutes*	*Concurrent Notes + Audio Recording*
4A	*18/09/15*	*Semi Structured*	*30 Minutes*	*Concurrent Notes*
4B	*1/10/15*	*Semi Structured*	*20 Minutes*	*Concurrent Notes + Audio Recording*
4C	*1/09/15*	*Semi Structured*	*30 Minutes*	*Concurrent Notes*
4D	*1/09/15*	*Semi Structured*	*30 Minutes*	*Concurrent Notes*

6.2.1.2 Analysis of Interview

The analysis of interview following the thematic approach detailed in section 6.1.3.3. A number of similar words were queried to see the pattern of conversation and the frequency of a word used by the expert (refer Appendix H to see the 30 most frequent words). From these patterns, we can identify a number of themes that help to explore the proposed framework. All the themes were mapped and further developed based on the interview questions listed in Table 6-1. The themes are summarized in Table 6-6 below;

Table 6-6 List of Themes

No	***Themes***	***Description***
1	*Anthropomorphic Characteristics*	*List of characteristics of anthropomorphism*
2	*The degree of anthropomorphism*	*Consideration of the type of anthropomorphism*
3	*Accessibility issues*	*Consideration of Accessibilities*
4	*Gamification*	*Gamification implementation in health application, list of game elements, and the issue of pointsification*
5	*Transition Healthcare*	*Transition description, age related and suggestion of design for an anthropomorphism*

6	*The needs for gamification in healthcare & transition care*	*Why gamification should be implemented in healthcare or transition care*
7	*Anthropomorphism and Gamification for motivation*	*Perception of anthropomorphism and gamification in motivating a user/player*
8	*Theory of Motivation*	*Theory used in accordance with motivation*

These eight themes emerged from the findings and are discussed below;

Theme 1: Anthropomorphic Characteristics

Respondents felt that the anthropomorphic characteristic should have a human-like personality and appearance. They should be able to express their emotions, communicate, and move naturally. The appearance of the anthropomorphic character also should be as desirable to the user as possible. Thus, a customised function related to gender, shapes, hairstyle and skin colour would be helpful.

"..Like talking to a real person, not just a plain face… listen to a real human voice, seeing a face with impression or expression… importantly, mirroring their appearance... the avatar is best if it can be customised to meet user satisfaction… but, it is not conclusive for every user…" (3E)

"The character should be able to communicate with the user and move in a more natural way..." (1B)

"…human qualities include the way it's(avatar) talking …the expression, emotion like sad, happy, angry… appearance like skin colour, hair, faces … All of the qualities are normally customisable… User get to choose which one they preferred …They have the power or control over which they like more…" (2B)

"… Can choose male or female..." (1A)

"…have to come with human characteristic as well, the way it communicates, voice, hand gesture, facial expression, and appearance like skin colour, hair, boys or girls... "(2A)

"…You may also consider characters like skin colour, gesture, position and many others… I also have thought about physical appearance, like men or women, with a specific culture. It seems biased and I might say, not a practical design unless your intention is into this user… or maybe having a customised character… From our previous study, facial expression and real human voice have increased the interaction effect …" (3D)

"…pleasurable or a supportive messages – you have done a good job! Congratulation! Level up! Superb...the kind of encouragement that helps users to be motivated…" (2B)

"…real human voice increases the effect in interaction…" (3C)

"…the illustration of the body… fat or skinny…the body shape, more or less mirroring the user…" (1C/2A)

"…It is good to have a character that can influence kids…with some emotion and facial expression is better… You will feel like you are talking with somebody…" (1D)

Respondents also felt that emotions and facial expressions have to come together. Facial expression without emotion is meaningless and emotion can be projected effectively through human faces.

> *"…Face expression and emotion have to come together. If your face is smiling without emotion in it, smiling is just smiling. To put emotion in, is hard work…both have to come together…" (2A)*

> *"Emotion must be conveyed by facial expression." (1A)*

Theme 2: The Degree of Anthropomorphism

It is quite difficult to pronounce the word anthropomorphism and for those who are not really familiar with anthropomorphism, they would prefer to call all types of human representations as 'avatars'.

> *"…We call it user personalisation…It is not as real as human but it has a human characteristic, just like avatar…" (2A)*

> *"…Human representation, like avatar…" (2B)*

> *"…I may say the avatar is more or less like a real human..." (3E)*

Respondents were asked to name the types of characters that affect them the most or types of character they would prefer to be or to represent themselves. 10 respondents mentioned characters that represent more human-like features such as the Sims, Tomb Raider, Super Mario, Doctor, Japanese Professor, King Wrynn and Harry Porter. The respondents also categorized these characters into a more human or avatar type of category. Meanwhile, six (6) respondents named characters that represented a mixed design between human and animal such as alien, the Thrall and Malfurion Stormrage in the World of Warcraft game, and the air penguin. In addition, six (6) respondents pointed out the type of character design that is more like an animal or an object such as a talking dog, a running conman, a pineapple, Om Nom in cut the rope game, candy crush, plant of zombie, and the paper clip.

> *"…Character can be in the form of an avatar, humanized, or may be a variation of character, evolved from the concept of human…" (2B)*

> *"...I wish if we could have a different type of avatar, not only human. Perhaps more a cartoon type, animation thing…" (2A)*

> *"…non-human…Other than human representation… something about mixed design... does not have to be a real one..." (3D)*

> *"..Alien thingy…Interesting design could make scary as attractive…" (1A)*

Respondents also argued that the type of character was normally designed and applied with a specific purpose.

Theme 3: System Accessibility Issue

Respondents 4C & 4D felt that people who live with a long-term health condition are vulnerable and at some point will be very sensitive. However, respondent 2B pointed out that they may be vulnerable, but not disabled. Developing an application, by having this group of users in mind, should take the accessibility option into account.

> *"Yes, accessibility of an application is important. Following accessibility guidelines is the best idea… they may have a serious condition that requires more help, like with diabetes, they may have a very poor eye sight, but bear in mind, it cannot be generalized… Look at your intended user carefully and work your application based on that…fulfilling accessibility guidelines, like colours, text, audio help, and standard requirement, should be covered." (2A)*

> *"They may be vulnerable, but not disabled, I suppose…standard accessibility guideline must be fulfilled to ensure every user is treated equally, especially if you do a web based application…" (2B)*

Theme 4: Gamification

Gamification is perceived as part of the game revolution and as an interesting technique to be incorporated into the learning process in the healthcare settings. As healthcare is the focus of this study, examples of goals in games were referred to such as measuring the insulin level (1D), weight level (3E), immunisation (1A), dietary intake (2A), health routine (3B), and calorie usage (2B). Avatars, a Leaderboard, levels, points, progress, ranking, and status are among gamification elements that the respondents felt should be incorporated into most applications.

> *"…I realised when my children connect themselves into a game, they are very excited by their avatar. Especially when they can upgrade their avatar and keep comparing their avatar power to each other. Interesting observation…" (3B)*

> *"We implement points to encourage the user… an encouragement message from the system and function that a friend can send received heart (player's life or health), make them return to the apps..." (2A)*

> *"…scores…stars…gold…" (3C/1A/3B/1B)*

> *"…showing the level...rank..." (2B/1A/1B)*

> *"…User can check their health bar and can see the other user performance in one chart…" (1C)*

> *"…share good news with friends…" (2A)*

Having a reward system such as points in a game is also perceived as an effective technique to engage users with the application.

> *"It's good and encouraging. People will tend to be more competitive and persevere, also it will be more exciting." (1A)*

> *"…it gives motivation to the user to continue doing the task until it is finished as well as it gives the sense of being appreciated…"(3A)*

"..It's one way, not the only way, you encourage the player to move forward..." (2A)

"…the rewards system can be used, but in par with other gamification elements as well…" (4B)

Remarkably, respondents reviewed a gamifying application through a perspective of a serious game concept in which designing challenges are part of it. Thus, balancing the purpose and excitement of the application makes it more valuable.

"Challenges, to what extent the games have to be played. How hard and easy it can be and a clear mission to be achieved…too easy or too hard make the user feel bored…" (2B)

"…but the most important thing is how you design the challenges of the games. It's not too hard or not too boring…" (3B)

Theme 5: Transition Healthcare

Respondent 4A, 4C and 4D respectively explained the transition care concepts as noted below;

"A period of time, to hand over a patient from hospital care to self-care and it's involved with medication information, the do and don't for safer and healthier life."

"..To give them time to learn... Be independent and responsible...they need to equip themselves with knowledge and information…"

"…time, around 5 to 10 years, to transfer the patient from hospital care to patient self-care… to guide them with sufficient information...about their condition…"

The respondents further explained that the age for the transition to take place varies, depending on the age when the patient was first diagnosed. However, in Southampton General Hospital, current patients in the transition process were between 10 to 15 years old. When asked about the suitable games for transition care, respondents felt that the types of games and characters that should be implemented are;

"…trendy, funky. Not too childish. And look strong… Good for their influence…" (4A)

"…that kids can relate more…heroes' type… "(4B)

"…Cartoon type, 2D or 3D like angry bird, cars, 'Go Diego Do'..." (4C)

"…2D, colourful and trendy… Cartoon-ish not too realistic…" (4D)

Theme 6: The needs for gamification in healthcare & transition care

Respondent 4D mentioned that it is important to include a motivational factor in a healthcare application. Support from a technology could help the patient face their condition. Most respondents agree that gamifying transition healthcare would result in positive benefits for the patient. When it comes to considering gamification in healthcare, the following statements were made;

"The emergence of a game application in healthcare is a positive approach…people consider games as one of the educational tools that help them in the learning process and improve their problem solving skills." (1B)

"The health context needs a lot more innovation…the idea of using games for health is interesting…they are vulnerable user, emotionally…they need a bit more excitement..."(2B)

"…it adds fun elements, people like to do fun things and not plain boring things." (3A)

"Of course, why not. It is (healthcare) not a new field, but perhaps a suitable application, especially for people with conditions."(3D)

In addition, as noted, these are their responses for the transition care:

"…it is very interesting… perhaps long overdue although we have achieved lots of medical breakthrough by gamification, we could have achieved so much more..." (4B)

"A fantastic idea. I expected this game will support them in going through their condition… know when to take their pills, when to rest, when to go for their appointment…" (4D)

"Good for them... Keep their motivation looking forward… helping with the do and don't…a good practice of reminder" (4A)

Theme 7: Anthropomorphism and Gamification for Motivation

Respondents believed that anthropomorphism and gamification would encourage users' motivation. In particular, respondent 1A felt that an anthropomorphic character could improve communication and users will develop a connection with it and see it is a real friend. Respondent 1B added that anthropomorphism may enhance users' learning ability. In addition, respondent 3A said that using an avatar creates a sense of identity in the applications. While, with regards to the gamification, respondents felt that it could help to improve users' skill, especially the young users.

"…make people improve their skills not only gaining knowledge but working hard and competing for rewards and for satisfaction." (1A)

"…it (games) will make them feel good about themselves and at the same time provides a sense of improving themselves. This kind of feeling will encourage them to engage themselves more often and improve themselves progressively." (1B)

"…gamification will give the feel of fun and leisure that can be a motivating factor for improving health among young adults." (3C)

"Gamification makes the tedious work fun, in a way, it explains why young adult moans when we asked them to take out the trash, but can wake up at 3am to 'kill 10 monsters' …" (4B)

Remarkably, respondent 1D pointed out that gamification should be incorporated together with an anthropomorphism (he refers to an avatar).

"…gamification on its own may less attract somebody to use…Something if you combine with a very similar applied interface (refers to avatar)…If you like that kind of avatar that has a kind of character or show a kind of personality, it will attract people to use that kind of application..." (1D)

Some respondents also wanted to clarify that the application is not supposed to motivate users. The purpose of utilising the application is to improve users' motivation or maintain their engagement.

"…measuring motivation is quite subjective. But if you are saying to improve, yes. A character might help in improving or providing a better interaction." (3D)

"…more into improving or maintaining their interaction or involvement…" (3B)

"…waiting time at the hospital is boring, maintaining their commitment is a hard work…playful application or a game may be can help…" (4D)

Theme 8: Theory of Motivation

Some respondents also supported their motivational perspectives with theories. Respondent 1B reflected the motivational perspectives with self-actualization in Maslow's theory. Respondent 3B said that it is important to focus on how intrinsic and extrinsic motivation are connected and the same respondent also mentioned about Maslow's theory in fulfilling users' satisfaction. On the other hand, respondent 2A, 3B and 4B specifically pointed out the self-determination theory (SDT) in emphasizing intrinsic and extrinsic motivation. However, the expert believed that the theory should be applied based on what type of information a study is seeking to asses. Other respondents did not mention any specific theory, as they may not have any relevant experience in the subject matter.

6.2.2 Survey Results

There were 33 participants involved in the survey. Table 6-7 summarized the participant's background based on age, gender and health condition.

Table 6-7 Participant Background - Age * Health Condition * Gender Cross tabulation

			Health Condition				
Gender			Asthma	Diabetes	Renal	Others	Total
Female	Age	> 30	1	7	2	1	11
		25 - 30	1	4	2	0	7
		18 - 24	1	0	1	0	2
Male	Age	> 30	0	2	2	0	4
		25 - 30	0	3	4	0	7
		18 - 24	0	2	0	0	2
	Total All		3	18	11	1	33

The purpose of the survey was to understand the following queries;

i. The types of anthropomorphism preferred most by the participants based on the games they are playing and their selection of characters,
ii. The importance of game elements such as rewards and the Leaderboard,
iii. The age range and problems when the participants were in the transition period.
iv. The motivational effects in playing games,
v. The characteristics of anthropomorphism and its relation to the reliability and intelligence of human behaviour,

Considering the first, second and third queries, participants' responses were listed to see which options were selected. Descriptive and frequency analyses were used to understand the responses (in section 6.2.2.1). For the fourth and fifth queries, questions were analysed using the t-test (in section 6.2.2.2).

6.2.2.1 Descriptive and Frequency Analyses

There are several types of anthropomorphic interface in a game. The type was summarized based on the most popular games in the market rated by *pcgamer*[2]. The preferred type of anthropomorphic interfaces selected by the participant were summarized in Table 6-8. The 2D non-figurative character (N=17) and 2D mixed of human and animal character (N=17) were the most selected types. Participants chose those types of anthropomorphic interface mostly because they were comfortable in interacting with them (N=29, 28.7%) (Refer to Table 6-9).

Table 6-8 Type of character Frequencies

		Responses	
		N	Percent
Type of Character	Zombie3D	8	7.5%
	Animal 2D	12	11.2%
	Non-Figurative Character 2D	17	15.9%
	Real 3D	10	9.3%
	Animal 3D	9	8.4%
	Alien 2D	8	7.5%
	Mixed Human Animal 2D	17	15.9%
	Human Cartoon 2D	14	13.1%
	Non-Figurative Character 3D	12	11.2%
Total		107	100.0%

Table 6-9 Choose Character Frequencies

		Responses	
		N	Percent
Why choose the character	Like to represent	16	15.8%
	comfortable to interact with	29	28.7%
	perceive attractiveness	21	20.8%
	character convincing	15	14.9%
	character is funny	20	19.8%
Total		101	100.0%

The selections of type of anthropomorphic interface are matched with the type of game the participants have played or like to play. The games are angry bird (2D mixed of human and animal character) and candy crush (2D non-figurative character). Table 6-10 shows the results.

[2] http://www.pcgamer.com/best-pc-games/

Table 6-10 Type of Games that mostly played by the participant

		Responses	
		N	Percent
Type of Game	Final Fantasy (Real 3D)	0	0%
	PGA Tour Golf (Real 3D)	5	5.4%
	Angry Bird (Animal 2D)	11	11.9%
	Clash of Clans (Human Cartoon 2D)	8	8.7%
	Chess (Non-Figurative Character 3D)	8	8.7%
	Dragon Warrior (Zombie3D/Real 3D)	2	2.2%
	Counter Strike (Real 3D)	5	5.4%
	Sonny the Hedgehog (Mixed Human Animal 2D)	1	1.1%
	Farmville (Human Cartoon 2D)	6	6.5%
	Candy Crush (Non-Figurative Character 2D)	14	15.3%
	Warcraft (Zombie3D/Real 3D)	3	3.3%
	Need for Speed (Real 3D)	10	10.9%
	Brunswick Bowling (Real 3D)	4	4.3%
	Doom (Zombie3D/Real 3D)	4	4.3%
	Monopoly (none)	3	3.3%
	Others	8	8.7%
Total		92	100.0%

Table 6-11 indicates that, over three-quarters of the participants (78.8%) select the element of points (the most rewards) that grab their attention when playing games. Based on a Likert-scale of 1 = strongly disagree to 5 = strongly agree, the average of Leaderboard items in sharing and showing status publicly (M = 3.9, SD = .95), sharing and showing score publicly (M = 3.9, SD = .92), and sharing and showing progress publicly (M = 4.0, SD = .88) were relatively perceived as acceptable. The result for Leaderboard is shown in Table 6-12.

Table 6-11 Selection of Rewards

		Responses	
		N	Percent
Rewards that mostly grabs participant's attention	Points	26	42.6%
	Trophy	8	13.1%
	Badges	11	18.0%
	Stars	9	14.8%
	Others (status/ranking)	3	4.9%
	Not prefer anything	4	6.6%
Total		61	100.0%

Table 6-12 Leader Board Descriptive Statistics

	Mean		Std. Deviation	Variance
Leader Board Item	Statistic	Std. Error	Statistic	Statistic
Status	3.9	.17	.95	.91
Score/Ranking	3.9	.16	.92	.84
Progress	4.0	.15	.88	.78

Table 6-13 shows the age ranges of participants in transitional care. Ages between 15 and 25 were the most common (39.4%). There were nine participants who indicated that they were not sure about the age range or indicated that they have never been hospitalized. So, their age range varied was designated according to the time when they were first diagnosed.

Table 6-13 Participant's Age range when they thought be in a transition care

	Responses	
Age Range	N	Percent
15 – 25	13	39.4%
20 – 30	11	33.3%
Do Not Know the Age Range	9	27.3%
Total	33	100%

Participants also indicated that confusion (31.9%) and lack of information (29.8%) in the medication/treatment/process contributed to the problem in the transfer process (refer Table 6-14). This may be due to the fact that they did not really experience a proper transition.

Table 6-14 Problem in transition period

		Responses	
		N	Percent
Problem face by Patient	Lack of Information	14	29.8%
	Confusion	15	31.9%
	Readiness	10	21.3%
	Individual Support	3	6.4%
	Others	5	10.6%
Total		47	100.0%

6.2.2.2 Analyses of Motivational Effects and Anthropomorphic Elements

There are two factors being tested, playing games has a motivational effect and the element of anthropomorphism. Each factor constructed several variables. Table 6-15 demonstrates all the items in each factor.

Table 6-15 Factor details with mean and standard deviation

Factor	Item	Mean	Std. Dev.
Motivation effect	Playing games should be fun	4.7	.45
	Playing games should be compulsive	4.6	.83
	Playing games should be rewarding	4.7	.47
	Playing games should help me to improve my health	4.1	.65
	Playing games should be engaging	4.8	.44
	Playing games should be with teams	3.7	.82
	Playing games should be an individual effort	4.4	.66
	Playing games can be both team led and individual	4.2	.53
	Playing games with character rather than human is fun	4.3	.47
	Playing games helps me release stress	4.7	.45
	Playing games helps me to lose myself	4.6	.50
Anthropomorphic Element	provide gender selection	4.3	.59
	be around the same age as yours	2.6	1.15
	provide a variety of skin colour	4.3	.59
	provide body shape customisation	4.1	.78
	portray a facial expression	4.9	.33
	make an eye contact	4.1	.69
	show body motion	4.1	.71
	display body position	3.5	.91
	mimic human dialogue	4.6	.56
	offer praise or pleasurable feedbacks	4.7	.45

1. Descriptive Analysis

The mean and standard deviation for all items for the motivational effect and anthropomorphic elements are listed in Table 6-15. All items were measured using the Likert-scale from 5-strongly agree to 1-strongly disagree. For motivational effects, the results show that the mean scores were ranged from 3.7 to 4.8, indicating that participants were motivated while playing games except for when playing in a team. For anthropomorphic elements, the results show that the mean scores ranged from 2.6 to 4.9, indicating that all anthropomorphic elements, except for body position and age, are important in designing an anthropomorphic character.

2. Reliability of Each Factors

The reliability test was performed to see the internal consistency of every test items in a survey questionnaire (Hair et al., 2009). Table 6-16 shows that the Cronbach's alpha measurement of internal consistency for factor motivation effect was .73, and for anthropomorphic elements was .75. According to Sekaran (2013), a Cronbach's alpha between 0.6 and 0.8 shows that the measuring item is considered to have an acceptable internal consistency.

Table 6-16 Cronbach's Alpha Reliability Test

Item	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Motivation Effect	.73	.76	11
Anthropomorphic Elements	.75	.77	10

3. Comparing One Sample Mean t-test

A Kolmogorov-Smirnov test and a Shapiro-Wilk test were used to test for normality on the items of *motivation effect* and *anthropomorphic element*. The result are shown in Table 6-17. A non-significant result in which the sig. value is more than .05 is perceived as normal and a significant result in which the sig. value is less than .05 is perceived as not normal (A. Field, 2014; Tabachnick & Fidell, 2007). For the motivation effect, D (33) = .111, p > .05, and for the anthropomorphic element, D (33) = .103, p > .05, were both normal, indicating that the data was normally distributed.

Table 6-17 Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Motivation Effect	.111	33	.200	.971	33	.507
Anthropomorphic Element	.103	33	.200	.965	33	.347

A sample mean t-test was conducted to determine if there was a statistically significant difference between the mean score of both factors (the motivation effect and anthropomorphic interface) from the agreement value (5 and 4) to disagreement value (2 and 1) and the neutral value, which was 3. The t-test result is shown in Table 6-18.

Table 6-18 One-Sample Test

	Test Value = 3						
						95% Confidence Interval of the Difference	
Factor	Mean	SD	t	df	Mean Difference	Lower	Upper
Motivation Effect	4.4	.31	26.92	32	1.43	1.32	1.54
Anthropomorphic Element	4.1	.39	16.41	32	1.13	.98	1.27

The motivation effect was statistically different, at .05 of significance, from the test value of 3 (M = 4.4, SD = .31, DF = 32, t = 26.92, p < .05). The result shows that the participants' agreement on motivation effects has a higher mean than the test value. Thus, showing that the motivation factor is important.

The anthropomorphic element was statistically different, at .05 of significance, from the neutral value of 3 (M = 4.1, SD = .39, DF = 32, t = 16.41, p < .05). The result shows that the participants' agreement on anthropomorphic elements has a higher mean than neutral. Thus, assuming that the factor of the anthropomorphic elements is important.

6.2.2.3 Correlation

1. Correlation between Anthropomorphic Elements and Human Behaviour

Pearson Correlation Coefficients analysis was conducted to examine the strength and the relationship between anthropomorphic elements and human behaviour (HB). The results in Table 6-19 indicate that the element of anthropomorphic and intelligence aspect of human behaviour were significantly correlated, $r = .43$, $p < .05$. The results also indicate that the anthropomorphic element and reliable aspect of human behaviour were significantly correlated, $r = .40$, $p < .05$.

Table 6-19 Correlations

Items	Anthropomorphic elements	HB Intelligent	HB Reliable
Anthropomorphic elements	1.00	.43	.40
HB Intelligent		1.00	.48
HB Reliable			1.00

According to Cohen (1988, pp. 79-81), a correlation value between 0.10 and 0.29 is perceived as weak, while a correlation value between 0.30 to 0.49 as moderate, and a correlation value between 0.50 to 1.0 as strong. Thus, the relationships between anthropomorphic elements and human behaviour were found to be moderately correlated.

2. Correlation between Motivation Effect and the Involvement of technology in healthcare

A Kolmogorov-Smirnov test and a Shapiro-Wilk test were used to test for normality on the item '*involvement of technology in healthcare'.* The result in Table 6-20 shows that D (33) = 0.44, p < .001, indicating that the data was not normal. Thus, a nonparametric correlation test using Spearman's rho test was conducted to examine the correlation between '*motivation effect'* and '*involvement of technology in healthcare'*. Table 6-21 shows the result of the Spearman's rho test. Based on the results, the involvement of technology in the healthcare setting has a strong relationship with motivation effects, $r = .51$ and $p < 0.01$.

Table 6-20 Tests of Normality for Technology Involvement

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Technology Involvement	.44	33	<.001	.58	33	<.001

Table 6-21 Correlations between Motivation Effect and Technology Involvement

			Motivation Effect	Technology Involvement
Spearman's rho	Motivation Effect	Correlation Coefficient	1.00	.51
	Technology Involvement	Correlation Coefficient		1.00

6.3 Discussion of the confirmation study

The study aimed to confirm that the factors in the suggested TAG framework are the key factors for the use of anthropomorphic interfaces in gamified applications for transitional healthcare. Factors and components in the TAG framework were explored by asking the questions in Table 6-1. However, in the interview, experts were not directly asked about what was missing from the framework, as the aim of the interviews was to explore the important factors. The interviewees did raise a number of issues that were then confirmed through the response on the questionnaire given to people with health conditions. Table 6-2 presents the additional questions that were included in the survey arising from the interviews. Thus, discussion for each of the factor (F1 to F6), triangulated of literature, interviews, and surveys, were presented as follows;

F1: Degree of anthropomorphic interface

Different degree of anthropomorphic interface designs were expected to have an impact on the games, as presented in Chapter 3.1.2. Degree of anthropomorphic interface suggested in Chapter 4.4 in Figure 4-3, could be defined as 1) avatar, a mere human imitation, 2) human cartoon, 3) interface agents that could be mixed between human and animal or human and object, 4) hybrid character that can be represented by animal or an object, and 5) an abstract design that could be mixed with anything but designed with human characteristics. These anthropomorphic interfaces also verified by experts in the interview. When translated in the questionnaire, the 2D non-figurative character (abstract design), the 2D of a mix between human and animal (interface agents), and a 2D human (avatar) design were the most preferred when playing a game. These selections were in line with the most played types of game, denoted by the surveys' participants. It showed that the experts' opinion and surveys' participants were parallel with the design characterization in the literature (Chapter 2.1).

Previous studies by Kuramoto et al. (2013) and Otake et al. (2014) demonstrated that the incorporation of an avatar in a gamified application was used as a player's representation that offers a personalisation tool. Implementing an avatar as player's personalisation was similar to the experts' opinion, reported in section 6.2.1.2. The questionnaire's results showed that the patients' choice of a character depended on how comfortable they felt when interacting with it. Often if the character was funny, it was perceived as attractive. The patients saw the character as an independent interface, separate from the games. However, self-representation was not very popular. The results of the choices of the character indirectly informed that in any application of the anthropomorphic interfaces, the selection or perception of anthropomorphic interfaces would be more stimulating if they were designed with the characteristics of anthropomorphic

interfaces, which will be discussed in F2. This was in line with the experts' comments on the importance of anthropomorphic characteristics (Theme 1, section 6.2.1.2) and the review of the previous work in Chapter 2.3.

F2: Anthropomorphic Element

The TAG framework in Chapter 4.4 suggested general elements for anthropomorphic design. The set could be divided into social response and social presence. The social presence consisted of gender, age, ethnicity, and facial attractiveness. The social response consisted of facial expressions, emotions, eye contacts, gestures, postures, flattering effects, voice instructions, and intelligence. The analysis showed that the experts' opinions and patients' survey matched the suggested framework, except for these elements:

a) Emotions exhibited through facial expressions,
b) The use of the words 'skin colour' rather than ethnicity,
c) The offer of body shapes options,
d) Body angles and perspectives,
e) The age of the anthropomorphic interface does not seem to be critical.

It was argued by Cowell & Stanney (2005) and Yoo, Peña, & Drumwright (2015) that the element of age is subjective and it depended on certain purposes. Incorporating them to the general set of anthropomorphic design could strengthen the design effect and will provide wider options to design an effective anthropomorphic interface. Considering all the suggested elements in the TAG framework, the design of the anthropomorphic interface showed an association with a trustworthy and intelligent aspect of a human's behaviour. Additionally, anthropomorphic elements for a gamified application also needs an accessible option for character personalisation.

F3: Game Element

Gamification was perceived as a way forward in healthcare (Wilson & McDonagh, 2014). According to Hamari, Koivisto, & Sarsa (2014), the reward system and the Leaderboard have a certain amount of effect when applied in a gamified application. The award of points in gamified application was esteemed very highly by both patients and experts, as reported in theme 4 section 6.2.1.2 and in Table 6-12 in section 6.2.2.1. This views indicated that the points are important and may not undermine the gamification effects on the patients. However, it is important to note that according to Nicholson(2012) and Seaborn & Fels(2014), *pointsification* could occur when there are too many points in games, undermining the gamification effect. The experts considered other game elements such as level, progression, and ranking, as important as well, as elaborated in theme 4, section 6.2.1.2.

F4: Motivation Theory

The theory of motivation was explored to understand how an anthropomorphic interface can affect in a gamified application for a healthcare application. The motivational theory was considered valuable and offered choices such as Maslow and Self Determination Theory (SDT) as mentioned by the experts, in theme 8, Chapter 6.2.1.2. In gamification, SDT was employed to investigate the motivational effects of gameplay. SDT helps to demonstrate how intrinsic and extrinsic elements can affect users' motivation (Seaborn & Fels, 2015; Ziesemer et al., 2013). Maslow, on the other hand, could be looking at achieving human needs in playing games, having fun while interacting socially in the virtual world could be one of the satisfaction (Ren, Liu, & Liang, 2009). Thus, it keeps the motivation on going. In view of both theories, the analyses of the experts' opinions in theme 8, Chapter 6.2.1.2, indicate that they were not certain what theory should be used.

F5: Transition Care

Different approaches to transition could support the process and may increase people's motivation. According to Wilson & McDonagh (2014), gamification can be a great innovation for supporting the transition process. Similarly, gamification of anthropomorphic interfaces could improve the patient's motivation in going through their transitional care, as argued by the experts in Theme 6 and 7 (section 6.2.1.2). According to Marape (2013) and the experts' views in Theme 5, in transitional care, the patients would be between 10 and 18 years old, with long-term conditions. However, the patients in the survey set this age range as 15 to 30 years old. The experts also argued that the age ranges varied depending on the age when the patients were diagnosed.

For a long-term period, an application should also address the problem patients normally face during the transition process. In order to develop a transition care gamified application, experts thought that it would be useful to consider the following: 1) the period and process of transitioning, 2) the nature of the illness – patient's health condition, and 3) the problem to address – more practical information about self-management such as medication reminders, body limits and appointment for treatments.

F6: Motivation for young adults

A person's motivation could be related to the factors of age or context such as a disease. However, these factors affected the way the content of an application is designed. For example, which types of anthropomorphic interfaces should be designed for young people? How should one design an anthropomorphic interface to represent a cancer patient? In this research, the

motivation factor relates not just to the content but also to the context in which an anthropomorphic interface is used in a gamified application for transitional healthcare.

In Chapter 3.1.2, there were no specific requirements for helping young adults in their transition process as discussed about gamification and motivation aspect for young adults. Looking into the young adults' perspective, implementing a fun tool that incorporated an attractive avatar in the gamified application could attract their attention. Additionally, gamification and anthropomorphic characters have shown a significant motivational effect, as presented in the survey's result. Thus, applying an anthropomorphic interface in gamified application may indirectly help to increase the patients' motivation in the transition process.

6.4 A Confirmed TAG framework

The framework was confirmed using the triangulation process, as discussed in section 6.3. Analysis of the interview and survey showed that there were other components and elements in the factors that should be added and removed. There were also arguments that lead to a re-factoring process, such as the anthropomorphic interfaces factor being combined with the anthropomorphic elements factor. For that, the proposed TAG framework has to be restructured based on the following arguments;

1- The degree of anthropomorphism (Avatar, ECA, and Hybrid character) and the element of anthropomorphism (Social responses, Social Presence, and Accessibility) are merged, and become one; the anthropomorphic interfaces. This is because, in designing any degree of anthropomorphic interface, the characteristics of anthropomorphism will strengthen the anthropomorphic design and its effect in the human and computer interaction. Thus, the degree of anthropomorphic interfaces is suggested not as a single factor in this framework. Furthermore, the purpose of the anthropomorphic interface designs should be taken into account in order to apply them in a computer application.
   From the triangulation of literature, interview, and survey, elements that could be used to create a comprehensive anthropomorphic interface are;
   a. Anthropomorphic interface design - The avatar, human cartoon, interface agent, hybrid character, and abstract character.
   b. Design purpose – the use of a particular anthropomorphic design, whether is it for personalisation or for strategy.
   c. Anthropomorphic elements of social response - consisting of eye contact, facial expression & emotion, gestures, posture, flattering effects, voice instructions, and intelligence.

d. Anthropomorphic elements of social presence - consisting of gender, age, skin colours, and body shapes.

2- The factor of game elements should remain the same. The choice of game elements in a gamified application for transition process will consist of a rewards system, a Leaderboard, and level. The rewards system is important in increasing a patient's motivation to carry out the transition process. The Leaderboard will show a patient's achievement and using the Leaderboard will make the patients compete with each other in a gameplay. The level is an approach applied for the stages in the transition process. As for progression and ranking, these elements should be covered in the Leaderboard.

3- Based on the triangulation of literature, interview, and survey, the specific requirements for motivating young adults in transition process were not specifically defined. This is because, examining a person's motivation to learn is based on how they are attracted to the applications in terms of their design, strategy, or the experience they have using the application. With this in mind, the issue of age and the context of application should be included when the motivation is in line with the motivation theory.

Considering the focus of sustaining patient motivation while learning and adapting to their health conditions, the research proposes the use of the ARCS model (Keller, 1987) as presented in the framework development, Chapter 4.4. Patient's learning motivation is defined in four elements. These are;

- Attention – how the patient gains attention and give response to the subject,
- Relevance – how preceding knowledge affects the learning environment,
- Confidence – gaining confidence for positive learning outcomes, and
- Satisfaction – learning satisfaction, particularly when given a reward.

4- The factor of transition process remains the same. The transition process is specific to patient living with health condition. In a transition process, a patient's readiness for self-care can be understood through the self-management issues, which the patients need to focus on. The self-management issues have to reflect on how much patient knows about their condition. Based on the analyses of results, the issues could include medication, body conditions and appointments for treatments.

Thus, there are four main factors in the TAG framework. Based on the research discussions and the arguments, elements for each of the factors showed a little change. The changes are presented in Table 6-22. The confirmed TAG framework shown in Figure 6-2. The confirmed factors constructed for the TAG framework are specifically designed for the application of anthropomorphic interfaces in a gamified application for transitional healthcare as a whole.

Table 6-22 Previous and New Framework Elements

No.	Factor	Previous Component	New Factor	Refactor Component
1.	Degree of anthropomorphism	Avatar, human cartoon, Interface Agent, hybrid character, and abstract character	Anthropomorphic Elements	***Anthropomorphic Interface design*** *(*avatar, human cartoon, Interface Agent, hybrid character, and abstract character)***,**
2.	Elements of anthropomorphism	*Social Responses* (eye contact, facial expression, gesture, posture, voice instruction, flattering effect, emotion, and intelligent), *Social Presence* (gender, ethnicity, age, facial attractiveness), *Accessibility*		***Design Purpose,*** ***Social Responses*** *(*eye contacts, facial expression & emotion, gestures, flattering effects, voice instructions, and intelligence*),* ***Social Presence,*** (gender, skin colours, and body shapes) ***Accessibility***
3.	Game elements in gamification	Badges, level, rewards, progression, Leaderboard	Game Elements	***Reward system*** (point, badge, trophy), ***Leader board*** (progress, status, ranking), ***Levels***
4.	Motivation theory	ARCS theory of motivation	Motivation theory	***Attention*** ***Relevance*** ***Confidence*** ***Satisfaction***
5.	Motivation for young people	People aged between 11 to 18 years old		
6.	Health Transition care	Three processes involved: Early, Middle, and Late	Transition Health Care	***Stage of transition,*** ***Health condition,*** ***Self-Management***

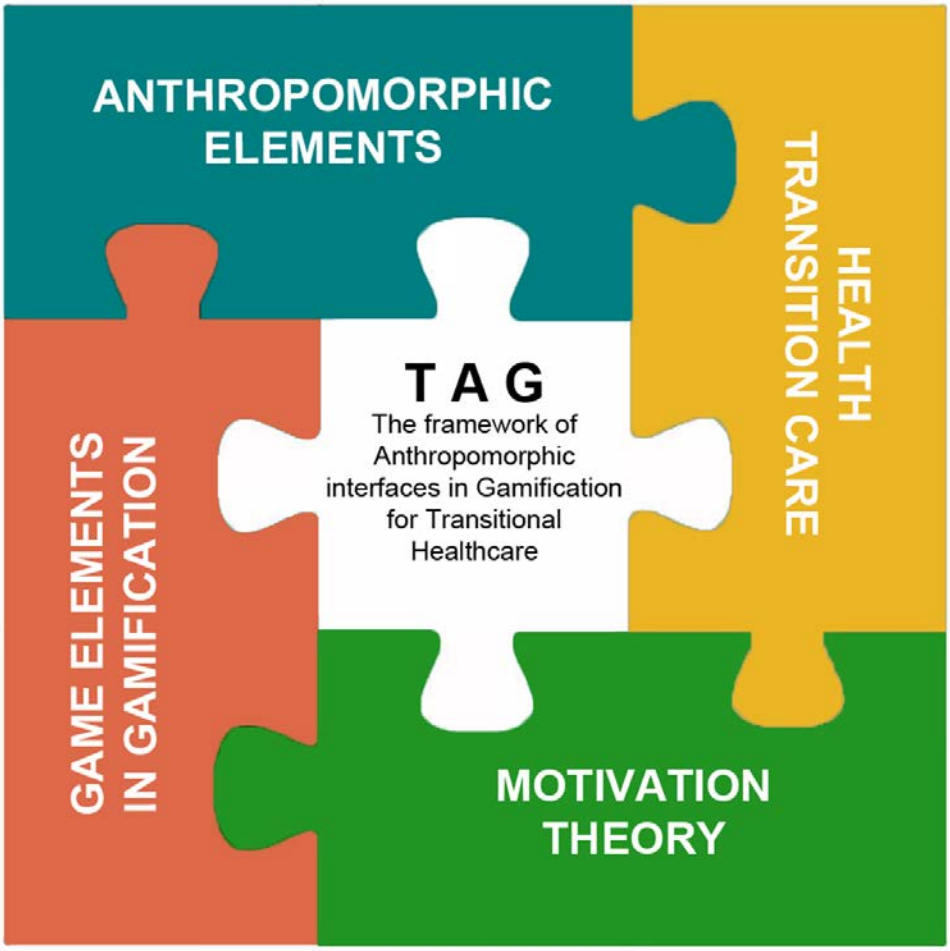


Figure 6-2 the TAG Framework

6.5 Chapter Summary

This chapter first describes the approach taken to confirming the proposed framework. An exploratory descriptive research design was chosen and a triangulation methodology was adopted for the mixed method approach. For the mixed method, sequential procedures were applied. The study was conducted by undertaking 15 interviews to find any omitted or redundant elements in the framework. The interviews were analysed using a thematic analysis with NVIVO software. A questionnaire survey administered to 33 people who may have experience in the transition healthcare process. The survey was conducted to confirm the elements composing the framework were reasonable and sensible. T-test analyses were used to find the significant correlation of all elements in gamification of anthropomorphic interfaces for the transition care in the framework.

Secondly, this chapter also presents findings and results from the study. The key results indicated that there was agreement with regards to anthropomorphic characteristics, the degree of anthropomorphism, the accessibility consideration in a gamified application, gamification in healthcare application, *pointsification*, the transitional background and issues, anthropomorphic interfaces and gamification for motivation, between the experts and the patients.

Thirdly, the discussion of the obtained data has contributed to confirming the suggested framework. The interview findings and survey results were triangulated with the literature relating to the development of the framework. Thus, the factor that contribute to the framework were anthropomorphic elements, game elements, transition healthcare, and motivational theory.

Following the confirmation of the framework, the next chapter will demonstrate the use of the TAG framework. The chapter will investigate the extent of anthropomorphic interfaces in gamified applications for transitional healthcare application.

Chapter 7: Development of the Transitional Anthropomorphic Gamification Scale (TAGS)

In Chapter 6, the suggested framework, TAG, was confirmed using triangulation of experts' interviews, the patients' surveys, and previous literature on anthropomorphic interfaces, gamification, and transition healthcare. Following the confirmation of framework, this chapter seeks to validate the use of the TAG framework in context. In order to do so, this research develops a new measuring instrument whereby answering the second research question of this thesis;

> *RQ2: What are the appropriate metrics to measure the gamification of anthropomorphic interfaces in transitional care applications?*

Therefore, a set of appropriate metrics were developed and grouped together. Chapter 7 demonstrates the development process of a newly created instrument. The instrument is called the Transitional Anthropomorphic Gamification Scale (TAGS). TAGS can be used to measure the extent of anthropomorphic interfaces in gamification applied to games, in informing the users about their transition care. The TAGS was developed employing an incremental approach, using the TAG framework as a reference. This is presented in section 7.1 and summarised in section 7.2.

7.1 Measuring Anthropomorphic Interfaces in Gamification for Transitional Healthcare

In order to validate the use of the TAG framework, a set of metrics was developed and validated, and subsequently formulated into an instrument. This instrument will measures the extent of how anthropomorphic interfaces in gamified applications are applied for transitional healthcare. Measuring these will inform the developer or designer of the design requirements for the application of anthropomorphic interfaces in gamification for transitional healthcare. It also will help to understand the suitability of the game used in a transitional process.

To this end, this instrument has yet to be developed and integrated within the TAG framework. Thus, factors and components in the TAG framework are defined to develop the instrument. Each component was analysed and the items for each component were synthesised as the metrics for the instrument. Figure 7-1 shows the process of developing the metrics.

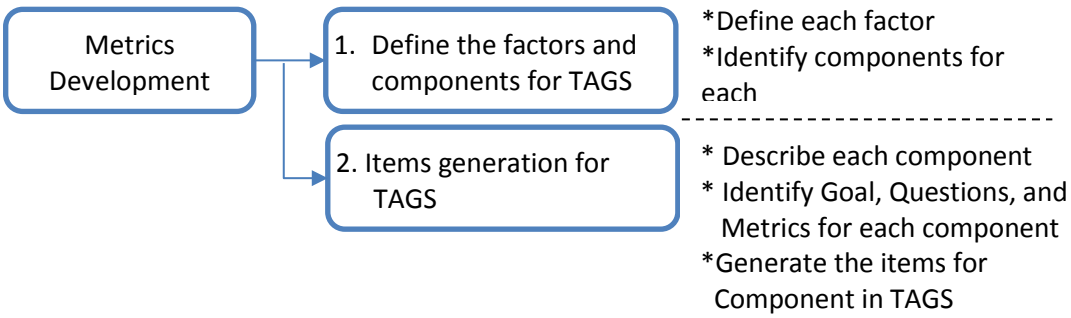


Figure 7-1 the metrics development process

7.1.1 Identifying factors and component

Taking the TAG framework as a reference, all four factors were included in the instrument for measuring the anthropomorphic interface in gamification for transitional healthcare (See Table 7-1). Each of the factors are defined below for their inclusion in the instrument;

i. *The factor of the anthropomorphic element*: Describes a design characteristic of the anthropomorphic interface in creating trustworthy and reliable interfaces.
ii. *The factor of gamification:* Describes the applicability of game elements in a gamified application.
iii. *The factor of motivation:* Describes the motivational outcome which comply with the theory of motivation.
iv. *The factor of transition healthcare:* Describes the requirement for gamifying transitional healthcare.

A total of 15 components were derived from the key factors, of which five components are from the anthropomorphic elements, three components from gamification, four components from motivation, and three components for transitional healthcare. Table 7-1 lists the components for each of the factors.

Table 7-1 List of factors and its component

Factors	Components (IDs)
Anthropomorphic Elements	1) Anthropomorphic Interface Design (AID) 2) Design Purpose (DEP) 3) Social Response (SOR) 4) Social Presence (SOP) 5) Accessibility (ACC)
Gamification	1) Reward System (RES) 2) Leaderboard (LEB) 3) Levels (LEV)

Motivation	1) Attention (ATT) 2) Relevance (REL) 3) Confidence (CON) 4) Satisfaction (SAT)
Transition Health	1) Stage of transition (SOT) 2) Health Condition (HEC) 3) Self-Management (SEM)

7.1.2 Operational definition for each component

A description of each component's inclusion is detailed below;

1. Anthropomorphic interface design (AID):

The anthropomorphic character is the user's representation in a gamified application. The framework has confirmed that there are five (5) types of anthropomorphic characters. Thus, this component investigates the type of anthropomorphic character that is mainly applied in an application.

2. Anthropomorphic elements (DEP):

The anthropomorphic characters expected to have a connection between user's motivation and their achievement (Baylor, 2009; Mumm & Mutlu, 2011). This is particularly important when the user allows personalization of his/her anthropomorphic character and directs the anthropomorphic character as part of a strategy in the application. At this point, current research measures personalization differently from game strategy. Previous items constructed in Bartneck, Kulić, Croft, & Zoghbi, (2009), and Heerink, Kröse, Evers, & Wielinga, (2009) are not suitable for measuring the design purpose of an anthropomorphic interface in an application. The items measure the user acceptance or measure the effects of personalization towards user interaction. However, those measuring items are not related to the arguments for TAGS. For inclusion in the TAGS, new items will be generated to investigate the design purpose of applying an anthropomorphic character in an application.

3. Social Response (SOR):

According to the TAG framework, socially responsive anthropomorphism has the characteristics of making eye contact, smooth gestures, offering praise or flattering feedback, human or synthetic voice instructions, and intelligence. In Heerink et al., (2009), developed an instrument to measure user acceptance on a social robot and one of the items was perceived sociability – the ability of the social robot to perform sociable behaviour. Another developed instrument measuring human avatar relationship also includes the items of social interaction (Zhao & Wang, 2008). However, in both instruments, the measurements focus more on a user's interaction and acceptance. These are not what this component was intended to measure. Therefore, for inclusion in TAGS, this

component measures the characteristics of anthropomorphic interfaces that offer socially responses in an application.

4. Social Presence (SOP):

In the TAG framework, anthropomorphism that exhibits social presence has the features of gender, skin colour, and body shape. Current research measures social presence in several ways. Heerink, Kröse, Evers, & Wielinga (2009) developed 5 items to measure social presence in determining the user acceptance of an assistive robot. The social presence has also been measured by the extent of being present in a virtual environment particularly, in interacting with others (Nowak & Biocca, 2003). However, items of acceptance and social presence are not practically related to the TAG framework. Thus, for inclusion in the TAGS, new items will be created to measure the extent of anthropomorphic interface design in informing the presence of a user in an application.

5. Accessibility (ACC):

For inclusion in the TAGS, this component investigates the accessibility options for the anthropomorphic interface in an application. Following the TAG framework, designing anthropomorphic interfaces should also consider the accessibility features in a gamified application. Accessibility features are not only for users with disabilities (Hull, 2004). Providing any digital content with accessibility features like an anthropomorphic interface in a game will enhance system usability (Kelly, Sloan, Brown, Seale, Petrie, Lauke, & Ball, 2007). However, in current research, very little attention is given to considering this component for the design of anthropomorphic interfaces. Thus, for inclusion in the TAGS, new items will be generated.

6. Reward System (RES):

In the TAG framework, research has shown that reward systems play an important role in gamification. The reward system includes points, badges, and trophies. In previous research, this reward system was measured as part of user's experience after playing a game (Sweetser & Wyeth, 2005) and the effect of points in a game (Mekler et al., 2013), but not the applicability of a reward system in a gamified application, particularly, how the anthropomorphic interfaces are part of it. For inclusion in the TAGS, a new item will be generated to investigate the range of reward systems and their implementation on anthropomorphic interfaces in a gamified application.

7. Leaderboard (LEB):

The Leaderboard is also one of the game elements that has a significant role in the TAG framework. Generally in gamification, Leaderboards show important information on players and their achievements in a board (status, accumulative points, ranking, and progress). For inclusion in the TAGS, the use of Leaderboards in gamified applications needs to be assessed and understood.

In particular, how anthropomorphic interfaces may represent users in the Leaderboard. Generally, the Leaderboard in itself is not related to competition (Ziesemer et al., 2013), however, it may arouse feelings of competition between the participants (Domínguez et al., 2013; S. H. Hsu, Chang, & Lee, 2013). Previous research such as Hall, Glanz, Caton, & Weinhardt, 2013 and Mekler et al. (2013), measures the impact of a Leaderboard on a player's motivation. Also, research by Sweetser & Wyeth, (2005) considers the Leaderboard as experience feedback after playing the game. Other than the user's information and achievement on the Leaderboard, the previous research does not include the use of anthropomorphic interfaces. The impact of such interfaces on competitiveness has yet to be tested. Thus, new items will be generated for this component.

8. Levels (LEV):

Apart from the reward systems and Leaderboard, the TAG framework also showed the importance of levels in gamification. Levels differentiate the degree of difficulties in gamification. Research by Barata, Gama, Fonseca, Gonçalves, & Jorge (2013) and Mekler et al. (2013) measured the effect of levels on user's participation, in particular when they progressed onto the higher levels. However, for inclusion in the TAGS, this component does not looking into the effects of levels on user's participation. Instead, this component would like to measure the applicability of levels in gamified applications. Also, how the anthropomorphic interfaces are implemented in levels. Thus, this research will create new items for inclusion in the TAGS instrument.

9. Attention (ATT):

This component investigate the ways in which the user's attention can be grabbed, so that he/she gets absorbed into the gamified applications. The TAG framework adopts the ARCS model of motivation by Keller (1987) to understand the motivational outcome in gamification (See Chapter 6.4, confirmation of the Motivation Factor for TAG). Four elements of motivation were adopted; Attention, Relevance, Confidence, and Satisfaction. Previously, Keller (2010) had developed a survey instrument named Instructional Material Motivational Survey (IMMS) to measure motivational problems within an instructional tool. This instrument has been widely used, such as in Hung, Lee, Chao, & Chen (2011) and Proske, Roscoe, & McNamara (2014). The IMMS was designed in correspondence with the ARCS model. The IMMS instrument also has four factors that reflect the four elements of the ARCS model. The elements in the ARCS model are;

- Attention; relates to perceptual arousal, inquiry arousal, variability
- Relevance; relates to goal orientation, motive matching, familiarity
- Confidence; relates to learning requirements, success opportunities, personal control
- Satisfaction; relates to consequences and equity

However, the questions in the IMMS indicates that they were not specific to the application of anthropomorphic interfaces in gamification for transition healthcare. A specific question is

required for inclusion in the TAGS. As of the component of attention, the IMMS measured attention based on the content of the application where effective stimuli is presented, such as text, graphic, and video. When the user feels excited and surprised, their attention is grabbed (Huang, Huang, Diefes-Dux, & Imbrie, 2006). The element of attention in the IMMS also measured if the contents are unappealing or too abstract. The user's attention could also be grabbed when they feel supported in the application (Proske et al., 2014). Thus, based on the related elements in ARGS model and adapted questions from the IMMS, this attention component could be perceived as the elements of excitement, support, and surprise.

For other motivational components in TAGS (REL, CON, and SAT), the questions in IMMS instrument associated with the ARGS elements are discussed within the context of the TAGS instrument. Detail for other motivational components are discussed as the following Component 10 (REL), 11 (CON), and 12 (SAT).

10. Relevance (REL):

This component helps to investigate the ways in which the content of a gamified application relates to a user's interests. The IMMS measures relevance based on relatedness to previous experience, relatedness to previous learning subject, content familiarity, and relatedness to personal interests. If the content is related, it could help to accomplish the user's goals, and the users are therefore more likely to be motivated to use it (Hung et al., 2011). Thus, this component could be understood as the elements of relatedness to previous experience and personal interest.

11. Confidence (CON):

This component will help to investigate what the users expect to experience in the application, in order for the users to become confident in completing the given task (Hung et al., 2011; Proske et al., 2014). The IMMS instrument measures confidence by how easily the users make choices in the application, whether users feel confident in completing the task, and how instructions provided in the application could help user to learn. Thus, this component could refer to the elements of opportunity, expectation, learning outcome, and confidence in choice making.

12. Satisfaction (SAT):

In IMMS, satisfaction was measured on the elements of enjoyable learning, application feedbacks and comments, and success in completing the given task. This component considers what the users received when they accomplished certain tasks. If the task and the reward are defined, the users should be motivated and thus, feel satisfied about their achievement (Hamzah & Ali, 2014; J. T. Kim & Lee, 2015). Thus, this component can be understood as the elements of outcomes, experiences, feedback, and value after achieving something.

The mapping between the components of attention, relevance, confidence, and satisfaction, with their concepts in the ARGS model, their implementation in the IMMS instrument, and the related subject for inclusion in the TAGS are summarised in Table 7-2.

Table 7-2 Mapping of elements in ARCS model * IMMS Instrument * TAGS

Component	ARCS Model	IMMS Instrument (the questions main subject)	Related subject to items in TAGS
Attention	Perceptual Arousal	Interesting Content arouses attention (text, diagrams, passages)	Surprise
	Inquiry Arousal	Eye Catching information and activities	Excitement
	Variability	Content too abstract, unappealing, repetitive	Provides Support or help function
Relevance	Goal Orientation	Content relatedness to learning subject	Relatedness to previous experience and personal interest
	Motive Matching	Content relatedness to previous experience and interest	
	Familiarity	Matching diagrams and examples	
Confidence	Learning Requirements	User instruction helps in learning	the element of opportunity, expectation, learning outcome, and confidence of choice making
	Success Opportunities	Ease of making choice, Feels of confident in completing the task	
	Personal Responsibility		
Satisfaction	Intrinsic Reinforcement	Enjoyable learning Pleasure to work	outcomes, experiences, feedback, and value after achieving something
	Extrinsic Rewards	Working feedbacks, review material, comments	
	Equity	Successfully complete the given tasks	

13. Stage of transition (SOT):

In the TAG framework, the stages for transferring people/patient from one condition to other condition or from one care to another kind of care, are used as an indication of the transitional healthcare process. For transitional gamified applications, stages are translated into levels (Wilson & McDonagh, 2014). To define and differentiate the stages, each level should have different presentation and content. For that, this component investigates the extent to which the stages of

the transition are applied in the application. New items will be generated for inclusion in the TAGS.

14. Health Condition (HEC):

According to the TAG framework, transitional healthcare covered a specific health condition in order to transfer people/patients from one condition to another or from one care to another. The characteristics of the health condition were defined to investigate health conditions through games. Thus, this component would like to find the extent to which the health condition is being addressed in a gamified application. New items will be generated for inclusion in the TAGS.

15. Self-Management (SEM):

The TAG framework indicates that throughout the transition, patients will have an idea of how to manage and adapt to his/her condition. Through the transition process, patients might have different problems to look after and the change in behaviour resulting from the transition will show how far they are affected by the process (Sawicki et al., 2011). Current measurement tools for transition called TRAQ (Sawicki et al., 2011), question self-management. However, the questions are more into clinical/hospital readiness and not relevant for adaption into gamified applications. Thus, this component seeks to investigate the extent to which the application supports user's self-management for a change in their behaviour. For inclusion in the TAGS, new items will be generated.

All 15 components have been defined. To develop the metrics for each component, the next section will explain the generation of items for inclusion in TAGS.

7.1.3 Items Generation

The second steps conducted in developing the metrics for the TAGS is the Items generation. A systematic approach is applied to generate a new metric for the TAGS instrument. Previous established instruments for measuring user's engagement or play experience in games such as Brockmyer, Fox, Curtiss, McBroom, Burkhart, & Pidruzny (2009) and O'Brien & Toms (2010), had created their survey instrument based on their conceptual framework or the analysis of the previous research. This situation also applied to research in Human-Computer Interaction research, such as Banks & Bowman (2016) and Fu, Su, & Yu (2009). However, in mobile usability research, a Goal- Question-Metrics (GQM) approach was employed to develop a usability metric for mobile application (Hussain & Ferneley, 2008).

The GQM approach was introduced by Basili et al. (1994) as a systematic approach to defining the measurement framework (Hussain & Ferneley, 2008). This GQM approach mainly applied for measuring processes, products, and resources in a software project (Basili et al., 1994)

whereby the approach was tailored to achieve the specific requirements of a particular software project. Other than a software project, GQM also provides a useful approach to focus any measurement problem (Hussain & Ferneley, 2008; Subramanian & Geetha, 2011). As the TAGS instrument is yet to be developed, a structured approach like GQM could be adopted to create a new metric for the TAGS instrument.

7.1.3.1 The Goal-Question-Metrics (GQM) Approach

In the GQM approach, there are three basic levels to determine a metric – 1) conceptual level (goal), 2) operational level (question), and 3) quantitative level (metrics). These levels are kind of top-down procedures wherein metrics (lower level) were identified based on the measurement goal (upper level). In the conceptual level, the goal of a product or a project is defined according to its purpose and condition. For the operational level, a set of questions is used to describe how to assess and achieve the specified goal. The quantitative level will provide a metric that could quantitatively answer every question associated with the goal.

7.1.3.2 Implementations of GQM Approach

In this research, the instrument to measure transitional anthropomorphic gamification followed the GQM approach. Firstly, the goal for each component is defined, based on the description of TAG's components in section 7.1.2. Secondly, after defining the goal, questions related to the goal are created. Third, metrics are outlined in order to answer the question. In this research, the metrics are the key point to answer the questions and to achieve the goal. This metrics are itemised to measure a component. Consequently, these itemised metrics become the measurement items for the component. Figure 7-2 shows the structure of the adopted GQM approach.

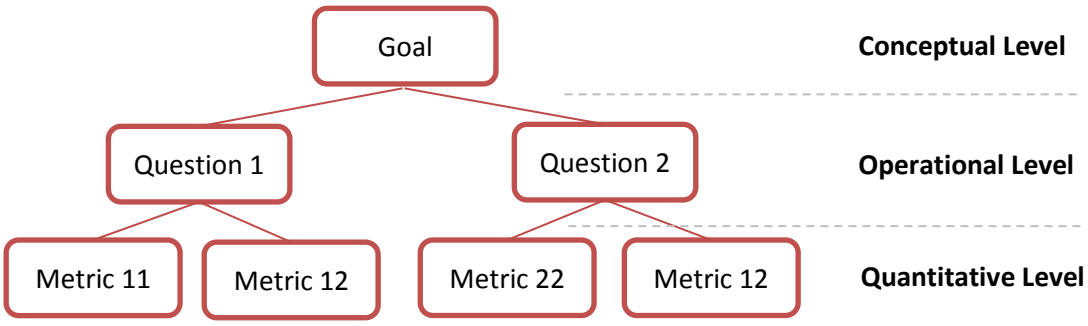


Figure 7-2 Illustration of GQM

As of example, one component was chosen to demonstrate the steps for generating the items for the TAGS. The component is the design purpose (DEP), one of the components in the factor of anthropomorphic element. Based on the DEP description in section 7.1.2, the goal for

DEP is to understand the purposes of using or applying an anthropomorphic interface in an application. For that, two questions are asked. The First question asks why the anthropomorphic interfaces are applied and the second question asks how the anthropomorphic interfaces are used. Following the TAG framework, the purpose of anthropomorphic interfaces could be seen as a personalisation tool or as a game strategy. The metrics were generated based on the two questions. This information is presented in Table 7-3.

Table 7-3 Example of generated metrics and items for DEP using GQM approach

Factor	Anthropomorphic Elements	
Element	Design Purpose (DEP)	
Goal: To understand the purposes of using or applying anthropomorphic interfaces in an application.		
Questions		**Metrics**
Q1. How anthropomorphic character is applied? *(Ease of character customization)*		*1. I can easily customize my own character*
		2. I can easily customize my character's environment (for example; house, car, office, garden, etc.)
Q2. How are the anthropomorphic interfaces used in an application? *(As a strategy to win)*		*3. I normally use my character as a tactic to confuse other characters or opponents*
		4. I normally do not choose a character as a strategy to win
		5. I am allowed to upgrade my character to be more powerful or meaningful as the application progresses

The GQM approach was applied to all components with the same concept that was presented for DEP. The details for all the components consisting of the goals, questions, metrics, and items can be found in TAGS pool description, in Appendix A. For the 15 components, an initial pool of 80 items was generated and the summary of each component is presented in Table 7-4.

Table 7-4 Summarization of developed items for TAGS

Factor	Component	No. of potential Items
Anthropomorphic Elements	Anthropomorphic Interface Design (AID)	1
	Design Purpose (DEP)	6
	Social Response (SOR)	8
	Social Presence (SOP)	7
	Accessibility (ACC)	5
Gamification	Reward System (RES)	8
	Leaderboard (LEB)	5
	Levels (LEV)	5
Motivation	Attention (ATT)	4
	Relevance (REL)	6

	Confidence (CON)	6
	Satisfaction (SAT)	6
Transition Health	Stage of transition (SOT)	4
	Health Condition (HEC)	5
	Self-Management (SEM)	4
Total all items		80

7.1.4 Response Item

Suitable response items are used to respond to each of the items in the instrument. Based on the explanation of the use of the type of Likert scale in Chapter 5.3.2, and based on the nature of the item that acquires users opinion about the TAG applicability in a gamified application, the Likert agreement scale was utilised; 5 – Strongly agree, 4 – Agree, 3 – Neutral, 2 – Disagree, 1 – Strongly Disagree. The use of these scales in TAGS is defined as follows;

i) Strongly agree – The highest scale that indicates a total agreement to the application of anthropomorphic gamification in transition. The scale shows an important effect on the items in TAGS.

ii) Agree – the second highest scale that indicates an agreement to the application of anthropomorphic gamification in transition. The scale shows a satisfactory effect on the items in TAGS.

iii) Neutral – the medium scale that indicate undecided agreement to the application of anthropomorphic gamification in transition. The scale shows some effect on the items of TAGS.

iv) Disagree – the second lowest scale that indicate for disagreement to the application of anthropomorphic gamification in transition. The scale shows a minor effect on the items of TAGS.

v) Strongly Disagree – the lowest scale that indicate for a total disagreement to the application of anthropomorphic gamification in transition. The scale shows very little effect or may not effect on the items of TAGS at all.

However, this response item is not applicable to the component of Anthropomorphic Interface Design (AID). This is because, according to its operational definition in section 7.1.2, AID is intended to investigate the type of anthropomorphic character mainly applied in an application.

7.1.5 The Instrument

Once the metrics for anthropomorphic gamification in transition has been developed, the metrics and the response items are formed to serve as an instrument for measuring the anthropomorphic gamification for transitional healthcare application.

In the TAGS, respondents are asked to choose a score on the scale according to the item's description. For example; *Item 1: I can easily customize my own character (for example; change clothes, trousers, shoes, hair, add jewellery, etc.)*. The item refers to the design purpose component for how personalisation of a character is applied for anthropomorphic gamification in transitional healthcare. The respondents are required to rate on how much they agree or disagree with each items. The complete instrument can be found in Appendix D.

7.2 Chapter Summary

This chapter presents the development of an instrument for measuring anthropomorphic interface gamification for transitional healthcare. The instrument, called TAGS, Transitional Anthropomorphic Gamification Scale has been created. The process involved identifying the factors and components related to the TAGS, and generating the items to measure the extent of anthropomorphic interfaces applied in gamified application for transitional healthcare. These items were generated by adopting the Goal-Question-Metrics approach and guided by the TAG framework. Initially, fifteen components were defined and a total of 80 items were generated. Next, this instrument required validation in order to assure that the items measured the right content. The validation process is presented in Chapter 8.

Chapter 8: Validating the Transitional Anthropomorphic Gamification Scale (TAGS) Instrument

Validity and reliability are important criteria to assess items in an instrument (Banks & Bowman, 2016; Fu et al., 2009). The validity assessment consists of assessing the content and construction of items, and the reliability assessment will involve checking on the item's internal consistency for the inter-item relationship. In this Chapter, a test was designed to validate the Transitional Anthropomorphic Gamification Scale (TAGS) developed in Chapter 7. The validation process for TAGS is an iterative process. These processes followed the usual method applied in the previous research for instrument development and validation (such as in Dwivedi, Choudrie, & Brinkman, 2006; Fang, Zhang, & Chan, 2013; O'Brien & Toms, 2010). The process took place in three steps. The first step involved a content validation, to determine the suitability and necessity of the items in the metric. The second step involved a pre-test, to determine if the items are clear and understandable to the participant. The last step is an experiment that validates the instrument by determining its reliability. This validation process is illustrated in Figure 8-1.

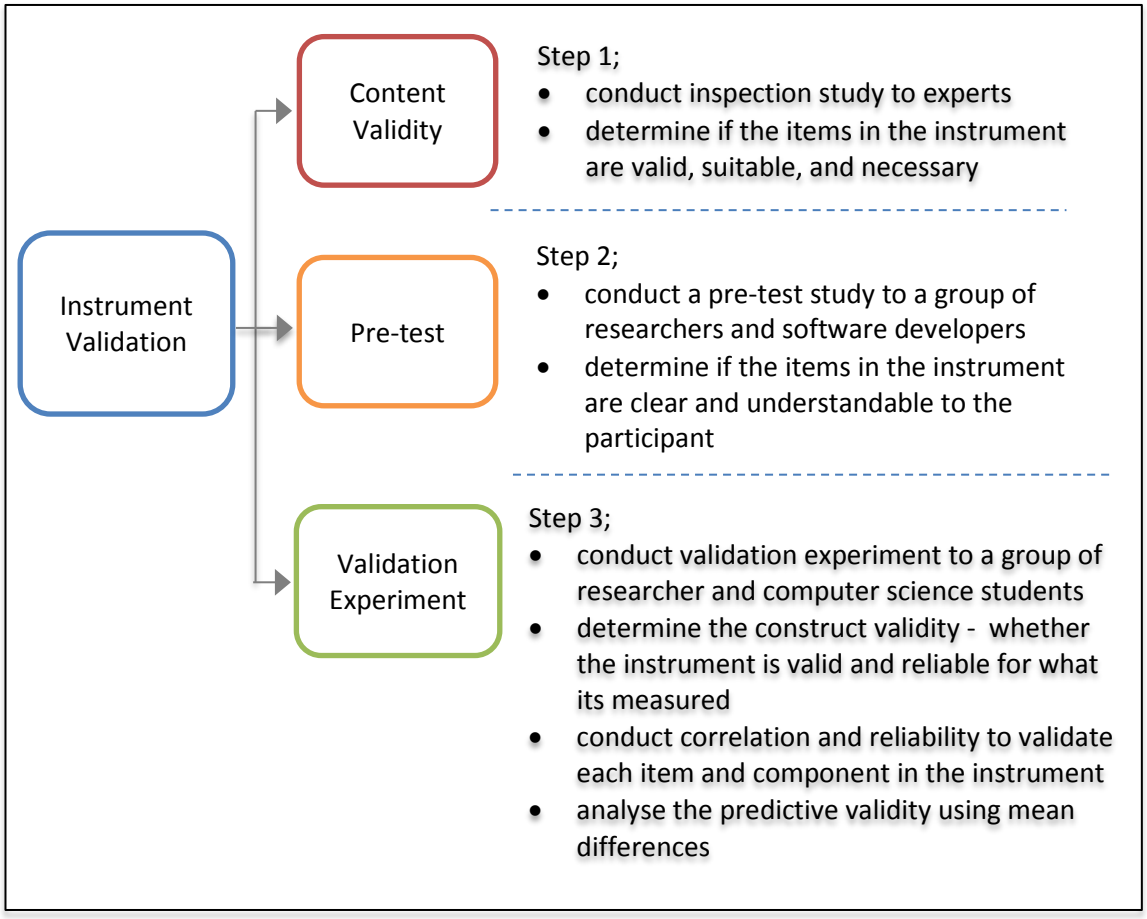


Figure 8-1 The steps involved for validating the TAGS instrument

The details of each of these tests including the method, procedure, participants, and results are presented as follows, section 8.1 explains the content validity test, section 8.2 explains the pre-test, and section 8.3 explains the experiment. The reasons for employing the methodology for each test were explained in Chapter 5.1.1. In Section 8.4, discusses the findings and results from all tests and make a confirmation of the final instrument.

8.1 Content Validity

Content validity assessment of the TAGS instrument was performed to determine if the items in the instrument are measuring what they are supposed to measure, in accordance with the TAG framework. The reason for employing the content validity assessment for this study was explained in Chapter 5.2.4.

8.1.1 Method

An inspection method was applied (see Chapter 5.3.3) to assess the suitability and necessity of all of the items. The instrument is assessed in two steps. The first steps is about English grammar and structure. In this step, the instrument was sent for English proofreading and editing. The second steps assesses the meaning of the item, its suitability and necessity. An evaluation document consisting of the instructions, information, and the TAGS instrument and evaluation form was provided to the experts via email. Each of the items was assessed according to two criteria;

1) The necessity of the item, and
2) The suitability of the response item.

The necessity criterion of the item is graded on a 3 point scale;

1) Necessary,
2) Neither necessary nor unnecessary,
3) Unnecessary.

The assessment criteria for the response items was also graded on a 3 points scale;

1) Appropriate,
2) Neither appropriate nor inappropriate,
3) Inappropriate.

The evaluation document is attached in the Appendix B.1 and B.2. In the inspection method, the expert went through the items one-by-one, assessed all of the items according to the given instructions, and made comments wherever necessary. A one-to-one interview session was conducted to personally obtain comment from the expert.

8.1.2 Participants

A total of 8 experts and 2 English proof-readers were employed. Among the experts were 5 researchers in gamification, 1 researcher in health sciences, and 2 academics with HCI background. They were identified based on their current research, previous publications and interest in the related fields of game, gamification, health sciences, and HCI. The number of experts was considered sufficient because, based on the discussion of the determination of sample size in Chapter 5.4.1, to obtain expert view, a range of five to eight experts may provide a maximum variation of data to the subject being studied.

8.1.2.1 Procedure

The procedure conducting the inspection method was comprised of elements before, during, and after the session, they are detailed below;

Pre-Study:

Invitation. A week before the study took place, an invitation email was sent to the prospective participants. If they were to participate, an email containing information about the study, data management, a consent form and contacts for person-in-charge, were emailed to them. The participant needed to sign the consent form and send it back to the researcher before commencing the study. Once the researcher received the consent form, the instructions and the evaluation document were detailed in another email.

During the study:

Personal information sheet. Participants were given an information sheet (attached in the email) to inform them about the study. Participants were assured that no personal information was collected and all responses would be available as statistical data. However, emails and consent information were kept as confidential. No link was visible between participant emails and his/her response's sheet. Participants were also informed that their involvement was voluntary. They could request to pull out from the study at any time and no further action was required.

Once the participant read the information sheet, they could proceed to the self-administered assessment.

Self-administered assessment. Once agreed and ready, the participants can start to assess all the items in the evaluation document, which had been emailed to them earlier according to the given instructions, on their time and at their convenience. Once completed, the participant will inform the researcher and a session will be planned to discuss the instrument and obtain all of their comments. The participant can submit the evaluation document either in-person or emailed back to the researcher.

One-to-one session. A time, date, and venue were set with the expert to discuss his/her opinion about the instrument. The expert came to the venue as agreed. The researcher made sure that the evaluation documents were there. The discussion started once all the documents were ready. All comments were noted.

After the study:

Once the participants completed the study and send back the evaluation document, they were thanked. No further contact about the study was made.

8.1.3 Results

Responses from all experts were gathered and for each of the items, all items indicated as "necessary" by the experts were calculated. A statistical significance level for each component was estimated based on the content validity ratio (CVR). This CVR is a quantitative approach to content validity introduced by Lawshe (1975) where the CVR is calculated according to the following equation 8-1.

$$CVR = (n_e – (N/2))/ N/2,$$

Equation 8-1

Where n_e is the number of experts who agree with item's necessity and N is the total number of experts in the study. Following the equation, the CVR value for each item is evaluated for a statistical significance level of 0.05 (Ayre & Scally, 2014; Lawshe, 1975). An item that was not significant at the 0.05 level was eliminated. The list of all components with the CVR value for each item, are presented in Table 8-1. An item that has a CVR greater than or equal to 0.50 on a 0 - 1 scale is considered statistically significant, and a CVR lower than 0.50 is considered not statistically significant (Ayre & Scally, 2014; Lawshe, 1975).

The results show that of the 80 items of the TAGS, the experts considered only 70 significant items necessary for their inclusion in the instrument. The CVR ranged between 0.99 (highest) to 0.53 (lowest), at 0.05 significance level. These CVR averages indicate that the components in the TAGS had an adequate level of content validity, which means that the items in TAGS were reflected the subject being measured. From the assessment, the experts also provided a number of suggestions. The suggestions were mostly about the use of words (e.g. DEP5, ACC2), the structure of sentences (e.g. SOR3, SOR8), and adding examples for the item (e.g. ATT4, RES7). The suggestions were to ensure that the meaning of the items can be delivered accurately and effectively. The response items (5 – Strongly Agree to 1 – Strongly Disagree) were considered appropriate. The updated version after the content validity test can be found in Appendix B.3.

Table 8-1 Content validity results

Component	Number of Items	Number of Significant Items	CVR item 1	CVR item 2	CVR item 3	CVR item 4	CVR item 5	CVR item 6	CVR item 7	CVR item 8	Average CVR
AID	*1*	*1*	*1*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*0.99*
DEP	*6*	*5*	*0.75*	*0.75*	*0.25*	*0.5*	*0.75*	*0.75*	*-*	*-*	*0.63*
SOR	*8*	*6*	*0.75*	*0.75*	*0.75*	*0.5*	*0.25*	*0.0*	*0.75*	*0.5*	*0.53*
SOP	*7*	*5*	*0.75*	*0.5*	*0.75*	*0.25*	*0.75*	*0.75*	*0.25*	*-*	*0.57*
ACC	*5*	*4*	*1*	*0.75*	*1*	*0.5*	*0.0*	*-*	*-*	*-*	*0.65*
RES	*8*	*7*	*1*	*0.75*	*1*	*1*	*0.25*	*0.75*	*0.75*	*0.5*	*0.75*
LEB	*5*	*5*	*0.75*	*0.75*	*0.75*	*0.75*	*0.5*	*-*	*-*	*-*	*0.70*
LEV	*5*	*5*	*1*	*0.50*	*0.50*	*1*	*1*	*-*	*-*	*-*	*0.50*
ATT	*4*	*4*	*1*	*1*	*0.75*	*1*	*-*	*-*	*-*	*-*	*0.94*
REL	*6*	*5*	*1*	*1*	*0.25*	*1*	*1*	*0.5*	*-*	*-*	*0.79*
CON	*6*	*5*	*1*	*0.75*	*0.25*	*0.5*	*0.75*	*0.75*	*-*	*-*	*0.71*
SAT	*6*	*6*	*1*	*1*	*1*	*0.75*	*0.75*	*1*	*-*	*-*	*0.92*
SOT	*4*	*4*	*1*	*1*	*1*	*0.75*	*-*	*-*	*-*	*-*	*0.94*
HEC	*5*	*4*	*1*	*1*	*0.25*	*1*	*1*	*-*	*-*	*-*	*0.90*
SEM	*4*	*4*	*0.75*	*0.75*	*1*	*1*	*-*	*-*	*-*	*-*	*0.87*
Total	*80*	*70*									

8.2 Pre-Test

Following from the revision of the TAGS items from the content validity in step 1, the validation of instrument is continued in step 2 by conducting a pre-test. The pre-test was conducted to make sure that all the items in the instrument were cleared and understandable to the participant. The pre-test enabled the internal consistency of each item to be determined for its reliability. Chapter 5.2.3 explains the reason for employing the pre-test.

8.2.1 Method

A survey method was applied (see Chapter 5.3.2) to obtain responses from the participants. The instrument was converted into a survey and the survey was disseminated online using an online tool, the *iSurvey* (*https://www.isurvey.soton.ac.uk/21251*). Also, the instrument can be found in Appendix B.3. The survey was self-administered. The prospective participants were approached personally before commencing the study.

To pre-test the instrument, four games were selected; 1) Club Penguin, 2) Pirate101, 3) Monster Manor, and 4) Re-Mission2. The games were selected based on the functions of the game which were closely related to the application of anthropomorphic gamification in healthcare. These games were based on two different categories of applications. The first category is of a general type of game, played by anybody for fun and to socialize. Club Penguin and Pirate101 are of this category. The second category is health related games. The Re-Mission2 is a game for cancer and Monster Manor is a game for diabetics. All participants were required to play one of the games for a minimum of 10 minutes. Once finished, to express their views about the game on the TAGS, they has to complete the survey using the online tool.

8.2.2 Participants

The experiment was conducted with 34 participants. The number of participants was above the estimated minimum required sample size for a quantitative study, which was discussed in Chapter 5.4.1. The participants were researchers and software developers. The researchers were identified through a research network having the same research interest, and the software developers were identified based on their experiences, with at least one year's experience developing an application or a game.

8.2.3 Procedure

Procedure in conducting the survey had steps before, during, and after the test starts with recruiting the participants until the participants completed the survey. The procedure is detailed as follows;

Before;

Invitation. A week before the study takes place, an invitation email was sent to the prospective participants. If they were to participate, they were required to reply to the email for further arrangement. They could choose to participate offline or online.

During;

i. *For the offline participant;*

   This was a one to one session. The participants came to the venue at the agreed time, and date. Upon arrival, the participants were greeted, asked to be seated and relaxed. They were given a copy of an information sheet to read. They could ask about the study while reading the information. Once they understood and were satisfied about the information, they were given a consent form to sign.

   Beginning of the study;

- First, the researcher briefed the participants on the detailed tasks involved in the experiment.
- Second, the participants were required to select one (1) of the games used in the experiment.
- Third, the participants were given an iPad to play the chosen game for about 10 minutes. The researcher set the timer when the participant started and after 10 minutes, the researcher asked the participants to stop playing.
- Lastly, still using the iPad, the researcher opened the survey and the participants were asked to complete them. They would spend maximum of 40 minutes answering the questions.

At the end; the participants were thanked for their participation in the experiment.

ii. For the virtual participant (online);

Upon agreement to participate, the participants would receive another email explaining the tasks involved and the time window to complete them. The explanation was as follows;

- Choose one (1) game to play. The link to all games and their login details were provided.
- Play the game for about 10 minutes. Since the time was not managed automatically, the participants would play the game and manage their own time.
- After they finished playing, go back to the instructions and click the link given to fill out the online survey. The participants would spend a maximum of 40 minutes answering the survey.
- When the survey was completed, the participants must click the submit button. Ensuring that the responses were completely saved. If there were uncompleted responses (the *iSurvey* data system can flag this), an email (through the *iSurvey*) was sent to them again as a reminder.

Seeing as the survey was conducted virtually, the participants could choose whenever they wished to do it, within the given date.

<u>After;</u>

Once the participants completed the tasks and the survey,

- For the offline participant, they can leave the venue and no further contact related to the experiment would be made.
- For the online participant, they just need to close the related links and no further contact about the experiment would be made.

8.2.4 Result

The results obtained from the pre-test were first run to examine if a bias might be existed due to different games utilised in the study. An independent t-test was conducted for two sample means, one with general type of game and one with health related game. The results shown in Table 8-2, indicate that there were no significant differences between responses obtained for three of the factors (anthropomorphic elements, gamification, and motivation) and a significant differences for one factor (transition Health) for the two types of games. The significant result of the transition health factor shows that there is a different response between the health games and general games. However, for other factors, it shows that the games utilised in the study have not contributed to the pattern of participants' responses. The study considered the games to be unbiased.

Table 8-2 Independent Sample Tests between means of two types of Game vs TAG's Factors

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
Component	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Anthropomorphic Elements	1.39	.25	1.32	32	**.19**	.24	.18	-.13	.60
Gamification	6.20	.02	.66	32	**.52**	.14	.21	-.29	.56
Motivation	2.61	.12	1.02	32	**.32**	.19	.18	-.19	.56
Transition Health	.07	.79	-2.69	32	***.01***	-1.11	.16	-1.43	-.79

Secondly, the results were analysed for items reliability. A good reliability is implied to Cronbach's α more than .60 (Hair et al., 2009; Sekaran, 2013). The item-total statistic resulted from the reliability test showing the relation within items and their effect on component reliability. The '*Corrected Item-Total Correlation'* is suggested to be more than .30 to indicate that the items are correlated in measuring the same construct (A. Field, 2014). The '*Cronbach's Alpha if Item Deleted*' will indicate how much improvement there is to the overall reliability if an item is deleted. These values will help to justify the acceptable level of reliability of an item and a component.

From the reliability results, the significant items that have a good inter-item correlation and reflect a good internal consistency were retained. The decision to eliminate any non-significant items were referred to the developed metrics, as outlined in the GQM approach. An item with a low effect and/or having a negative effect on the components will be considered for elimination. However, it's only applicable if there is more than one item measuring a particular question.

For example, the DEP component, *item no. 3: I normally use my character as a tactic to confuse other characters or opponents* and *item no. 4: I normally do not choose a character as a strategy to win*, *and item no. 5: I am allowed to upgrade character to be more powerful,* are the metrics that measure the same question (Q2. Character as a strategy to win) (see Table 7-3). From the pre-test result in Table 8-3, item no.4 has a very low effect (Corrected Item-Total Correlation is < .30) when correlated to the other items in the DEP component. Since item no.4, item no.5, and item no.3 are measuring the same question, removing one of the items would not undermine the validity of the content being measured. Thus, item no. 4 is removed due to it not being statistically significant. The complete result for each component in the instrument is attached in Appendix C.

Table 8-3 Item-Total Statistics for Design Purpose (DEP)

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
1. Customize own character	14.00	7.03	.308	.625
2. Customize character's environment	13.85	5.71	.717	.348
3. Tactic to confuse other characters	14.06	8.85	.333	.589
4. Choose a character as a strategy to win	*14.97*	*9.79*	*.102*	*.667*
5. Upgrade character to be more powerful	13.59	7.70	.467	.524

The summary of all components' reliability tests is presented in Table 8-4. The table shows the components according to their factor and their corresponding Cronbach's α for all items and for only the significant items. A Cronbach's α of more than 0.6 is considered to have a good level of reliability (Sekaran, 2013). A good level of reliability indicates that the items in the component are internally consistent and are measuring the same content. All the significant items show a Cronbach's α between 0.65 (for SOR and HEC) and 0.83 (for SOP). According to the reliability results for each component, few items in 12 components (highlighted in purple in Table 8-4) were reduced due to an insignificant effect on the component. Only 2 components (ACC and SEM) showed a statistically significant effect for all of its items. The statistically significant items are gathered and formed, in order to be considered for inclusion in the TAGS instrument for measuring the application of anthropomorphic gamification in transitional healthcare (See Appendix D).

Table 8-4 Summary of Reliability Test (N=34)

Factors	Components	Number of all Items	Cronbach's α	Number of significant Items	Cronbach's α
Anthropomorphic Elements	*AID*	1	1	1	1
	DEP	5	.538	4	.667
	SOR	6	.529	5	.651
	SOP	5	.659	4	.833
	ACC	4	.782	4	.782
Gamification	*RES*	7	.711	5	.768
	LEB	5	.640	4	.780
	LEV	5	.442	3	.677
Motivation	*ATT*	4	.592	3	.676
	REL	5	.614	4	.760
	CON	5	.403	4	.722
	SAT	6	.486	4	.680
Transition Health	*SOT*	4	.449	3	.656
	HEC	4	.637	3	.757
	SEM	4	.729	4	.729
Total	15	70		55	

8.3 Validation Test

The multistep validation process for the TAGS instrument concludes with the final validation test. The test is to validate the modified version of the TAGS that resulted from the pre-test. The experiment looks at the construct validity and the predictive validity. The two validation concepts are deemed necessary as a way to ensure that the instrument measures the underlying concept. They are explained in details in Chapter 5.2.4. To be valid, the experiment examines;

i. The exploratory factor analysis,
ii. The internal consistency of the items, the components, and the instrument as a whole,
iii. The correlation for inter-items and inter-component,
iv. The descriptive analysis to find the similarity scores of predictive condition and
v. The repeated measure mixed ANOVA to find a statistically significant difference of TAGS components in games.

8.3.1 Methods

A within-subject design was adopted to conduct the validation experiment. In the design, the participants were required to undergo all the conditions being tested. The method was chosen because it helps to obtain multiple outcomes from each subject and to test the consistency level of individual responses when condition under treatment being changed (Blanco et al., 2011). The

concept of within-subject design and the reason for implementing it are explained in Chapter 5.2.5.

There were two games (conditions) being tested in this test; Club Penguin and Monster Manor. These games were chosen based on the average mean of the TAGS score, for the four games used in the pilot test. The two games with the highest mean score were selected. The means indicate that the selected games were rated highly, based on the functions which reflected the instrument. Details of the results are attached in Table E2 in Appendix E. These two games were used to test the instruments based on the functions provided in the games.

The within-subject design applied a crossover design as a method to obtain responses from participants. A crossover design required participants to test the two games interchangeably. The first participant will play one game, then the second participant will play the other games. Once finished, both participants will submit their responses. After that, the participants will swap the game, play them and give responses again. The reason for applying this method is to minimize the possible problem when applying the within-subject design. Further explanations about crossover design are offered in Chapter 5.3.4.

The final version of the TAGS is transformed into an online survey using the *iSurvey* tools. The survey can be accessed at *https://www.isurvey.soton.ac.uk/21800*. The survey is available until December 31st, 2017. The instrument can also be referred in Appendix D.

8.3.2 Participants

The experiment was conducted with 75 participants. All recruited participants completed the study acceptably and thus, no data was removed. The number of participant was above the estimated minimum required sample size for a quantitative study, which was discussed in Chapter 5.4.1. This number of sample participants was higher than estimated because it is deemed necessary to conduct a factor analysis. According to De Winter, Dodou, & Wieringa (2009), for any research, the minimum acceptable number of participants for conducting an exploratory factor analysis is 50. In Hubbard (2014), the “rule of five” explain the random answers obtained from five people will have a 93.75% chance that the median of population will be between the highest and lowest values of the five person sample. The sample size is also determined by the ratio between observations (*N*) and component (*c*), *N : c*, for example 5:1, 10: 1, and 20: 1. In Hair et al., (2009), they suggest a minimum ratio of five observations per component to perform a factor analysis. Therefore, considering Hubbard and Hair, each component will have at least five homogenous sample observations. This is the reason for obtaining at least 75 participants for this experiment (five samples for 15 components).

The participants were researchers from the Electronics and Software Systems research group and computer science students at the Faculty of Physical Sciences and Engineering, at the University of Southampton. The researchers were identified based on their research interest and the students were identified based on their interests in playing games and have some knowledge and understanding about developing an application or a game.

8.3.3 Procedure

The procedure for conducting the validation test included recruiting participants; the activities during the study, and the closure after the participants completed the study.

Pre-Study;

Invitation. The prospective participants were approached individually. They were asked personally, either in person, or email. A brief explanation about the study was given to them. If they were interested participating, the time, date, and venue for the study was arranged. The participants were arranged into a group. There were a maximum of four participants and a minimum of two participants per group.

During the Study;

The participants came to the venue as arranged earlier. They were welcomed, asked to be seated, and get comfortable. Then;

- First, the participants were given an information sheet to read. The information sheet contained; the background of the study, purpose of the study, data management, exit policy, benefit of participation, and the person in charge.
- Second, once they finished reading it and were ready, they could play the first game for 10 minutes on an iPad.
- Third, they were given access to the online *iSurvey*. They had to insert the given password and tick the consent checkbox before starting to give their responses about the game they just played.
- Fourth, they would do the second and third steps again for the second games.
- Finally, once the participants completed both of the games, they were thanked for their participation.

After the study;

Once the participant completed the study, they could leave the venue and no further contact about the study would be made.

8.3.4 Result and analysis

The data obtained was screened beforehand, to conduct statistical techniques such as correlation and reliability tests. The screening involved reverse coding and checking for missing variables. A total of nine items were reverse coded (DEP4, SOR2, SOR4, SOR5, SOP2, RES1, LEV2, SAT1, SAT2) and no missing values were found. The coded items can be referred in Appendix D. The validation experiment analysed in two parts; construct and predictive validity.

For validity of the construct, the results were analysed for exploratory factor analysis, reliability, and correlation (results are presented in section 8.3.4.1). For predictive validity, the results were further analysed for their distribution according to prediction condition. The results are presented in section 8.3.4.2. The flow to analyse the result is illustrated in Figure 8-2. Starting with the data obtained, screened, construct validity, and predictive validity.

8.3.4.1 Construct Validity

The exploratory factor analysis, utilising principle component analysis (PCA) with *varimax rotation* was conducted to examine the interrelationships and patterns among the TAGS items. The reliability test, a Cronbach's α, is conducted in order to confirm the internal consistency of the measuring items in a component. The Pearson's correlation coefficient (*r*) is one of the correlation analyses conducted to measure the strength of a relationship between two or more factors, components, or items in the TAGS instrument. The factor, correlation and reliability tests are conducted for all components except for the first one, the Anthropomorphic Interface Design (AID), because, the AID only has one item and thus, conducting a factor, correlation and reliability test is irrelevant.

8.3.4.1.1 Exploratory Factor Analysis (EFA)

The results were analysed for exploratory factor analysis, using a method of Principal Component Analysis (PCA). For conducting the exploratory factor analysis, generally the analyses follow the criteria recommended by Hair et al., (2009);

1) Keiser-Meyer-Olkin (KMO) for measuring sampling adequacy value must be above .50
2) The result of the Bartlett's test of sphericity should be significant at .05 to indicate a sufficient correlations among variables.
3) Communalities of variable has to be more than .50.
4) The percentage of variance criterion is usually 50% and above to indicate the goodness of fit of a propose factor/component.
5) The factor loadings of .45 or above for each item are considered practical for 150 of sample data, with cross-loaded not higher than .30.

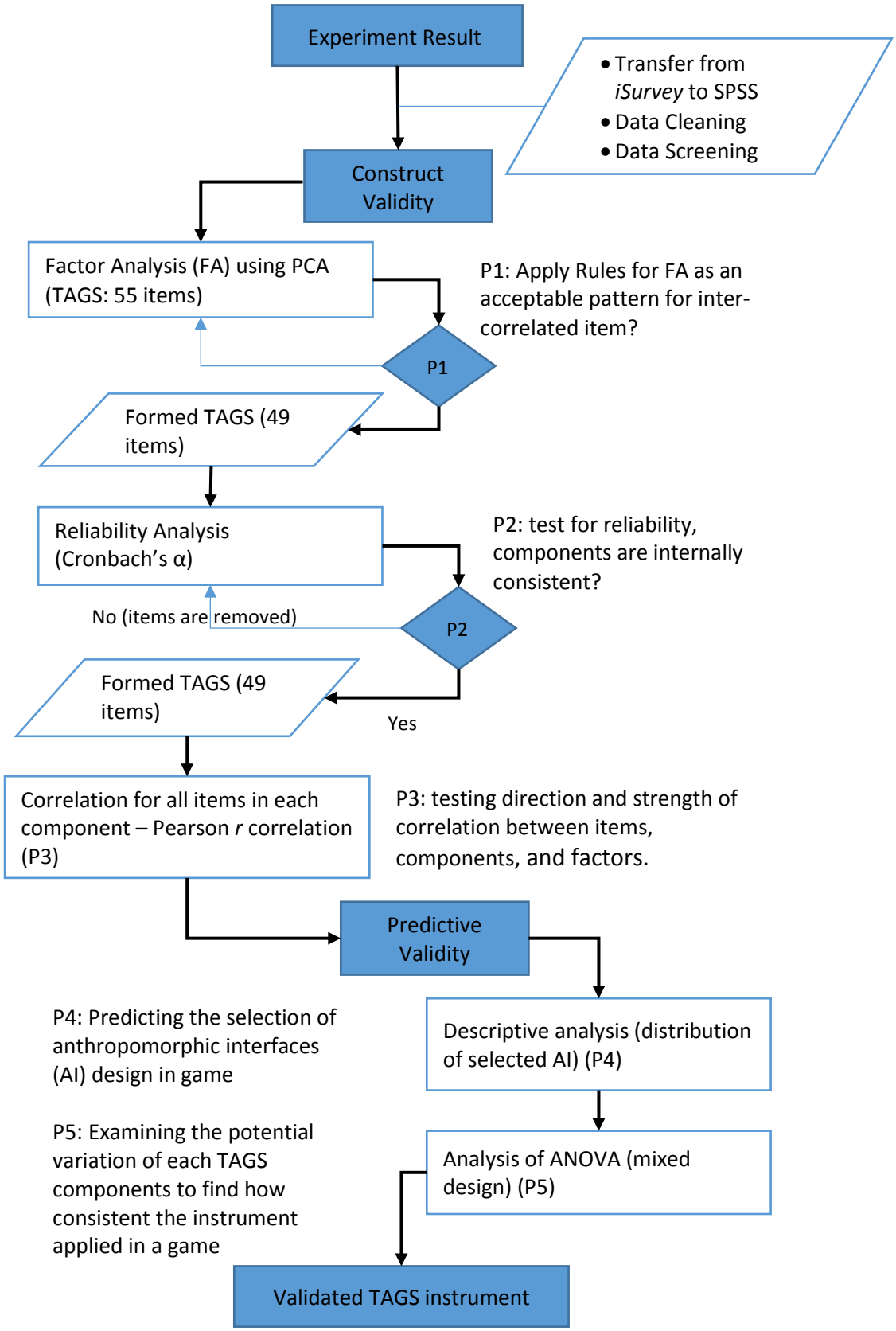


Figure 8-2 The flow diagram analysing the results of the validation test

i. Factor Analysis of Anthropomorphic Elements

The initial run of factor analysis on 17 items of anthropomorphic elements produced four components with eigenvalues above one. The result showed;

- The KMO value is .76 and the Bartlett test of sphericity is significant (< 0.05).
- The communalities of 17 items ranged from .27 (DEP3) to .73 (DEP4).
- The eigenvalues explained 55.90% of the total variance.
- Three items achieved communalities below .50; DEP1 (.34), DEP3 (.27), SOR4 (.47).
- One item has a factor loading of less than .45 (DEP1, .39).

However, the factor loading and communality are not too low and considered acceptable. According to Hair et al., (2009), items that have a low communality should be retained if they contribute to a well-defined factor.

Four notable items have loaded on two different components; DEP1, DEP2, SOR1, and SOR2. A cross loaded item indicates that the items might have unclear meaning which lead to confusion (Hair et al., 2009). In this situation, as the items have thoroughly been defined in the development phase, the decision to remove or retain will refer the TAGS pool document. The document can be found in Appendix A. For item DEP1 – *Customize own character*, the item is cross-loaded higher in component 4 (Design Purpose) than in component 1 (Social Presence). Item DEP 2 – *Customize my character's environment*, is cross-loaded higher in component 1 (Social Presence) than in component 4 (Design Purpose). When referring to the TAGS pool document in Appendix A, these two items are important to indicate the personalisation of anthropomorphic interface in a game. Removing them would affect the content validity and might undermine the concept being measured. These items were retained. To retain the items (DEP1 and DEP2), they were re-arranged into the same group (in component 4 – Design Purpose) as identified earlier in the TAGS pool document.

For item SOR2 – *Cheering after completing a given task*, and item SOR1 - *Instructions using vocal and text*, they are cross-loaded on component 3 (Social Response) and 4 (Design Purpose). Although they were cross-loaded, they were also group together with the same items as defined in the TAGS pool document. The loaded value also shows that the items were measured the same related construct. Deleting them could affect the content validity. Thus, the items (SOR1 and SOR2) were retained. The results of the factor analysis are presented in Table 8-5. The components for anthropomorphic elements labelled the same way as in the TAGS pool document.

Table 8-5 Factor Analysis of Anthropomorphic Elements

Items		Communalities	Component 1	2	3	4
Component 1: Social Presence (SOP)						
SOP3	Choosing the character's body shape	.681	.792			
SOP1	Choosing a gender for a character	.640	.780			
SOP2	Changing the character's skin colour	.641	.771			
SOP4	Modify the character's body shape	.550	.677			
Component 2: Accessibility (ACC)						
ACC4	Ability to adjust speech volume	.652		.776		
ACC3	Ability to change the game's background	.621		.769		
ACC2	Ability to change between spoken and text	.600		.765		
ACC1	Ability to adjust the character's text speech	.564		.704		
Component 3: Social Response (SOR)						
SOR5	Making eye contact while talking	.604			.753	
SOR2	*Cheering after completing a given task*	*.577*			*.637*	*.399*
SOR3	Making gesture while talking	*.508*			.630	
SOR4	Ease of controlling character	.467			.617	
SOR1	*Instructions using vocal and text*	*.528*			*.617*	*.401*
Component 4: Design Purpose						
DEP4	Upgrade character to be more powerful	.727				.833
DEP2	*Customize character's environment*	*.533*	*.521*			*.501*
DEP3	Tactic to confuse other characters	.274				.472
DEP1	*Customize own character*	*.336*	*.354*			*.393*
Eigenvalue			4.13	2.35	1.72	1.31
% of Variance			24.27	13.82	10.10	7.72
Total Variance Explained		55.90%				
KMO		.763				
Barlett's Test of Sphericity		727.80				
Significant		.000				

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 7 iterations.

ii. Factor Analysis of Gamification

The first factor analysis conducted on 12 items of gamification produced three components with eigenvalues above one. The KMO value is .67 and the *Bartlett test of sphericity* is significant, < 0.05. Two items were removed; RES4 and LEB1. The item RES4 - *Increasing character's power*, was removed because the item was statistically not significant. It was loaded below .45 and achieved very low communality (.13). Based on the TAGS pool document, item RES4 measures a metric for the implementation of points in a gamified application. Item RES1 and RES5 also refer to the same metric. Thus, removing one would not affect the validity of the content being measured. Item LEB1 - *Recognizing skills and effort*, was removed because it was cross-loaded negatively on another component. When referring to the TAGS pool document, there are other items that also measure the same Leaderboards metric. Thus, deleting one of them would not undermine the

content being measured. The details of this exercise can be referred to in Appendix F.2. After items were removed, the factor analysis was run again.

The second run of the factor analysis extracted three components with eigenvalues greater than 1. The KMO value is the same (.67) and the *Bartlett test of sphericity* is significant, < 0.05. The total variance increased from 53% to 59.37%. The communalities of ten items improved and they ranged from .429 (LEB3) to .803 (RES2). There are two items that have communalities slightly below .50; LEB3 (.429), and LEB4 (.487). These communality values are still considered acceptable. All items have a factor loading of more than .45, and one item, the LEV1 was cross-loaded on components 2 and 3. Cross-loaded items are not recommended. However, if item LEV1 is deleted, the KMO value and the percentage of variance will substantially decrease. Deleting item LEV1 may not be necessary. Moreover, based on the TAGS pool document, item LEV1 - *Complete a level and allow to continue*, is measuring the element of levels in gamified applications. The item is important and deleting it may affect the content being measured. Therefore, the item is retained.

Based on the second run of factor analysis, the results are accepted as final. This is because they are loaded significantly on three components as conceptualized. Details of the results are presented in Table 8-6. The gamification factor consist of ten items. The components for gamification are labelled the same way as in the TAGS pool document.

Table 8-6 Factor Analysis of Gamification

Items		Communalities	Component 1	2	3
Component 1: Reward System (RES)					
RES2	Receiving a badge	.803	.883		
RES3	Receiving a trophy	.760	.851		
RES1	Intention buying additional points	.503	.701		
RES5	Exchanging points for others	.319	.525		
Component 2: Leaderboard (LEB)					
LEB2	Increase competition among users	.547		.721	
LEB4	Character's appearance in a Leaderboard	.487		.676	
LEB3	Position in a Leaderboard	.429		.650	
Component 3: Levels (LEV)					
LEV2	Character's appearance within level	.751			.865
LEV3	Gaining more power when progressing to the next level	.713			.829
LEV1	*Complete a level and allow to continue*	*.624*		*.650*	*.417*
Eigenvalue			2.84	1.71	1.39
% of Variance			28.35	17.11	13.90
Total Variance Explained		59.37%			
KMO		.668			
Barlett's Test of Sphericity		364.32			
Significant		.000			

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 5 iterations.

iii. Factor Analysis of Motivation

The initial run of factor analysis conducted on 15 items was extracted into four components. The results shows that the KMO value is .63 and the *Bartlett test of sphericity* is significant, < 0.05. The total variance explained is equal to 56.03%. Details of the results can be referred to Appendix F.3. Two items were removed; REL3 - *Objectivity of the other characters,* and CON1 - *Able to choose mini apps*. They were removed because they were cross-loaded into two components and the loading values were relatively high. When referring to the TAGS pool document, there are other items in the same component that measure the same metrics. Thus, deleting these two items would not affect the content being measured. After removing them, the factor analysis was run again.

The second run of factor analysis on 13 items was also extracted into four components. The KMO value is .64 and the *Bartlett test of sphericity* is significant, < 0.05. The total variance explained is equal to 58.06%. The communalities ranged from .431(ATT2) to .722(REL1) with three items having communalities slightly below .50; ATT2 (.431), REL2 (.498), REL4 (.493). No items had factor loadings at less than .45, and only one item, item SAT4 – *Like to use the application again*, was cross-loaded in components 1 (Satisfaction) and 3 (Relevance). However, the cross-loaded value is very low and thus, item SAT4 is retained. The results from second run of factor analysis shows that they are practically acceptable and statistically significant. Details of the results are presented in Table 8-7. The components for motivation are labelled the same way as in the TAGS pool document.

Table 8-7 Factor Analysis of Motivation

			Component			
Items		Communalities	1	2	3	4
Component 1: Satisfaction (SAT)						
SAT1	Hints come up when getting lost	.690	.774			
SAT3	Skills acknowledgement from application	.596	.726			
SAT2	Receiving Feedback is encouragement	.525	.716			
SAT4	Like to use the application again	.607	.709		.302	
Component 2: Confidence (CON)						
CON2	Chosen character increase confidence	.610		.776		
CON3	Giving feedback on character's performance	.568		.742		
CON4	Enhanced knowledge through similar tasks	.521		.680		
Component 3: Relevance (REL)						
REL1	Provided with appropriate choices	.722			.808	
REL2	Character is relevant	.498			.677	
REL4	Getting familiar with the graphics	.493			.605	
Component 4: Attention (ATT)						
ATT3	Random elements in the applications	.694				.813
ATT1	Excited when successfully performs a task	.593				.687
ATT2	Supported by the help functions	.431				.543

Eigenvalue		2.78	2.33	1.38	1.06
% of Variance		21.36	17.90	10.63	8.18
Total Variance Explained	58.06%				
KMO	.643				
Barlett's Test of Sphericity	409.38				
Significant	.000				

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 5 iterations.

iv. Factor Analysis of Transitional Healthcare

The first factor analysis conducted on 10 items of transitional health produced three components with eigenvalues above one, the KMO value is .76, and the *Bartlett test of sphericity* is significant, < 0.05. The total variance explained is equal to 63.03%. Two items were removed; SEM1 – *Reminder to do certain task*, and HEC1 – *Type of illness shows in the application*. Item SEM1 was removed because the factor loading was below .45, its communalities was low (.296), and it was cross-loaded in components 1 and 3. Item HEC1 was removed because it was cross-loaded in all components. Details of this exercise can be referred to in Appendix F.4.

Factor analysis was conducted again for 8 items of transitional health. The analysis extracted three components with eigenvalues above one, which explained 69.89% of the total variance. The KMO value is .71, and the *Bartlett test of sphericity* was significant, < 0.05. All items achieved communalities above .50, ranging from .625 (SEM3) to .775 (HEC3). All items also had factor loadings of more than .45. These results show that they are statistically significant. The items were group as conceptualized and the components are labelled the same way as in the TAGS pool document. Details of the results are presented in Table 8-8.

Table 8-8 Factor Analysis of Transition Health

			Component		
Items		Communalities	1	2	3
Component 1: Stage of Transition (SOT)					
SOT1	A series of health related tasks form in stages	.715	.835		
SOT3	Doing the same range of health task in every stage	.700	.818		
SOT2	Appearance of character in every stage	.665	.801		
Component 2: Self-Management (SEM)					
SEM2	Ability to set health routine	.689		.817	
SEM4	Recognize character's recovery	.679		.793	
SEM3	Ability to organize health goals	.625		.780	
Component 3: Health Condition (HEC)					
HEC3	Health condition appear in the character	.775			.873
HEC2	Tasks are related to the illnesses	.743			.837
Eigenvalue			2.77	1.57	1.25
% of Variance			34.66	19.57	15.67
Total Variance Explained		69.89%			
KMO		.705			
Barlett's Test of Sphericity		294.73			

Significant	.000

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 4 iterations.

8.3.4.1.2 Reliability Test

The reliability test was performed to determine whether the generated components from factor analysis and its group of items are internally consistent in measuring the underlying construct of the TAGS. For this, the Cronbach's alpha was calculated for each component and the results are presented in Table 8-9. The Cronbach's alpha varied between 0.50 (the lowest) for the Leaderboard component and 0.83 (the highest) for the social presence component. All components indicated that they have a good reliability, thus implying that they are measuring the same content. Overall, the total reliability for 15 components had a good internal consistency with Cronbach's alpha equal to 0.74.

Table 8-9 Reliability Test for TAGS

Factors	Components	Number of Items	Cronbach's α
Anthropomorphic Elements	*Anthropomorphic Interface Design (AID)*	1	.999
	Design Purpose (DEP)	4	.521
	Social Response (SOR)	5	.707
	Social Presence (SOP)	4	.830
	Accessibility (ACC)	4	.779
Gamification	*Reward Systems (RES)*	4	.737
	Leaderboard (LEB)	3	.499
	Levels (LEV)	3	.647
Motivation	*Attention (ATT)*	3	.546
	Relevance (REL)	3	.594
	Confidence (CON)	3	.620
	Satisfaction (SAT)	4	.726
Transition Health	*Stage of Transition (SOT)*	3	.773
	Health Condition (HEC)	2	.690
	Self-Management (SEM)	3	.734
Total	15	49	

8.3.4.1.3 Correlations

Correlation analysis was performed to indicate the direction and strength of relationships between all of the items and all of the components in the TAGS. The following is the correlation of components in each factor.

1) Correlations for Anthropomorphic Elements;

The correlation results are presented in Table 8-10. The results show that there is;

- A moderate significant correlation exists between the design purpose (DEP) and social presence (SOP) (r (4) = .38, p < .01), and between the social presence (SOP) and accessibility (ACC) (r (4) = .36, p < .01).
- A weak correlation exists between the design purpose (DEP) and social response (SOR) (r (4) = .29, p < .01), and between the social presence (SOP) and social response (SOR) (r (4) = .22, p < .01).

Table 8-10 Correlation for the Anthropomorphic Elements factor

Components	***1***	***2***	***3***	***4***
1. Design Purpose (DEP)	-	.28**	.38**	.15
2. Social Response (SOR)		-	.22**	.06
3. Social Presence (SOP)			-	.36**
4. Accessibility (ACC)				-

**. Correlation is significant at the 0.01 level (2-tailed).

2) Correlations for Gamification;

The correlation results for the gamification factor are shown in Table 8-11. The results show that the reward systems (RES) has a weak correlation with levels (LEV) (r (3) = .24, p < .01), and the Leaderboard (LEB) is moderately correlated with level (LEV), r (3) = .32, p < .01.

Table 8-11 Correlation for the Gamification factor

Components	***1***	***2***	***3***
1. Reward Systems (RES)	-	.13	.24**
2. Leaderboard (LEB)		-	.32**
3. Level (L)			-

**. Correlation is significant at the 0.01 level (2-tailed).

3) Correlations for Motivation;

The component of attention (ATT) is moderately correlated with relevance (REL), r (4) = .40, p < .01; and weakly correlated with confidence (CON), r (4) = .24, p < .01. The component of

relevance (REL) is significantly has a moderate correlation with confidence (CON), *r* (4) = .30, *p* < .01. The results are shown in Table 8-12.

Table 8-12 Correlation for the Motivation factor

Components	***1***	***2***	***3***	***4***
1. Attention (ATT)	-	.40**	.24**	-.05
2. Relevance (REL)		-	.30**	.04
3. Confidence (CON)			-	.07
4. Satisfaction (SAT)				-

**. Correlation is significant at the 0.01 level (2-tailed).

4) Correlations for Transition Health;

For the transition health factor (refer Table 8-13), all the components are consistently correlated to each other. The stage of transition (SAT) is significantly has weak correlation with health conditions (HEC), *r* (3) = .26, *p* < .01, and with the self-management (SEM), *r* (3) = .22, *p* < .01. The health condition (HEC) is significantly has a weak correlation with self-management (SEM), *r* (3) = .24, *p* < .01.

Table 8-13 Correlation for the Transition factor

Components	***1***	***2***	***3***
1. Stage of Transition (SOT)	-	.26**	.22**
2. Health Condition (HEC)		-	.24**
3. Self-Management (SEM)			-

**. Correlation is significant at the 0.01 level (2-tailed).

5) Overall factor to factor correlation;

The anthropomorphic elements have a direct significant correlation with motivation (r (4) = .20, p < .05), and have indirect significant correlations with transitional health (r (4) = .31, p < .01). The gamification has a direct significant correlation with motivation (r (4) = .26, p < .01). Basically, the indirect correlation means that an increase in transitional health is associated with a decrease in anthropomorphic elements. Based on the instrument, this correlation indicates that the anthropomorphic elements have not been fully applied in the transitional healthcare application.

There is no statistical correlation between gamification and the transition health factor (r (4) = .14), between motivation and transition health (r (4) = .08), and between anthropomorphic elements and gamification (r (4) = .01). These results are presented in Table 8-14.

Table 8-14 Correlations between factors of TAGS

Components	*1*	*2*	*3*	*4*
1. Anthropomorphic Elements	-	.01	.20*	-.31**
2. Gamification		-	.26**	.14
3. Motivation			-	.08
4. Transition Health				-

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

8.3.4.2 Predictive Validity

The predictive validity validation was employed to see how the instrument could be operationalized in making a prediction. In this study, the validation was performed to examine;

1) The prediction of anthropomorphic interface design in games,
2) The prediction of each component of the TAGS associated with games.

These predictions are presented in the following sections.

8.3.4.2.1 The Prediction of Anthropomorphic Interface Design

Different types of anthropomorphic interfaces are applied in gamified applications. The participants are expected to be able to differentiate the anthropomorphic design according to the anthropomorphic design scale in the TAGS. In the TAGS instrument, participants were asked to select one type of anthropomorphic interface design which they believed suits its role and design with the game they were played. There are five type of anthropomorphic interfaces; 1) Avatar, 2) Human Cartoon, 3) Interface Agent, 4) Hybrid Character, 5) Abstract character. It was predicted that participants would select;

- an avatar for a more humanlike representation of anthropomorphic interface;
- a human cartoon for an anthropomorphic interface that designed as less humanlike and more like a caricature;
- an interface agent for an anthropomorphic interface that designed as a mix between human and animal;
- a hybrid character for an anthropomorphic interface that is designed like an animal character or object; and
- an abstract character for an anthropomorphic interface that is designed in a non-figurative character.

The participants' opinions of each type of anthropomorphic interface are matched with the known anthropomorphic interfaces design. The known type of anthropomorphic interfaces for;

1) the Monster Manor game is the human cartoon,

2) the Club Penguin game is the interface agent.

A descriptive analysis was conducted to find the distribution of each selected anthropomorphic interface type on each game.

For the Monster Manor, the most commonly selected anthropomorphic interface in the game was the human cartoon (N = 31, 41.3%), followed by the interface agent (N = 22, 29.3%), and the hybrid character (N = 10, 13.4%). Both the abstract character and avatar were selected with N = 6 (8.0%).

For the Club Penguin, the most commonly selected anthropomorphic interface in the game was interface agent (N = 36, 48.0%), followed by hybrid character (N = 31, 41.3%), very few selected the human cartoon (N = 4, 5.3%) and abstract character (N = 4, 5.3%), and not one person selected the anthropomorphic interface of the avatar. These results are presented in Table 8-15.

Table 8-15 Anthropomorphic Interface Design * Title Game Cross tabulation

	Title Game	
Anthropomorphic Interface Design	Monster Manor (N / % within game)	Club Penguin (N / % within game)
Abstract Character (non-figurative character)	6 (8.0%)	4 (5.3%)
Hybrid Character (animal character or an object)	10 (13.4%)	31 (41.3%)
Interface Agent (Mix between human and animal)	22 (29.3%)	36 (48.0%)
Human Cartoon (Less human-like and more caricature-like)	31 (41.3%)	4 (5.3%)
Avatar (More human-like representation)	6 (8.0%)	0 (0.0%)
Total	75 (100.0%)	75 (100.0%)

8.3.4.2.2 The Prediction of the Transitional Anthropomorphic Gamification Scale in Games

Different games are expected to bring out different transitional anthropomorphic gamification features. Examining the potential variation of each TAGS component would show how consistent the instrument applied in a game. For example, a health-related game may elicit greater transition health component than a general game. This is because, more health functions are provided in a health related game than in a general game. In comparison, a general game played for fun may or may not elicit a higher motivational component than a health-related game.

To examine this possibility, further analysis to investigate the patterns of agreement among the participants on the TAGS was conducted. Repeated measure mixed design ANOVA was conducted to test the participant's interaction effect, based on the participant's score (5 – strongly agree to 1 – strongly disagree) on two games used in the experiment (general game: Club

Penguin, and health related game: Monster Manor). In addition, the data was analysed for descriptive statistics, calculated means and standard deviation (SD) for each factor and component in the TAGS according to the type of the game.

i. Analysis of ANOVA

Data were analysed using mixed design ANOVA with within-subject factors of types of games (Monster Manor, Club Penguin) and between-subject factors of TAGS (Anthropomorphic Elements, Gamification, Motivation, Transition Health). Mauchly's test indicated that the assumption of *sphericity* had been violated, F (χ^2 = 35.4, p < .001), therefore degrees of freedom were corrected using *Greenhouse-Geisser* (ε = 0.761). Table 8-16 details the result.

Table 8-16 Mauchly's Test of Sphericity

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
TAGS Components	.785	35.45	5	< .001	.761	.783	.333

A repeated measures mixed design ANOVA with *Greenhouse-Geisser* correction in Table 8-17 showed that the TAGS components in games differed significantly between the two games [F (2.58, 382.08) = 60.90, p < .001]. This indicates that participants' responses to anthropomorphic gamification for transitional health were different between the two games. The results in Table 8-18 show that there was a statistically significant effect between the two types of games rated by participants on TAGS, F(1, 148) = 6.83, p = .010.

The post-hoc test using the *Benferroni* correction revealed that there was a statistically significant effect between all factors of the TAGS (p < .05). This shows that the TAGS rated in the Club Penguin game were differently rated in Monster Manor game. Refer to Table 8-19 for full results.

Table 8-17 Mixed design ANOVA - Tests of Within-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Factors	188.41	2.58	72.98	766.89	< .001
Factors * Game	14.96	2.58	5.79	60.90	< .001
Error (Factors)	36.36	382.08	.09		

Table 8-18 Mixed design ANOVA - Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Type of Game	.83	1	.83	6.83	.010
Error	18.04	148	.12		

Table 8-19 Post-hoc comparisons for four factors

(I) Factors	(J) Factors	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-.662*	.031	<.001	-.745	-.580
	3	-.588*	.026	<.001	-.658	-.518
	4	.734*	.039	<.001	.630	.837
2	1	.662*	.031	<.001	.580	.745
	3	.074*	.028	.048	.000	.148
	4	1.396*	.037	<.001	1.297	1.495
3	1	.588*	.026	<.001	.518	.658
	2	-.074*	.028	.048	-.148	.000
	4	1.322*	.036	<.001	1.226	1.417
4	1	-.734*	.039	<.001	-.837	-.630
	2	-1.396*	.037	<.001	-1.495	-1.297
	3	-1.322*	.036	<.001	-1.417	-1.226

Based on estimated marginal means
*. The mean difference is significant at the .05 level.
b. Adjustment for multiple comparisons: Bonferroni.

ii. Descriptive Analysis

The mean and SD will show the game score distributions rated by the participants. The distributions are calculated for each TAGS component. The results indicate that;

- The gamification components have the highest mean for both game; Monster Manor (M = 3.95, SD = .30) and Club Penguin (M = 3.93, SD = .29). The components of transition health had the lowest mean for both games as well; Monster Manor (M = 2.69, SD = .34) and Club Penguin (M = 2.40, SD = .43)
- The anthropomorphic elements are rated higher for the Club Penguin game (M = 3.57, SD = .24) than the Monster Manor game (M = 2.99, SD = .27).
- The motivation components are rated about the same for both games; the Club Penguin game (M = 3.85, SD = .29) and the Monster Manor game (M = 3.89, SD = .22).

The results of the mean differences of the TAGS factors for each of the games are presented in Table 8-20 and illustrated in Figure 8-3. As illustrated in Figure 8-3, it clearly shows the mean scores discriminate between the two games. This indicates that the game do not implement all four factors of the TAG framework for the use of anthropomorphic interfaces in the gamified application for transitional healthcare. Thus, the four factors for designing a transitional health game are not balanced in practice. A balanced design for the application of anthropomorphic interfaces in a gamified application for transitional healthcare should have a similar mean for all of the TAG factors.

Table 8-20 Mean differences for TAGS component among the games

Factors	Games	
	Monster Manor Mean (SD)	Club Penguin Mean (SD)
Anthropomorphic Elements	2.99 (0.27)	3.57 (0.24)
Gamification	3.95 (0.30)	3.93 (0.29)
Motivation	3.85 (0.29)	3.89 (0.22)
Transition Health	2.69 (0.34)	2.40 (0.43)

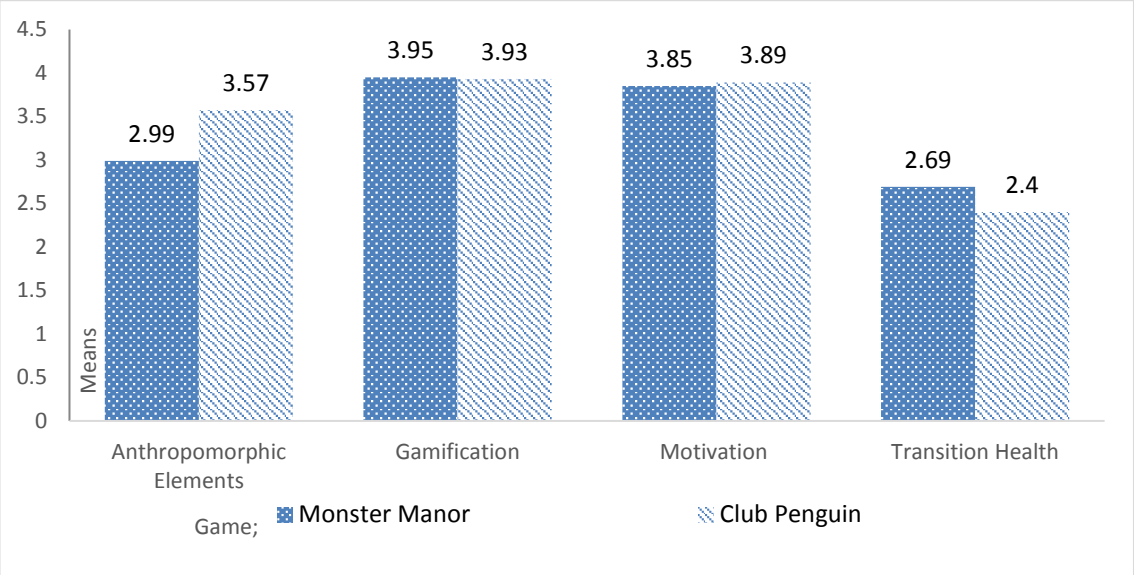


Figure 8-3 Profile plot of the differences of means of the responses of each TAGS components

8.4 Chapter Discussions

The TAG framework confirmed in Chapter 6 has formed the groundwork for developing a new instrument. The instrument is developed to measure the applicability of anthropomorphic interfaces in a gamified application in facilitating the users to acquire knowledge of his/her condition towards self-management. The process of developing the new instrument was described in Chapter 7.1. As the new instrument was developed, it had to be validated to ensure that the instrument met its purpose. Three tests were conducted to evaluate the validity and reliability of the instrument and these tests were explained in detail in sections 8.1 - 8.3. The outcome of these three tests found the TAGS instrument to be reliable and valid. Therefore, results obtained from all the tests are discussed in this section.

8.4.1 The validation process

The content validity results presented in Table 8-1 show the CVR for each of the items and components in an instrument. On a scale of 0 – 1, the CVR has to be more than .50. This to

indicate that more than 50% of the evaluator (expert) has agreed with the suitability of the item and its importance to the instrument (Ayre & Scally, 2014). Thus, the instrument consisted of 15 components and 71 significant items each having an appropriate level of content validity. This means, the TAGS instrument is logically measuring the same related concept.

The validation of the instrument was conducted with the validation experiment (refer to Figure 8-1 for Step 2). The preliminary data analysis shows that the items were internally consistent. The results from the pre-test were used as references to predict the significance of the items in the instrument. Thus, helping to improve the validity of the instrument. For that, items that are not correlated to the component and to the instrument as a whole, are removed. Applying the recommended acceptable level of item reliability, Cronbach's $\alpha > .60$, the results in Table 8-4 show that all 15 components are reliable and out of the 70 items in the instrument, only 55 items remained.

After the pre-test, a validation test was conducted to examine the construct and predictive validity of a newly created instrument. Data obtained from the experiment were first analysed for factor analysis, reliability, and correlation (see discussion in sections 8.4.2-8.4.4). Then, the data were analysed descriptively for mean, standard deviation, and percentage (see section 8.4.5).

8.4.2 Factor Structure

The factor analysis was conducted based on the four factor structure in the TAGS; 1) anthropomorphic elements, 2) gamification, 3) motivation, and 4) transition health.

Factor 1 – Anthropomorphic Elements;

The factor extracted 4 components and 17 items. They corresponded to the TAG framework. However, two items in component 4 (DEP1 and DEP2), and two items in component 3 (SOR2 and SOR1) were not statistically supported but remained in the instrument.

Item DEP2 – Customize character's environment, and DEP1 – Customize own character, are indicated for the customization function in a gamified application. Ability to customize own self representation and environment in the game will promote motivation (Barata et al., 2013; Baylor, 2009), engagement and immersion (Wiebe et al., 2014), and support behaviour change (S. Y. Kim, Prestopnik, & Biocca, 2014). Measuring to which purpose the anthropomorphic interface design is applied, will reflect the factor of the anthropomorphic element in the TAG framework (see Chapter 4.4). Item SOR1 - *Instructions using vocal and text* and SOR2 - *Cheering after completing a given task*, indicate the characteristics of anthropomorphic interface design. Voice or speech characteristics of anthropomorphic interfaces affects the users perceptions and how users interact with them (Lee, 2010; Sah & Peng, 2015). Similarly, a positive encouragement from

anthropomorphic interfaces would increase users' motivation and engagement (Mumm & Mutlu, 2011). According to the TAGS framework, these items are part of the anthropomorphic characteristics being measured in the TAGS instrument.

In this research, the insignificance of results may be due to inconsistency of customization and vocal functionality between the two testing games. However, as the items are theoretically important, they remained in the TAGS instrument. The final components in this factor are Social Presence (SOP), Accessibility (ACC), Social Response (SOR), and Design Purpose (DEP).

Factor 2 - Gamification;

From 12 items, the factor extracted three components. All component are consistent and match with the TAG framework. Two items from the initial scale were removed. This was because the items were not statistically supported in terms of low communality, factor loading below .45 and negatively cross loaded in other component. There is one item, the LEV1 - *Complete a level and allow to continue*, that is also statistically insignificant but remained in the TAGS instrument. The element of levels in the game were previously measured for its effect towards user's performance or motivation (Barata et al., 2013; Mekler et al., 2013). However, in TAGS, levels measures the extent of how it should be implemented in a gamified application.

Based on the results, item LEV1 is structured under component 2 (Leaderboard). Dissimilar with the initial construction, item LEV1 is created under component 3 (Level). In a Leaderboard, levels could be used to show player's rank, or status, or progress. But in the TAGS, this item does not refer to the levels in the Leaderboard. The item indicates if a game allows users to continue to the next level, stop at the current level, and/or return to the previous level. For that reason, item LEV1 should be placed under component 3 (Levels) instead of component 2 (Leaderboard). Thus, the item is restructured into its initial component.

After two insignificant items were removed, the remaining 10 items were structured into three components as conceptualized; Reward System (RES), Leaderboard (LEB), and Levels (LEV).

Factor 3 - Motivation;

Four components were extracted; Attention (ATT), Relevance (REL), Confidence (CON), and Satisfaction (SAT). Two items were removed due to insignificance. After the insignificant items were removed, all other items in motivational factors were structured as conceptualized in the TAGS instrument. The retained items in all components were relatively valid. However, item SAT4 - *I Like to use the application again*, was not significant but it remained in the instrument. The insignificance of results of this item SAT4 may be because of low correlation between items. Item

SAT4, is meant to measure outcome, which is one of the indications for satisfaction (refer Table 7-2). Thus, retaining the items was deemed necessary.

Factor 4 – Transition Health;

Three components were extracted; SOT, HEC, and SEM. Initially, the factors consisted of 10 items. However, two items were removed due to insignificance. All of the remaining items were relatively valid and they were matched with the conceptualized TAGS instrument.

8.4.3 Reliability Analysis

Following Hair, Anderson, Tatham, & Black (2009) and Sekaran (2013), acceptable reliabilities suggested to be more than .60. The reliability analysis of overall TAGS components provides evidence that the instruments are internally consistent. Among 14 components, 10 components have a Cronbach's alpha of over .60. Although the other four components have a Cronbach's alpha below .60 (between .50 and .59), they are still within the range of acceptable level of reliability which is typically considered reasonable. There is one component, the Anthropomorphic Interface Design (AID) that is considered valid by default. This is because the component has only one measurement item. This item was identified carefully, using the GQM approach with the TAG framework as reference. Conducting statistical tests for one item, was not necessary.

8.4.4 Relationships among the Factors

The relationships between the TAGS factors do not suggest strong model. There is a weak relationship between the anthropomorphic and motivation element, and between the gamification and motivation elements. However, the relationships between gamification and motivation support the aims of gamification that are designed for motivation (R. Brewer et al., 2013; Deterding, 2012; Kuramoto et al., 2013). Also, as anthropomorphic interfaces are associated with motivations, this provides further evidence advocating that the design and characteristics of anthropomorphic interfaces have an impact on users' motivation (Baylor, 2009; Rebolledo-Mendez, Burden, & De Freitas, 2008; Schmeil & Suggs, 2014). There is also a moderate correlation between anthropomorphic elements and transition health. This relationship supports the research argument for the TAG framework (see Chapter 6.3 in confirming the TAG framework), where implementing anthropomorphic interfaces in transitional health applications could help to increase people's motivation in a transitional health process. However, based on the results, they are not sufficient to suggest a model for TAGS. Thus, each of the factors is considered to independently measure the underlying concept of the TAG framework. As a whole, the correlation results between factors are illustrated in Figure 8-4.

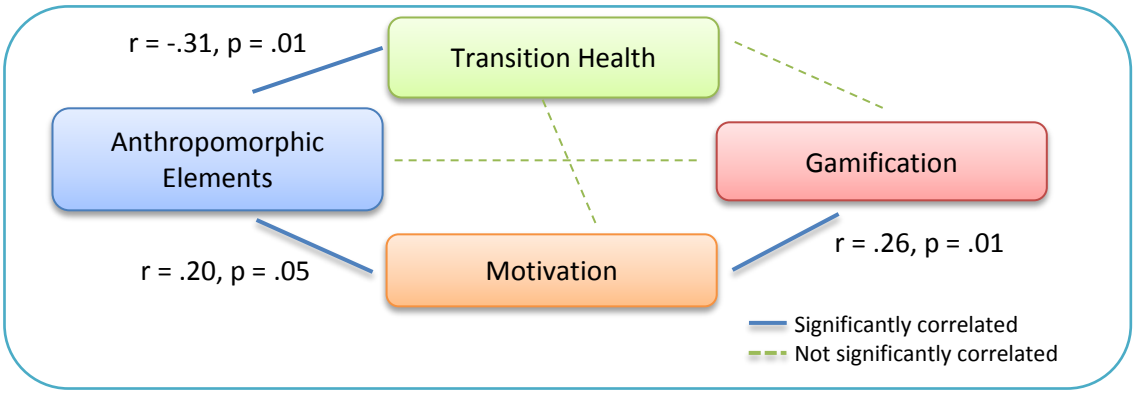


Figure 8-4 Correlation between Factors

The correlations between components in a factor are varied. The strength of the correlation, either significantly indirect or direct, and the insignificant correlation may be due to the availability or unavailability of functions in the tested game. As none of the games in the market are related to transitional care, the experiment employs the games that more or less could have the future functions of transitional care application; The Club Penguin and Pirate101 (general game), Monster Manor and Remission2 (health related game). The selection of these games was considered acceptable. Even though the games might at least contribute to the cause of the result, analysis from an independent t-test in Table 8-2 indicated that there was no significant effect between the types of games in participants' responses. Thus, limiting the bias existing in the collected data and controlling the risk in validating the instrument.

8.4.5 Validity analysis

Besides the instruments construct validity, the TAGS instrument was also explored for its predictive validity. The predictive validity involved the type of selected anthropomorphic interfaces based on the games and the average scores for each of the TAGS components. The selected anthropomorphic interfaces are matched as predicted for both games. However, for the Club Penguin game, selections of the game character showed only a slight difference between the hybrid character and interface agent. The character of the user in the game is a penguin designed to resemble like a human. Thus, indicating the penguin as interface agent. However, when users generalize the whole character in the game, they might include the pets as well. The pets are designed like objects with human attributes. Thus, influencing the users to interpret the interfaces as a hybrid character. For the Monster Manor game, the users clearly know that the main character is designed as a human cartoon. The results indicated that users can relate the design with the anthropomorphic interfaces scale associated with the TAG framework.

The statistical significance effect based on the mixed design ANOVA (refer Table 8-17) showed that the pattern of participants' scores is different in all factors for both games. According to the

means score in Table 8.20, the anthropomorphic elements scored highly on the Club Penguin game. Gamification and motivation factors were highly convergent for both games, the Club Penguin and Monster Manor. The transition health information is not highly supported in any of the games. This is could be due to none of the available games in the market being suitable for assessing the transition health process. This indicates that the amount of anthropomorphic gamification for transitional health in games is practically more applicable in the Club Penguin game (general game) than in the Monster Manor game (health game).

With the statistically significant results as well, all factors are considered important to support the TAGS instrument application in examining the amount of anthropomorphic gamification for transitional health in games. However, as the TAGS score's pattern is not balanced (refer to Figure 8-3), the current game design practice is not considered sufficient for the implementation of anthropomorphic gamification for transitional health game. Hence, there is a need for design guidelines to balance all the factors.

8.4.6 Final TAGS Instruments

A careful consideration has been made to develop and validate the instrument. The outcome of these research has shown that the TAGS instrument has provided an effective measure of the developed constructs. Which means that the items in the components statistically measured the same related content. The final version of the TAGS instrument is concluded to have a total of 49 items that belonged to 15 components, within the four factors. Of the 15 components;

- One components; the Social Response (SOR) is consisted of five items.
- Five components; Design Purposes (DEP), Social Presence (SOP), Accessibility (ACC), Reward Systems (RES), and Satisfaction (SAT) are consisted of four items each.
- Six components; Leaderboard (LEB), Levels (LEV), Attention (ATT), Relevance (REL), Confidence (CON), Stage of Transaction (SOT), and Self-Management (SEM) are comprised of three items each.
- The Health Condition (HEC) component consist of two items.
- The Anthropomorphic Interface Design (AID) component is composed of one item.

The final TAGS instrument presented in Table 8-21. The table shows all of the items that are associated with the components of the factors in TAG framework. The final item pool consisting of 49 items was established as the TAGS instrument.

Table 8-21 the relation of developed items.

Factor	Component	ID	Items
Anthropomorphic Elements	Anthropomorphic Interface Design (AID)	*AID1*	*Which type of anthropomorphic character best describes my character in the application?*
	Design Purpose (DEP)	*DEP1*	*I can easily customize my own character*
		DEP2	*I can easily customize my character's environment (for example; house, car, office, garden, etc.)*
		DEP3	*I normally use my character as a tactic to confuse other characters or opponents*
		DEP4	*I am allowed to upgrade my character to be more powerful or meaningful as the application progresses*
	Social Response (SOR)	*SOR1*	*I do better when my character gives instructions using vocal instructions, followed by text as the character speaks*
		SOR2	*I find my character cheering me after excellently completing a given task*
		SOR3	*I find my character does not make gestures while talking*
		SOR4	*I find it is hard to control my character, so it does what I want*
		SOR5	*I find it is strange when my character does not make an eye contact while talking*
	Social Presence (SOP)	*SOP1*	*I can easily choose the gender of my character*
		SOP2	*I can easily change my character's skin colour to something other than human skin colour*
		SOP3	*I can easily choose which body shape I want for my character*
		SOP4	*I am allowed to modify the body shape of my character*
	Accessibility (ACC)	*ACC1*	*I can easily adjust the text size of the character's speech*
		ACC2	*I can easily change the character's speech between spoken and text*
		ACC3	*I am able to change the background colour or image of the game's environment*
		ACC4	*I am able to change the speech volume of the character*
Gamification	Reward System	*RES1*	*I do not buy additional points when my current points are not enough to be traded*

	(RES)	*RES2*	*Receiving a badge makes my character look stronger than before*
		RES3	*Receiving a trophy makes my character look fabulous*
		RES4	*I can easily exchange my points/badges/trophies for other things in the applications (for example; life, food, power, dress, shoes, level, etc.)*
	Leaderboard (LEB)	*LEB1*	*I find the Leaderboard can increase the competition among the users in the application*
		LEB2	*Based on my position on the Leaderboard, I feel I have done a great job*
		LEB3	*I find my character looks stronger than the other characters in the Leaderboard*
	Levels (LEV)	*LEV1*	*After completing a level, I am allowed to stop/exit the application, and continue to the next level after returning*
		LEV2	*My character changed when I progressed to the next level*
		LEV3	*My character gained more power when I progressed to the next level*
Motivation	Attention (ATT)	*ATT1*	*I get excited when my character successfully performs a task*
		ATT2	*I feel supported by the help functions or tutorials given in the application*
		ATT3	*I find there are random elements which appear in the application (e.g. surprises, other tasks, additional rewards, bonuses, or new friends joining)*
	Relevance (REL)	*REL1*	*I am being provided with appropriate choices to take action*
		REL2	*I find the design of my character is relevant to the application*
		REL3	*I find the other characters used in the application are in line with the objectives of the application*
	Confidence (CON)	*CON1*	*The character I choose for myself in the application helps to increase my confidence levels*
		CON2	*I find the feedback about my character performance can help me to further understand what must be done in order to improve*

		CON3	*I find that the application provides a similar range of tasks that enable me to master my skills or enhance the knowledge I need*
	Satisfaction (SAT)	*SAT1*	*When I am lost, a pop-up hint comes up*
		SAT2	*Receiving immediate feedback encourage my involvement*
		SAT3	*When I have completed a task, the application acknowledges the level or type of skill I have acquired*
		SAT4	*I enjoyed using the application that I would like to use it again*
Transition Health	Stage of transition (SOT)	*SOT1*	*The application has a series of health related tasks - in the form of stages - in which the difficulty of the tasks will be increased* as *more stages are completed*
		SOT2	*The appearance of my character changed in accordance to the stage*
		SOT3	*My character does the same range of health task in every stage*
	Health Condition (HEC)	*HEC1*	*I find the given tasks are closely related to a specific health problem*
		HEC2	*My health condition can be seen through the appearance of my character*
	Self-Management (SEM)	*SEM1*	*I can easily set my own health routine or add my own care plan in the application (for example; what medication to take, what type of exercise to do, plan for a healthier diet)*
		SEM2	*I am able to organize my health goals in the application (for example; what tasks need to be done, in what order, which tasks are crucial or not)*
		SEM3	*I know how to recover my character from losing their health* *(for example; take time off, get enough supplement (medicine, water, food), or buying more energy)*
Total All items:			49 items

8.5 Chapter Summary

This chapter explained the development and validation of an instrument called the Transitional Anthropomorphic Gamification Scale (TAGS). The instrument aimed to measure how much anthropomorphic gamification applied in games in informing the users about his/her transitional healthcare. The instrument was developed by adopting the Goal-Questions-Metrics (GQM) approach and by referring the TAG framework as a guidance. Initially, fifteen components were defined and a total 80 items were generated.

The developed instrument required validation. To validate, the instrument went through two studies; the content validity and validation experiment. Eight experts were employed in the content validity study to check the English structure and to assess the necessity and suitability of the items. Data obtained from content validity test was analysed using the content validity ratio (CVR). The results of CVR indicated that only 70 items were significant. Following the content validity was a pre-test. The pre-test was conducted with 34 participants involving researchers and system developers. The pre-test was conducted to ensure the appropriateness of the selected games, to develop the instrument, and the settings of experiment. After the pre-test the instrument was revised. From that, 55 items were found to be significant. Next, the validation experiment was conducted.

In the experiment, a sample of 75 participants was employed to evaluate the revised instrument. The data obtained were analysed for factor analysis, its reliability, and correlation. These analyses were conducted to demonstrate that the TAGS instrument has a valid construct. The mean difference of each of the TAGS components further verifies that the applicability of the instrument was as predicted. The results implied that the TAGS was measuring a similar construct. The final instrument of the TAGS consisted of 4 factors, 15 components with 49 items.

Following the validation result, the TAGS instrument can be summarized as a reliable measurement tool, with its metrics proving that the framework can be successfully applied in this context of study. The TAGS instrument is anticipated to be useful in informing the design of anthropomorphic gamification for transitional healthcare. The next chapter demonstrates the development of a guideline. This guideline could be used as reference to develop gamified applications for transitional healthcare. The guideline makes use of the validated TAGS instrument.

Chapter 9: Guidelines for Researchers and Practitioners Designing for a Gamified Application for Transitional Care, Implementing Anthropomorphic Interfaces

This chapter presents a practical guidelines for the design of gamified applications for transitional care in health, implementing the anthropomorphic interfaces. The guidelines are a set of design considerations, which are developed based on the research framework (refer Chapter 6) and the research instrument (refer Chapter 7 and Chapter 8). The guidelines are suggested in order to understand the applicability of the framework. In addition, the outcomes from the assessment of the current game's design in Chapter 8, were not considerably adequate and balanced for the implementation of the anthropomorphic interfaces in gamification for transitional health game when against the TAGS instrument. This has suggested the need to provide guidelines to accommodate the designers and practitioners designing of a transitional care gamified application, implementing anthropomorphic interfaces. Thus, this chapter aims to answer the third research question of this research;

RQ3: What are the applicable guidelines for designing a gamified application for transitional care, implementing an anthropomorphic interface?

In the following section 9.1, the related and available guidelines will be reviewed followed by the development of suitable guidelines for transitional care gamified application in section 9.2. Then, the validation of guidelines employing focus group discussion is presented in section 9.3. Finally, the established guideline is formed in section 9.4.

9.1 The Guideline for Game

Guidelines for software, applications, or game such as those found in Davis, Dautenhahn, Powell, & Nehaniv, 2010; Isbister & Mueller (2015), Paraskevopoulos, Tsekleves, Craig, Whyatt, & Cosmas, (2014), are developed to assist the anticipated users (developers/designers/programmers) with a certain amount of information on how they should develop an application, in their context of study. The information in a guideline contains standard suggestions/advice, which act as a referral to users' actions and decisions.

In previous work by Davis et al. (2010), a guideline was developed based on researchers' collated experiences during the development of a game for autism, called *TouchStory*. The guideline to develop *TouchStory* seems adequate to provide a practical help for researchers or

practitioners in developing similar applications. It was because, the guidelines resulted from direct experiences of teaching and engaging autistic children. Thus, it carefully considered the characteristics and preferences of typical people with autism.

Other guideline research by Isbister & Mueller (2015) was developed based on research and development practice on movement-based games. The guideline was validated and refined through experts' reviews and interviews, which had made this guideline ready and accessible online to be used for designing a movement-based game and movement-based interfaces. Meanwhile, a guideline developed by Paraskevopoulos et al. (2014) provides design guidelines for developing a serious game for the physical therapy of people with Parkinson's Disease (PD). This guideline was developed based on the literature reviews of PDs and games, and outcomes from the pilot testing of PD's games designed. This PD game guideline was tailored to the unique requirement of the physical therapy of PD, which promoted the games for health. Following the guidelines by Davis, Isbister, and Paraskevopoulos, they are informed either by the review of literatures, practices, and experiences in developing a related application, or both. Through literatures and experiences, a guideline is required when there is a need to standardise information or to standardise a practice for a specific context of application.

In this study, the proposed guidelines follow a similar approach. The literature has informed the framework (refer Chapter 6) and instruments (refer Chapter 8), were utilised to develop the guidelines. This guideline aims to provide a design recommendation for the researcher and game designer in developing a transitional health gamified application, implementing anthropomorphic interfaces.

9.2 The development of guidelines

The guidelines were developed in a stepwise approach. First, the main category of the guidelines was extracted from the TAG framework. Second, these categories were synchronised with the element in the TAGS instrument and then, used to identify the sub categories for each category. Finally, the items for each sub-category were generated. These items were elaborated with some examples. The Figure 9-1 illustrates the development steps.

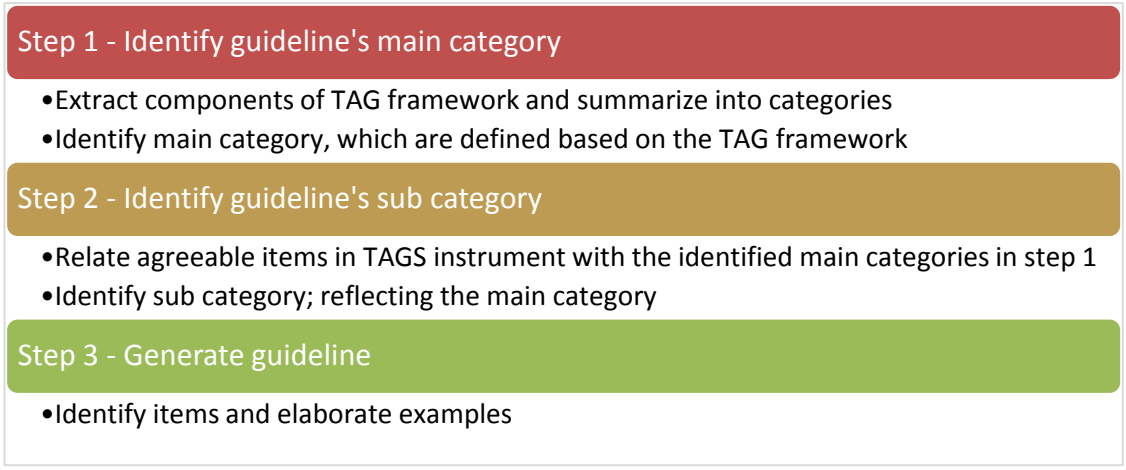


Figure 9-1 the steps involved in developing the guidelines

Following the development steps, the guidelines are comprised of 3 main categories, 9 sub-categories, and 43 items. The structure of the guideline is described in detail in section 9.4.

9.2.1 Identifying the guideline's main category

Taking the TAGS framework as a reference, there are four factors extracted for inclusion in the guidelines; anthropomorphic elements, gamification, motivation, and transition health. Based on these four factors, the purpose and design consideration for developing a transitional health application were analysed and summarized into main categories of the guideline. The summary indicated that the elements of anthropomorphic interfaces in gamification, the motivational effect on transitional health applications, and the elements of transitional applications, should be considered in the guideline. There are three categories being identified.

1) The gamification of anthropomorphic interfaces - is looking at how the elements and designs of anthropomorphic interface are gamified in an application.
2) The transitional application - is about the tasks or functions that are related to the transitional application. The tasks and functions are also related to the anthropomorphic interfaces and the gamified elements.
3) The motivational effect – mainly to connect the elements and designs of anthropomorphic interfaces, the gamified elements, and the transition functions.

The following section 9.2.2, will identify the sub-category for each category comprising the guideline.

9.2.2 Identifying the guideline's sub-category

Following the three main categories identified earlier in section 9.2.1, the TAGS instrument was referred to in order to find any related item that matched the main categories. Then, these related items were used to identify the sub-categories, which provided details of the main

categories. For each of the main categories listed in section 9.2.1, the extracted sub-categories are explained as follows;

9.2.2.1 The category of gamification of anthropomorphic interfaces

The sub-categories extracted from the components of the TAG framework and the items in the TAGS instrument related to these two arguments;

i) How the anthropomorphic interfaces (AIs) are designed and
ii) How the anthropomorphic interfaces (AIs) are gamified.

When referring to the first argument, three elements were considered as the content of the guideline. The elements were; 1) customization of anthropomorphic interfaces, 2) the characteristics of anthropomorphic interfaces, and 3) application accessibility options. When referring to the second argument, the gamification game elements and their implementation on anthropomorphic interfaces were included in the guideline. In Table 9-1 below, each sub-category identified is described in relation to the extracted items.

Table 9-1 Relationship between Identified Categories and Its Sub-Categories for the gamification of anthropomorphic interfaces

Extracted items related to the category	**Identified sub categories**	**Descriptions**
i. How the anthropomorphic interfaces (AIs) are designed	Customizing Anthropomorphic interfaces (AI)	If the application allows customization on the AIs, consider providing customization for the AI's environment as well (for example; house, vehicle) as well.
	Characteristics of Anthropomorphic interfaces	If a designer expects a user to maintain his/her engagement, creating an AI shouldn't be static, or just plain without expression and rigid movement. An animated, lively anthropomorphic interface will arouse the user's excitement and thus, maintain a user's engagement in the application.
	Accessibility options	In any application, accessibility options are important. So that the application is available for different situations such as low internet bandwidth or low computer performance, and usable for a wide range of users such as visually impaired users, or users with a hearing problem. The User Agent Accessibility Guidelines (UAAG) 2.0, (2014) in the W3C's Web Accessibility Initiative (WAI) have listed several guidelines related to an agent based interface. In this guideline, the relation to

		TAG and their suitability for a transitional health gamified application will be emphasized.
ii. How the anthropomorphic interfaces (AIs) are gamified	Create gamified Anthropomorphic interfaces	Anthropomorphic gamification offers excitement. It can welcome challenges for users to be involved, perform, and progress. The design for gamifying an AI depends on which aspect or purposes the AIs are going to be applied to an application. AIs can be customized when users have earned sufficient points or upon completion of a level. The AIs can also be changed, usually into more powerful or more attractive AIs.

9.2.2.2 The category of Transitional Application

Based on the components of the TAG framework and items in the TAGS instrument, the sub-categories extracted for the transitional application related to these two arguments;

i) what constitutes as a transitional application
ii) how transitions can affect the anthropomorphic interface or user's representation

A transitional application should reflect the self-management functions of transition and the transition process criteria to shift users from one stage of health to another. The functions and processes of transition will be more interesting when gamified anthropomorphic interfaces and other game elements are implemented in the application. Table 9-2 presents the relationship between the categories and their identified sub-category, and a description of the category.

Table 9-2 Relationship between Identified Categories and their Sub-Categories for Transitional Application

Extracted items related to the category	**Identified sub categories**	**Descriptions**
i) What constitutes as a transitional application	The health self-management function	Transitional applications involve functions that could help users to self-manage their conditions. These functions should help users to self-manage and change their behaviour.

	Transitional process criteria	The process of transition has several stages to ensure that the user gains the essential knowledge of his/her health condition. Designing mini-apps that related to the users could help them to learn more about their health condition. The mini-apps can be designed by manipulating the game elements and be applied to Anthropomorphic Interfaces.
ii) How transitional health can affect the Anthropomorphic Interface or user's representation	Anthropomorphic interfaces on health and transition	When an Anthropomorphic Interface represents a user's health condition, it makes the application more interesting. A user can monitor his/her conditions through their Anthropomorphic Interfaces; any changes to an Anthropomorphic Interface indicate the user's healthiness. For example, if a user is not feeling very well, his/her Anthropomorphic Interface will look pale, or if a user is too tired, his/her Anthropomorphic Interface can turn green. From this representation, users will learn how to manage their health situations.

9.2.2.3 The category of Motivational Effect

Following the components of the TAG framework and items in the TAGS instrument, the sub-categories for transitional application relate to these two arguments;

i) What should be included to make an application a motivational learning environment
ii) How anthropomorphic interfaces gamification can be used to motivate the users

Utilising the game elements in the transitional application could affect the users' motivation in learning and gaining knowledge about their conditions. Gamifying the anthropomorphic interfaces will reflect the user's representation and achievement in a game play. Consequently, this situation will indirectly maintain the user's motivation. Table 9-3 describes the related sub-categories in the category of motivational effect.

Table 9-3 Relationship between Identified Categories and their Sub-Categories for Motivational Effect

Extracted items related to the category	Identified sub categories	Descriptions
i) What should be included to make an application a motivational learning environment	Support a motivational learning environment	A transitional application designed for motivation involves how a person acquires knowledge and learns. Some triggers and learning may affect their routine and behaviour. Taking advantage of the utilization of game elements can contribute positively to their play experience.
ii) How anthropomorphic interfaces can be used to motivate the users	Anthropomorphic interfaces gamification in motivating the users	Gamification of Anthropomorphic Interfaces is anticipated to arouse the users' motivation and improve their engagement. The design of Anthropomorphic Interfaces has to be relevant and match the purpose of the application. The Anthropomorphic Interfaces for motivation are also involved with elements of customization. The customization could be used to personalise a user's representation or to change a user's representation to a different design of Anthropomorphic Interface that reflects their achievements.

9.2.3 Generating the guidelines

The items in the guideline were generated in accordance with the descriptions for each of the sub-categories, the components of the TAG framework and the items of the TAGS instrument were also taken into consideration. For example, the items generated for the first sub-category of the gamification of anthropomorphic interfaces design, are shown in Table 9-4. Examples were first sketched on paper and then transferred to the online tool named the *storyboardthat.com*. A similar approach was applied to other categories in the guideline. Details of the generated items for all categories in the guideline can be found in Table 9-8, Table 9-9, and Table 9-10.

Table 9-4 An Example of a Guideline: Items Generated for the Sub Category of Customizing Anthropomorphic Interfaces

Category :	Anthropomorphic Gamification Design (AGD)
Sub Category :	Customizing Anthropomorphic Interface (AI)
Relation to components in TAG Framework :	Design Purpose (DEP)
Relation to items in the TAGS Instrument :	Ease of character customization

Guideline's Generated Items

AGD1.1: If customization involves Anthropomorphic Interfaces as a whole;

AGD1.1.1: Provide one or more Anthropomorphic Interfaces for users to select from

AGD1.1.2: Allow a user to change his/her Anthropomorphic Interfaces from one Anthropomorphic Interface to another Anthropomorphic Interface

AGD1.1.3: Make changes between AIs easy, so that users don't struggle and thus, get demotivated

AGD1.2: If customization involves personalization of Anthropomorphic Interfaces

AGD1.2.1: Provide Anthropomorphic Interfaces with elements to be personalized, such as hair, face, clothes, accessories

AGD1.2.2: Make a real-time overview of the Anthropomorphic Interfaces, so that the users can easily make choices

AGD1.3: Consider customizing the Anthropomorphic Interface's environment.

AGD1.3.1: Provide elements in the environment for personalization, such as sofas, lamps, pictures, and flowers

AGD1.3.2: Make movement options easy, like using drag-and-drop options or a preview function, so that the users feel customization is manageable rather than an inconvenience

AGD1.4: Make use of common designs and familiar interfaces for easy customization

AGD1.5: Offer purchasable items for a user to expand his/her collections

Examples of guideline implementation:

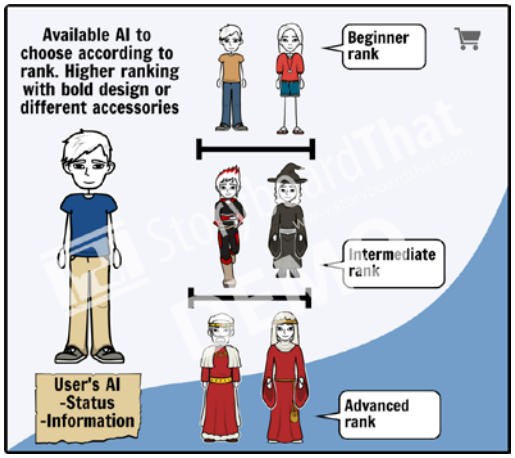


Figure 1: customization of an AI (AGD1-1)

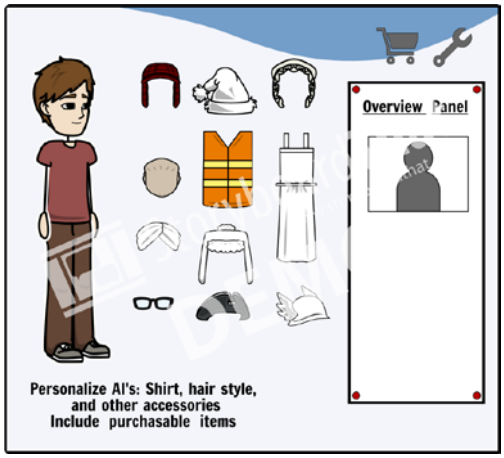


Figure 2: Personalization of AIs (AGD1-2)

9.3 Validating the Guideline

Validating a new set of developed guidelines is deemed necessary. The validation is to ensure that the contents are suitable and adequate for inclusion in the guideline. For that reason, a focus group discussion was performed. The discussion involved experts and researchers in game design and development. Employing a focus group discussion helps to gather experts' opinions from a similar background and experience to argue and agree on the subject being discussed. Previous studies such as Høiseth & Giannakos (2013) and Hsu, Chang, & Lee (2013) conducted a focus group discussion on the subject interest in order to validate their tools or guidelines. The subjects of interest were brainstormed and summarised into related features and these summarizations led to the general agreements among the participants. Thus, it was used as reference to validate their tools or guidelines. Similarly, in this study, experts' views were collected, analysed, and referred to as the basis to support and validate the developed guidelines. The details of the conducted study are presented in the following section 9.3.1 – 9.3.6.

9.3.1 Method for conducting the Focus Group Discussion

The method to validate the developed guideline was a focus group discussion, implementing inspection method for data collection. The focus group discussion is part of the interview method, explained in Chapter 5.3.1. The guidelines were validated in two steps. First, the guidelines were sent for English proofreading and editing. Second, the content of the guidelines was discussed with a group of researchers and experts who have a similar research background or research interest. The discussion was arranged and conducted in a small group of participants. This was because, with a small number of people, each participant will have ample space and opportunity to express his/her opinion on the subject being discussed. Furthermore, it was easier to manage a small group than a larger group, in terms of arranging the participants' availabilities, facilitating the discussion, and taking turns in giving comments and taking notes. Onwuegbuzie & Leech (2007) summarized that a focus group usually contains 6-10 people. However, they contended that a small group of participants, around 3-5 participants typically are sufficient to reach saturation. Thus, in this study, three participants were set in one group discussion. The discussion session involved one moderator, one assistant (note taker), and the participants.

9.3.2 The Participants

In total, ten people were involved in this study, aged between 23 and 40 years. Two people were engaged in piloting the guidelines and eight people were gathered for the group discussion. The participants in the group discussion were selected based on their involvement in game design or development either in research or in practice. Each of the participants was assigned with ID

number. The summary of the participants' background is presented in Table 9-5. Originally, participants in group 1 were arranged with three experts. However, due to one participant's last minute change in availability, the discussion was attended by only two participants.

Table 9-5 Participants' background

ID	Participants	Affiliation
Group 1 (5th July 2017)		
1A	*Researcher in Design, Female*	*Winchester School of Arts, University of Southampton*
1B	*Designer, Female*	*Software House, in London, UK*
Group 2 (6th July 2017)		
2A	*PhD Student in Design, Female*	*Winchester School of Arts, University of Southampton*
2B	*PhD Student in Design and Marketing, Male*	*Winchester School of Arts, University of Southampton*
2C	*Researcher in Web Analytics, female*	*Web of Science, University of Southampton*
Group 3 (14th July 2017)		
3A	*Researcher in HCI, Male*	*University of Nottingham*
3B	*Academician & Researcher in Computer Science, Female*	*University of Leicester*
3C	*Software Developer/Tester, Male*	*Software House, in Nottingham, UK*

9.3.3 Discussion Questions

Discussion questions were constructed to examine the suitability of the content of the guideline. For the purposes of examination, the discussion went through each of the guidelines and the following questions were asked;

1- What do you think about the guidelines? Do the guidelines make logically sense?

2- How do you think the guidelines can help you to design such applications?

3- What needs to be improved?

There was no particular personal information gathered during the discussion. However, participants were asked to sign the consent form and the discussion was recorded for the purpose of transcription and analysis.

9.3.4 Procedures

The procedure in conducting the focus group discussion includes before, during, and after the session, from participant recruitment until completion of the study. The details are as follows;

Pre-Study:

Invitation. An invitation email was sent to the prospective participants. If they agreed to participate, a meeting for discussion would be set up. The time, date, and venue were arranged according to participants' availabilities.

During the study:

Meeting. Participants arrived at the venue as arranged. They were asked to be seated, offered a drink, and an information sheet was given to them.

Information sheet. Participants were given an information sheet to inform them about the study. Participants were ensured that no particular information was collected. The responses were only available in the form of analyses and summary. The emails used for contacting the participants and consent information were kept confidential. No link would be visible between participant emails and his/her response sheet. Participants were also informed that their involvement was voluntary. They may request to pull out from the study at any time, and no further action was required. Once the participant read the information sheet, they were given a consent form to sign.

Discussion session. Once the consent form was signed and all participants were ready, the participants were given the guideline to be reviewed within 10 minutes. After that, the researcher acting as the moderator started the discussion. As a moderator, the researcher went through the guidelines one by one and asked for the participants' opinions on each of the guidelines. Each participant had a turn to give their opinions. The discussions were recorded and all opinions were noted. The discussion session lasted about 90 minutes.

After the study:

Once the discussions had finished, the researcher collected the guideline document and participants were thanked for their participation. No further contact about the study was made.

9.3.5 The Analysis of Findings

Data obtained from the focus group discussions were analysed following the steps in the thematic analysis. In thematic analysis, recorded discussions were transcribed, coded, and categorized into themes.

Initially, the recorded discussions were manually transcribed. The transcriptions were coded into related nodes. These nodes were created based on the mostly discussed text that was summarized in the discussions. Next, the related nodes were grouped together. These groups of nodes were linked to the discussion questions in section 9.3.3. Based on the links, the group nodes were classified into themes. At this point, an inductive approach was adopted to create a theme. This approach was explained in Chapter 5.5.1. Finally, the obtained data were discussed.

The discussion of experts' consensus was then summarized and used as a validation of the guideline. The steps to analyse are summarized and illustrated in Figure 9-2.

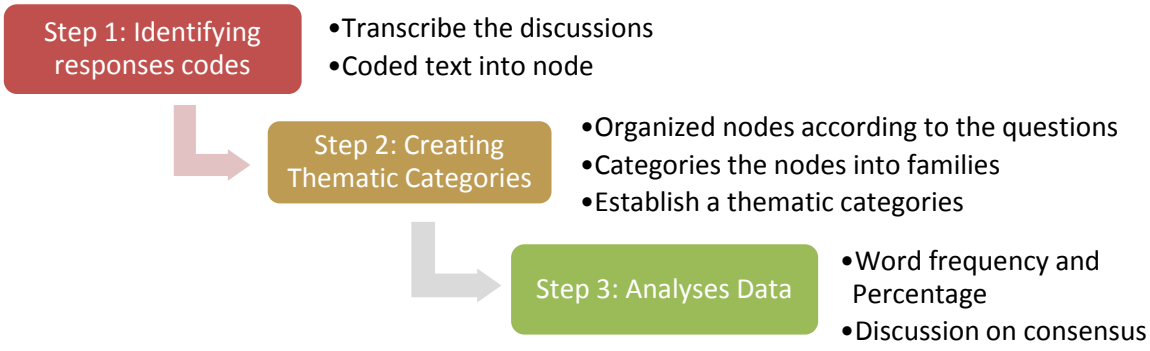


Figure 9-2 Stage of analysis for the focus group discussions

Similar words were queried to find the percentage of themes covered in the discussion. Most of the words found that correlated to the guideline were *relation*, *understand*, *reference*, and *example*. The word *relation* and *understand* were about the general opinions of the contents of the guideline. The word *reference* was referred to for the applicability of the guideline, and the word *example* was either used in a constructive and helpful content or referred to the comments that suggested areas for improvement.

Based on the nodes and the questions asked, a total of seven themes were generated and summarized according to the category shown in Table 9-6. These themes are discussed in detail in the next section, 9.3.6.

Table 9-6 List of themes generated from the focus group discussions

	Category		***Themes***	***Description***
1.	*Key findings about the guideline*	*i.*	*Makes Logically Sense*	*The guidelines were found to make logically sense applied to the context of transitional health application, implementing the anthropomorphic gamification*
		ii.	*Helpful example*	*The examples in the guidelines were found helpful for users to visualize the guideline. However, a caption and a cross reference between text and images were needed*
		iii.	*Relation to the research framework*	*The guidelines seem to have a connection with the framework and instrument in the research*
		iv.	*Consideration for future research*	*A suggestion for future enhancement, which had not been covered in the research framework and instrument*

2.	*Key findings about the applicability of the guideline*	*i. Reference*	*The guidelines can be used as a reference to develop and design the transitional health application*
		ii. Tool	*The guidelines are also seen as an assistive tool to help the designers*
		iii. Manual	*The guidelines are also perceived as a manual that can standardize the design of the transitional health application*

There were a number of comments and suggestions noted for improvement. The comments were argued and then, agreed for modification. The comments were synchronized between the three group discussions and summarized according to each of the sub guidelines, as shown in Table 9-7.

Table 9-7 Summary of comments for each guideline

Sub Guidelines	Comments to improve
AGD1: Customizing Anthropomorphic interfaces (AI)	• AGD1.2.2 – cross reference with the figure in the given examples • AGD1.4 – example of common designs in the context of children applications/games • AGD1.5 – add text option for buying, *such as a virtual money, gold bar, etc.* • Examples of the guideline implementation - Add captions for each figure
AGD2: Characteristics of Anthropomorphic interfaces	• AGD2.3 – Modify. Allow users to interact with an NPC. If using a Multiplayer application, the application should allow the AIs to interact with other users. • Add caption to examples. Some explanation about it might be helpful.
AGD3: Accessibility options	• AGD3.2 – change *alternative option* to *alternative text*. Rearrange the text to; *optionally, consider including alternative text for the images*. This is important for the user to further identify the image. • AGD3.2 – suggestion to add the text with; *Contrast design between icons and little animation to show a clickable movement* • Add caption to examples. Some explanation about it might be helpful.
AGD4: Create gamified AIs	• AGD4.1.1 – add cross reference about AI's customization in AGD1.1 and AGD1.2 • AGD4.1.3 - add reference, refer to the examples given in the example section • AGD4.6 – give examples to the other game element. Such as narrative, element of progression, etc. • Add captions to the examples. Some explanation of the examples might be helpful.
TA1: The health self-management function	• TA1.2 – give examples of mini apps such as collecting healthy or sugary foods, kill germs or bacteria, etc. • Cross reference the guideline with the given examples. • Add caption to examples. Some explanation about it might be helpful.

TA2: Transitional process criteria	• Cross reference the level of mini apps with AI's gamification in AGD4 • TA2.2 – rewrite: Try to design the mini-apps with levels and reflect the levels to AIs gamification as in AGD4. • TA2.2.1 refer the minimum 3 levels to the current implementation of transition stage. Thus, item TA2.2.1 change to – *A minimum of 3 levels should be designed per mini-apps are suggested. This reflects the 3 stages of a transitional process currently implemented in the ReadySteadyGo programme (reference)*. • Add caption to examples. Some explanation about it might be helpful.
Sub guideline TA3: AI on health and transition	• TA3.3 – add an example of non-recovery situations, such as users will lose their lives in the game play. • Add a caption to examples. Some explanation about it might be helpful.
Motivational Element (ME)	• Description that mentions about ARGS element of motivation should not be mentioned.
ME1: Support a motivational learning environment	• ME1.3 – add surprise elements like changing new themes • ME1.4 – cross reference the guideline with AGD4, TA1.2, and TA2.2 • ME1.6 – add an example to a similar range of tasks. Such as, task 1: choose the right food for maintaining the right level of blood sugar, task 2: choose the right food that contains less sugar, task 3: create a balanced meal. • ME1.8 – item is not suitable for inclusion in the guideline. Suggested for deletion. • Add caption to examples. Some explanation about it might be helpful.
ME2: AIs in motivating the users	• ME2.4 – cross reference with AGD1.1 • ME2.5 – a very high target is too broad and not clear. Suggestion to change the guideline into; do not set a very high target for the users to achieve the points or levels to be able to customize his/her AI • ME2.5 – cross reference the customization of user AI with guideline in AGD1.1, AGD1.2, and AGD1.3

9.3.6 Discussions of Feedback

The main concern of this study was whether the guidelines were suitable and adequate. All eight respondents of those three group discussions said the guidelines made logical senses that reflected insights from the research framework, the instrument, as well as their experiences and practices. Thus, the guidelines were reflected as suitable. With some improvements to the content, the guidelines were also considered adequate in this context of study. A sample of positive comment: *"This is interesting"*, *"understandable, even it is wordy, but easy to follow"*, *"this guideline looks comprehensive"*, *"it is simple and straight forward"*, and *"this should be helpful for future development of the application"*. There were two respondents who conveyed an interest about the use of a familiar term and element of design in the existing design practice. In addition, there were few respondents thought that the guidelines were very much suitable to a

novice designer or could be used as a starting point in developing such applications, not just for experienced designers.

In the beginning, respondents had explained about how the guidelines had been developed. Several respondents believed that the guidelines seemed to have a relation with the framework and had covered the content of the framework accordingly. Some comments made were; “it looks like you made the connection”, “I can see how you try to connect the concepts and put it into practice”, and “Of course you considered it all”, and “it certainly covers the research framework”.

At first, the respondents in the second focus group were not very convinced about the way the content of the guidelines was arranged. They thought each sub guideline was not associated with the others and only focused on specific content. After they scrutinized the guideline, they found the guidelines were actually connected and covered the related story of transitional health gamified application. Thus, they felt the guidelines were appropriate to the context.

When respondents were asked about how the guideline could help them in designing related applications, the respondents thought the guideline could be used as a reference or a manual that will help to standardize the design application. One respondent mentioned that the guidelines could be used as a starting point to a bigger idea in creating a motivational game in the context of healthcare. Another conversation between the respondents in the third focus group discussed the position of the guideline in a software development lifecycle. They projected that this guideline can be used as a supporting document to analyse and understand the user’s requirement and thus, can design the application before a programmer develops the application.

Respondents in group one and three did mention a positive comment on how they felt about the examples in each sub guideline. Some of the comments were: “barely see examples in a guideline, this is fine.”, “I like the example. It makes the guidelines easier to the users”, and “I like about the example. They are very helpful”. The examples were thought best if using some pictures from the existing games. Two of the eight experts felt that the guidelines should be kept the way they were designed to preserve their originality. However, examples were suggested for some revisions. The revisions are for the purpose of clearer documentation. The guidelines that were pointed out by most of the experts as needing revision were; 1) the caption of the figures, and 2) cross reference between the figures and text in the guidelines. These points were mentioned in each sub guideline as shown in Table 9-7.

There was also a suggestion addressing the multiplayer platforms, in particular for the customization and interaction of the anthropomorphic interfaces between the players. This was an important issue being discussed, but it was decided it would not to be included. It was because multiplayer was neither within the scope of the guideline nor the research in the framework.

Another issue that was discussed was a storyline or narrative of gameplay. Noticeably, the narrative is one of the game elements in gamification (Hamari et al., 2014; Pedreira et al., 2015; Seaborn & Fels, 2015). Based on the TAG framework, narrative or storyline was not indicated as the main element of the framework, thus, not in the main scope of the framework. However, as discussed by experts in the second focus group discussion, the narrative does not have to be told. Sometimes, the story is conveyed by the game design or by the combination of game elements used in the game. In the TAG framework, the anthropomorphic gamification could be considered as part of a narrative in games. In Proske, Roscoe, & McNamara (2014), the character is part of the game narrative that has an effect on the player as well as in the gameplay. Similar to Turkay & Kinzer (2014), the character developed the narrative in the game and affected the player's identification. Thus, the discussions agreed that the narrative was incorporated in the research, however it should be further investigated in the future.

Among the comments and the suggestions in Table 9-7, most of the experts requested an example for certain guidelines. This was to give more insight on how to practically implement the guidelines. There were no requests for restructuring the guidelines not even to change the format of the guidelines. However, two of the respondents (1A and 3B) pointed out that the physical rewards as outlined in sub guideline ME1.8, were not suitable for inclusion in the guideline. This was because the sub guideline ME1.8 was not a necessary item for creating or designing the gamified application. Thus, it was suggested for deletion.

Overall, the guidelines that were developed based on the TAG framework and scrutinised by the researchers and designers seemed to be appropriate. The guidelines have a potential to be used as a reference tool that accommodates the designers and practitioners designing transitional health gamified application. The related modifications were made in accordance with the comments and suggestions from the respondents. The final guidelines are presented in the next section, 9.4.

9.4 The Guidelines

From the validation study, the guidelines were comprised of three main categories, nine sub-categories, and 42 items. The structure of the guidelines is illustrated in Figure 9-3.

For each of the main categories, there are sub-categories associated with it. In the guideline, the title and description for each of the main categories will be on the top of the guideline. The guidelines are presented in three sections; 1) information on the main category of the guidelines consisting of title and description, 2) the description of the sub guideline and the items in the sub guideline, 3) the examples of the guideline implementation.

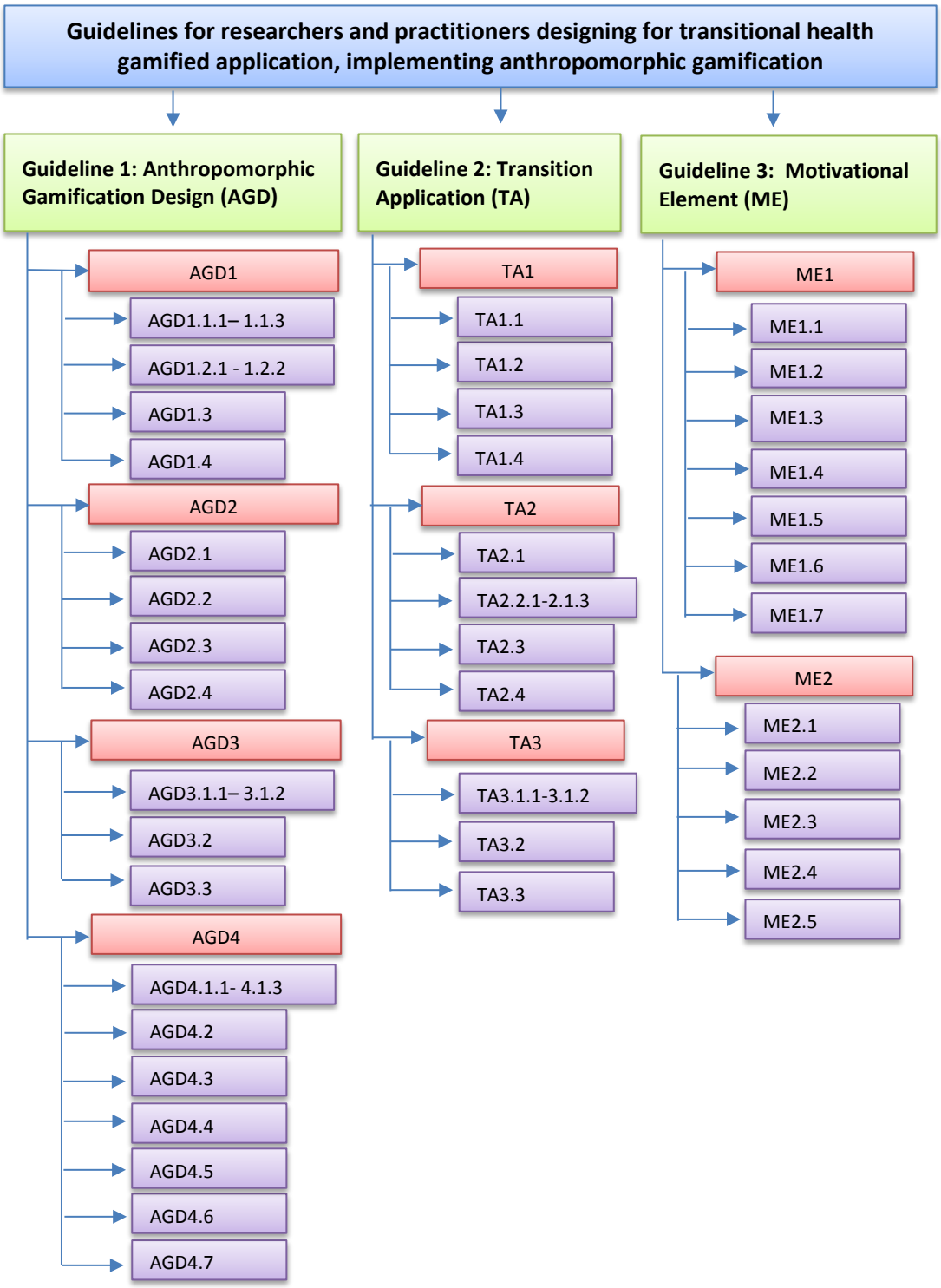


Figure 9-3 Structure of the Guidelines

The final version of the guidelines is presented in Table 9-8 for anthropomorphic gamification design, Table 9-9 for transitional application, and Table 9-10 for the motivational element.

Table 9-8 the guideline for Anthropomorphic Gamification Design (AGD)

Guideline Title	**Anthropomorphic Gamification Design (AGD)**
Description	Anthropomorphic interface (AI) applies as user's virtual representations in a gamified application. If designers intend to apply AI, following the TAG framework and TAGS instrument, a few designs elements should be considered.
Sub guideline AGD1	**Customizing Anthropomorphic interfaces**
Description	If the application allows customization on the Anthropomorphic Interfaces, consider to provide customization for the AI's environment (for example; house, vehicle) as well.

Guideline for designers

AGD1.1 If customization involves Anthropomorphic Interface as a whole (refer to figure 1 for example);

- AGD1.1.1 Provide one or more Anthropomorphic Interfaces for users to make selections
- AGD1.1.2 Users is able to change his/her Anthropomorphic Interface from one Anthropomorphic Interfaces to another Anthropomorphic Interfaces
- AGD1.1.3 Make an easy alteration between the Anthropomorphic Interfaces, so that users don't feel the struggle and thus feel demotivated

AGD1.2 If customization involves personalization of Anthropomorphic Interface (refer to figure 2 for example);

- AGD1.2.1 Provide AI with elements to be personalized such as hair, face, clothes, accessories, etc.
- AGD1.2.2 Make a real-time overview of the Anthropomorphic Interface, so that users can easily make choices

AGD1.3 Consider customizing the Anthropomorphic Interface's environment.

- AGD1.3.1 Provide the environmental elements for personalization such as sofa, lamp, picture, flowers, and etc.
- AGD1.3.2 Make easy movements like using drag and drop options or select then preview function, so that users feel manageable rather than inconvenience

AGD1.4 Make use of common designs and familiar interfaces for easy customization in the context of children. For example; make used of cartoonish or animated home icon, setting icon, purchasable icon, etc.

AGD1.5 Offer purchasable items for users to expand their collections such as using a virtual money, a gold bar, etc.

Examples of guideline implementation

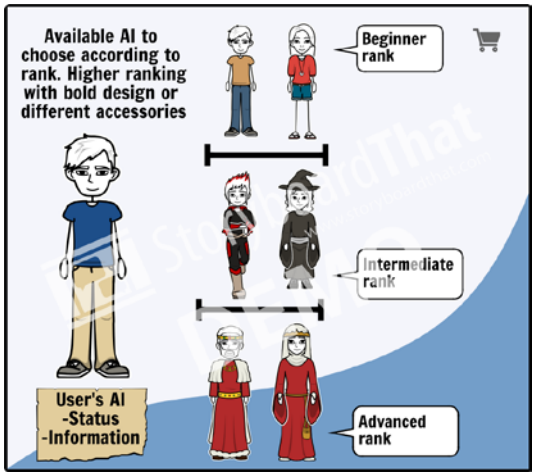


Figure 1: customization of an AI (AGD1-1)

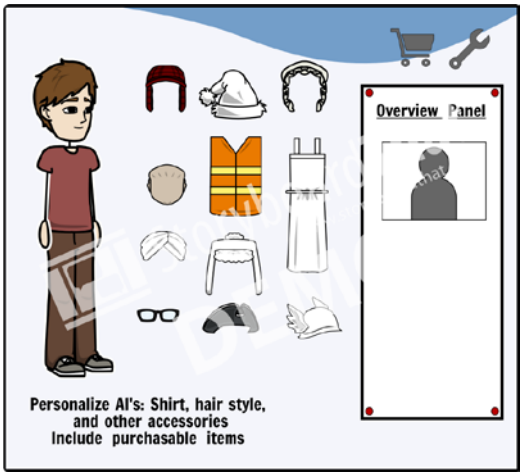


Figure 2: Personalization of AIs (AGD1-2)

Sub guideline AGD2	**Characteristics of Anthropomorphic interfaces**
Description	If a designer expects the user to maintain his/her engagement, creating an Anthropomorphic Interface shouldn't be static, or just plain without expression and rigid movement. An animated, lively anthropomorphic interface will arouse the user's excitement and thus, maintaining the user's engagement in the application.

Guideline for designers

AGD2.1 Consider designing Anthropomorphic Interfaces with natural gesture, expression, eye contact, and voice effect

AGD2.2 The appearance of Anthropomorphic Interfaces should include gender consideration, skin colour adjustment, and range of body shape

AGD2.3 Allow users to interact with his/her AIs, non-player character, and if using a Multiplayer application, allow AIs to interact with other users.

AGD2.4 Avoid rigid or static Anthropomorphic Interface, which may result in boring Anthropomorphic Interfaces

Example of guideline implementation

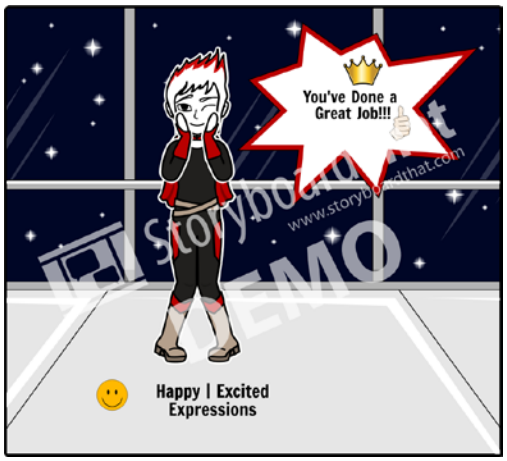


Figure 3: AI shows expression (AGD2.1)

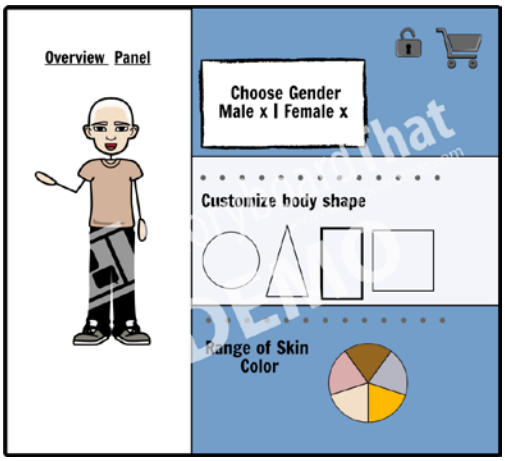


Figure 4: Appearance of AI includes (AGD2.2)

Sub guideline AGD3	**Accessibility options**
Description	In any application, accessibility options are important. So that the application is available for a different situation such as low internet bandwidth or low computer performance, and usable for a wide range of user such as normal users, visually impaired users, or hearing impaired users. The User Agent Accessibility Guidelines (UAAG) 2.0, (2014) in the W3C's Web Accessibility Initiative (WAI) has listed several guidelines relating to the agent based interface, however, the relation to TAG and its suitability for a transitional health gamified application emphasizes the following options;

Guideline for designers

AGD3.1 Designers should consider including basic accessibility option (refer to the example in figure 5);

AGD3.1.1 Switchable option between texts to voice command

AGD3.1.2 Ability to change the colour scheme or background images

AGD3.2 Optionally, consider including alternative text for the images, contrast the design between icons, and add little animations to show a clickable movement

(refer the example in figure 6)

AGD 3.3 Easy to manage which means all the icons or symbols in the application are familiar and try not complicate the process of changing or switching (refer to AGD3.1 and AGD3.2).

Example of guideline implementation (Picture/storyboard)

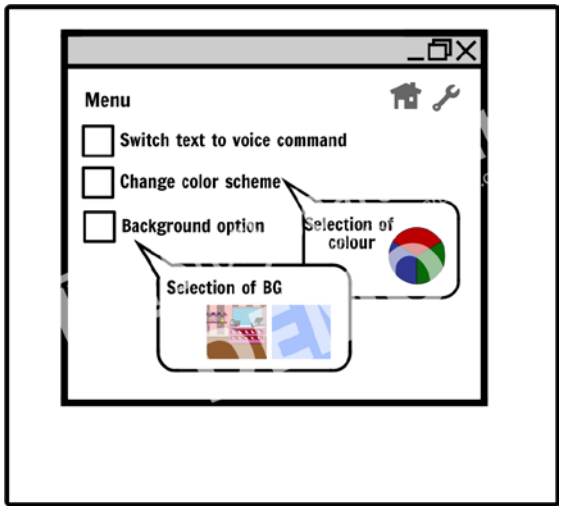


Figure 5: Setting for accessible options

Figure 6: Alternative text and clickable options

Sub guideline AGD4	**Create gamified Anthropomorphic Interface**
Description	Anthropomorphic gamification offers excitement. It can welcome challenges for users to involve, perform, and progress. The design for gamifying an Anthropomorphic Interface follows which aspect of Anthropomorphic Interfaces applied in the applications. Anthropomorphic Interfaces are customized when users have enough points or AIs can be changed into different Anthropomorphic Interfaces, usually into a more powerful Anthropomorphic Interface or more attractive Anthropomorphic Interface, when users complete certain levels.

Guideline for designers

AGD4.1 Implementing basic game elements should involve Anthropomorphic Interface (refer the example in figure 7);

- AGD4.1.1 Points, badges, trophy, and levels reflect the Anthropomorphic Interface's customization in AGD1.1 and AGD1.2
- AGD4.1.2 Users progress from easy levels to more difficult levels
- AGD4.1.3 Anthropomorphic Interface is part of a Leaderboard which represents user's identity and his/her achievement

AGD4.2 Try not to complicate the criteria to achieve points badges, trophy, and levels

AGD4.3 Consider adding various options on rewarding the user's achievement

AGD4.4 Offer purchasable points (with limits) for users to continue his/her activity

AGD4.5 Considered exchangeable points with other game elements

AGD4.6 Consider utilising other game elements as well such as progression, storyline, etc.

AGD4.7 Avoid giving too many points for a simple task

Example of guideline implementation (Picture/storyboard)

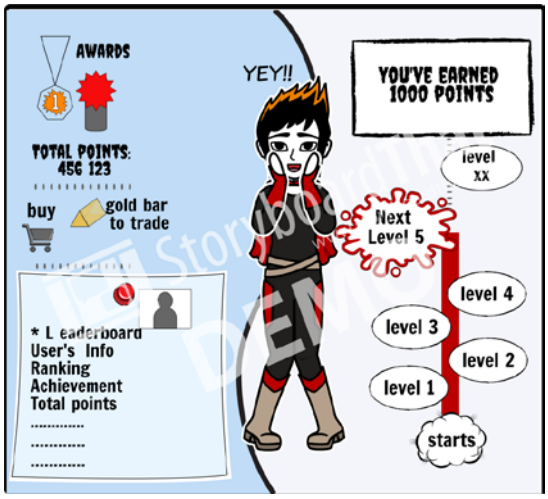


Figure 7: Implementation of game elements

Table 9-9 the guideline for Transition Application (TA)

Guideline Title	**Transition Application (TA)**
Description	Transition application is an additional tool that helps a user with his/her transition process. The process requires stages to differentiate the transition process and to indicate the progress of users in transition. Gamifying Anthropomorphic Interfaces with other implementations of game elements will help to make the transition application more interesting. To develop an application for transition health, designers should consider including the few design elements, reflected from the TAG framework and the TAGS instrument.
Sub guideline TA1	**The health self-management function**
Description	Transitional application involves with functions that could help the users self-manage their condition. The function should support users to self-manage for a change in their behaviour.

Guideline for designers

TA1.1 Provide functions for users to set or control his/her health routine. (refer the example in figure 8)

TA1.2 Provide mini apps that are closely related to health that covers the user's condition. For example collecting healthy or sugary food, killing gems or bacteria, etc. Having a similar range of tasks will help the users to master the related skill or knowledge

TA1.3 The users may be able to organize the task or mini apps where user can choose which tasks need to be done, and in which order they like to do them (refer to the structure of mini game in figure 9)

TA1.4 It could be good if the application is able to control user's long hour engagement (non-stop playing is not good for a user's health). Add a setting or manipulating the engagement through the presentation of Anthropomorphic Interfaces

Example of guideline implementation

Figure 8: Setting for user health control

Figure 9: Mini Apps in game

Sub guideline TA2	**Transitional process criteria**
Description	Process of transition requires several stages. This is to ensure users gain the essential knowledge of their health condition. This can be done by indicating to the users how well or how much information they gain from one activity (one mini app). The application can be designed by manipulating the game element and being applied with an Anthropomorphic Interface. Level elements could serve the purpose of indicating the different stages to the user.

Guideline for designers

TA2.1 Try to clearly show the type of health conditions the apps or mini apps are trying to cater for, so that the user will stay on track.

TA2.2 Try to design the mini apps with levels and reflects the levels to Anthropomorphic Interfaces gamification as in AGD4

TA2.2.1 A minimum of 3 levels should be designed per mini-apps suggested in accordance to the stage of a transitional process. However, the number of levels could be adjusted accordingly.

TA2.2.2 Try to design the levels with different difficulties

TA2.2.3 Difficulty in levels as completed in time or by a certain number of moves

TA2.3 Consider designing one learning subject in one mini app. For example; collect unhealthy food, or choose the right monster/gems to kill, etc. (refer the example in Figure 10)

TA2.4 Avoid complicated tasks as it could demotivate the users

Example of guideline implementation

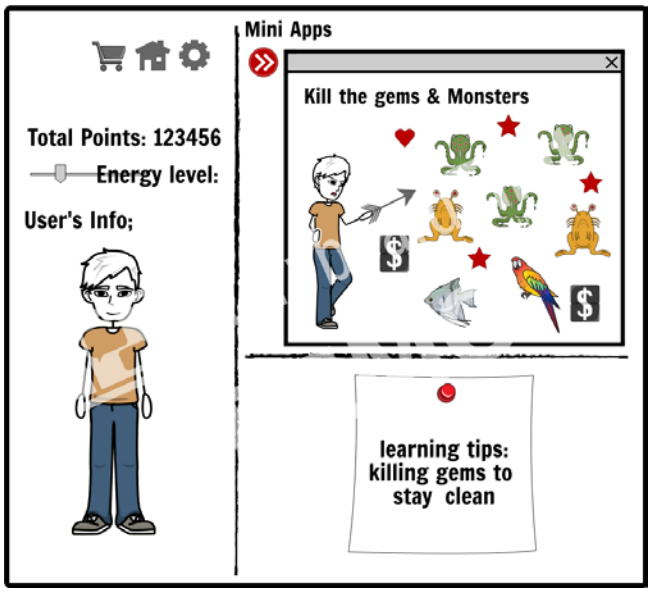


Figure 10: the Mini Apps and user info/status

Sub guideline TA3	**AI on health and transition**
Description	When an Anthropomorphic Interface represents the user's health condition, it makes the application more interesting. Users can monitor their condition through their Anthropomorphic Interfaces. Any changes to Anthropomorphic Interface indicates a user's healthiness. For example, if users are not feeling very well, his/her AI will looks pale or if the user is too tired, his/her Anthropomorphic Interface will change to green. From this representation, users will learn how to manage their health situation.

Guideline for designers

TA3.1 Apart from the user being able to customize his/her Anthropomorphic Interface, try to design the user's Anthropomorphic Interface according to his/her level of health condition (refer to the example in figure 11)

TA3.1.1 The Anthropomorphic Interface is changeable in colour, such as red for angry, blue for cold, white for pale, etc.

TA3.1.2 Consider providing the user with a recovery option like Anthropomorphic Interface needs to rest for some time from playing, or take medication, or exchange the condition with points. This will later affect the user's Anthropomorphic Interface.

TA3.2 The Anthropomorphic Interface could also has facial expressions based on the user's condition.

TA3.3 Avoid non-recovery situations such as those where the users will lose their life in the gameplay, and do offer more options of recovery.

Example of guideline implementation

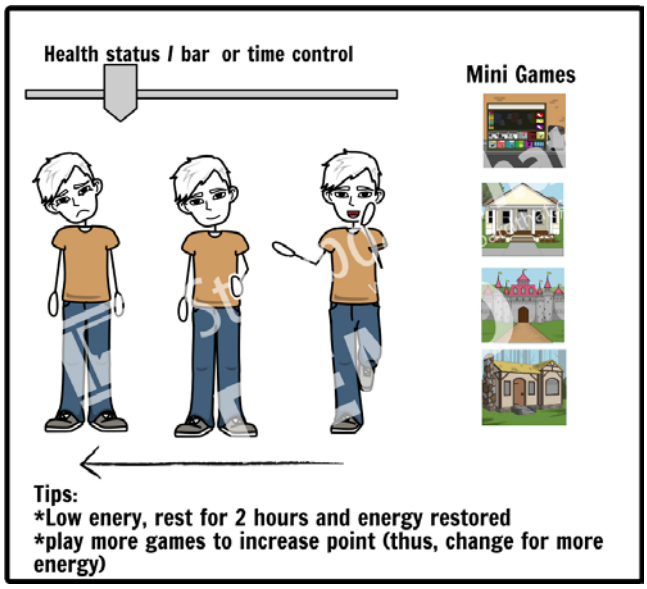


Figure 11: Anthropomorphic Interfaces representation according to the user's health status

Table 9-10 the guideline for Motivational Element (ME)

Guideline Title	**Motivational Element (ME)**
Description	Motivational Element relates to with how Anthropomorphic Interface gamification in transitional application could affect users' motivation and thus, maintain their engagement with the application. Following the TAG framework and the TAGS instrument, the motivational element could be one with gamified Anthropomorphic Interfaces and one that reflects the element of motivation. This to support users in learning/gaining knowledge about their condition.
Sub guideline ME1	**Support a motivational learning environment**
Description	A transitional application design for motivation involves one's learning acquisition. Users may get something, regardless of whether or not they subsequently use the application, it might affect his/her routine and behaviour. For that, taking advantage on the utilization of game elements can contribute positively to the play experience.
Guideline for designers	
ME1.1	Provide help functions to keep users feeling supported or giving hints when users seem lost
ME1.2	Try to design the application with familiar icons, symbols, and objects
ME1.3	Try to include surprise elements – bonus points, booster elements, jumping into higher levels, changing to a new available item for Anthropomorphic Interfaces, new theme etc.
ME1.4	Offer a selection of mini apps/games within the application such as in AGD4, TA1.2, and TA2.2
ME1.5	Provide unlimited opportunities to play and try again when users fail to complete a task
ME1.6	Try to design a similar range of tasks for a user to practise his/her skills. Such as, task 1: choose the right food for maintaining the right level of blood sugar, task 2: choose the right food containing less sugar, task 3: create a balanced meal.
ME1.7	It is good to provide some feedback on users performance but avoid a long sentence (users might not read it all) and unpleasant words (users might feel discouraged)

Example of guideline implementation

Figure 12: Range of functions to motivate the user

Sub guideline ME2	**AIs in motivating the users**
Description	Anthropomorphic gamification is expected to arouse a user's motivation and improve a user's engagement. The design of Anthropomorphic Interfaces has to be relevant and match with the purpose of the application. The Anthropomorphic Interfaces for motivation also involves with the element of customization. The customization could be to personalise the user's representation or to change the user's representation to the different design of Anthropomorphic Interfaces that reflect his/her achievement.

Guideline for designers

ME2.1 Make use of game elements. Allow a user to upgrade his/her Anthropomorphic Interface and/or to upgrade the Anthropomorphic Interface's accessories when they have enough points, when they have reached the required level, or when users complete a certain task.

ME2.2 Provide relevant Anthropomorphic Interface designs, which match with the purpose of the application.

ME2.3 Consider providing advanced design customization of Anthropomorphic Interface according to user's achievement. The higher the achievement the stronger the design of Anthropomorphic Interface could be done.

ME2.4 If the Anthropomorphic Interface is not customizable, provide a different Anthropomorphic Interface with a different ranking of design. Users with higher achievements can choose the higher ranking Anthropomorphic Interface such as in AGD1.1

ME2.5 If possible, do not set a very high target for the users to achieve the points or levels to be able to customize his/her Anthropomorphic Interface (refer to customization of Anthropomorphic Interfaces in AGD1.1, AGD1.2, and AGD1.3)

9.5 Chapter Summary

This chapter explained the development and validation of a set of guidelines for the design of transitional health care gamified applications, implementing anthropomorphic interfaces. Based on the outcome of the assessment of current games using the TAGS instrument, developing a new guideline was deemed necessary to balance the implementation of anthropomorphic interfaces in gamification for transitional care in a game. Thus, the guidelines would facilitate the task of a researcher or practitioner in designing a transitional health gamified application.

The content of developed guidelines consisted of main categories, with sub-categories, and items of guidelines. These contents were extracted from the TAG framework and the TAGS instrument based on the purpose and design consideration for the transitional health applications. The developed guideline required validation. The validation was conducted by employing focus group discussions. A focus group discussion is deemed necessary to gain insight from a specific group of experts pertaining the suitability and sufficiency of the new developed guideline. The discussions involved eight respondents and they were divided into three groups.

The findings from the discussions suggest that the guidelines were appropriate and sufficient to the context of this study. There was no amendment to the structured of the guideline. A few modifications were made according to the comments and suggestions from the discussions. The discussions agreed that the guidelines had connected the concepts and put them in practice. Thus, it showed the applicability of the research framework. Finally, the validated guidelines consist of three main categories, with nine sub-categories, and 52 items of guidelines.

Next, Chapter 10 will discuss the findings of the research conducted as a whole. The discussions will be based on the three main research questions outlined in Chapter 1.2.

Chapter 10: Final Discussion

This research investigated the issue of designing an acceptable interface tool for transitional care gamified applications by implementing an anthropomorphic interfaces. Considering this, this thesis answered three questions;

> *RQ1: What is a suitable framework for the use of anthropomorphic interfaces in gamification for transition healthcare, transfer from hospital care to self-care?*
>
> *RQ2: What are the appropriate metrics to measure the gamification of anthropomorphic interfaces in transitional care applications?*
>
> *RQ3: What are the applicable guidelines for designing a gamified application for transitional care, implementing an anthropomorphic interface?*

A conceptual framework was constructed by analysing research related to gamification, human computer interaction, and healthcare applications, and then synthesising these findings into related components. The framework for anthropomorphic interfaces in gamification for transitional care in health (TAG) was validated through a triangulation of research, interviews with researchers and developers, and a survey of people living with particular health conditions (diabetes and cancer) (see Chapter 6). In addition, to understand the framework, the framework was utilised to measure the extent of anthropomorphic interface in a gamified application, enabling users to acquire knowledge of their health condition to achieve self-management. For that, a measuring instrument called the Transitional Anthropomorphic Gamification Scale (TAGS) was developed (see Chapter 7), validated, and used to investigate the relationship among the factor of TAGS in game scores (see Chapter 8). The relationship helps inform which factors influence the design of anthropomorphic interfaces in gamification for transitional care application in existing games. The findings of TAGS (see Chapter 8.4.5) support the development of a design guideline for researchers and practitioners to design a transitional care gamified application, implementing anthropomorphic interfaces. The guideline was validated and it was implicitly shown that the framework could be practically applied to design a gamified application in this context of study (see in Chapter 9).

This chapter discusses and summarises the findings related to each research question, identifies research limitations, and offers practical suggestions and implications, related to anthropomorphic gamification for transitional healthcare.

10.1 The Framework

RQ1: What is a suitable framework for the use of anthropomorphic interfaces in gamification for transition healthcare, transfer from hospital care to self-care?

The framework of Anthropomorphic Gamification for Transition (TAG) is a result of the consolidation of three main research areas in the literature review - the human computer interaction (HCI) research, gamification research, and healthcare research. From the research, motivational design application of anthropomorphic interfaces in gamification that influences the behaviour of users in the transitional care process was synthesized as the main theme of the framework. This suggested that the element of anthropomorphic interfaces, game elements, motivation aspect, and the features of transitional application are the principles adopted to provide a conceptual framework. These principles become the factors of the framework. The factors break down into several components (e.g.; social response, game elements, attention, and self-management) and each component was divided into several elements (see Chapter 4.4). The elements represent the individual variables that can be modified or manipulated in the design and future research.

The TAG framework was validated in the context of experts' knowledge and practice, and patients who live with cancer and diabetes (in Chapter 6.1). Departing from the validation, the TAG framework was refined and integrated a few elements and components that were important for the design of anthropomorphic gamification in transitional healthcare applications.

The different types of anthropomorphic interfaces introduced in the TAG framework could have a positive benefit in defining the way the users perceive their representation in an application, which reflects in the way the user plays or engages in a gameplay (see Chapter 4.4). The TAG framework also supported the concepts of social responses and social presences (as argued in Chapter 2.3 and 2.4) in designing trustworthy and preferable elements of an anthropomorphic interface (see Chapter 6.3). The design of anthropomorphic interfaces is in line with accessibility suggestions for an agent based interface ('User Agent Accessibility Guidelines (UAAG) 2.0', 2014). Following the standard accessibility option, the TAG framework shows an integrated anthropomorphic interface design that ensures the usability and availability of an application to users with impairment or with limited access. Thus, this accessibility option could possibly help users with particular health conditions such as cancer and diabetes, to learn about their condition and enjoy the transition process.

The TAG framework could be manipulated to design a gamified application. By integrating an anthropomorphic interface and game elements of gamification, the gamified application would positively maintain the user's motivation, especially when they enjoyed using the application.

These positive effects were in line with research that mainly studied the effect of gamification using points, badges, and a Leaderboard (Deterding, 2012; Mekler et al., 2013). In the TAG framework, different combinations of game elements were embedded into the application. This includes the different types of anthropomorphic interfaces, which is not only the avatar. Following the analysis of experts' interviews on anthropomorphic interfaces and gamification in Chapter 6.2.1.2 and the analysis of the TAG framework in Chapter 6.3, the combination of game elements and anthropomorphic interfaces should expanded the utilisation of gamification. Thus, supporting the use of an anthropomorphic interface in gamification for transitional healthcare applications.

The TAG framework showed a holistic view of anthropomorphic interfaces in gamification for transition care, that the previous research did not adequately consider (see in Chapter 4.4). The proposition of TAG framework supported the integration of game elements (such as points, levels, badges, and trophies) applied for transition gamified applications (Wilson & McDonagh, 2014). In addition, the TAG framework promotes a different method of knowledge acquisition in gaining self-management skills. This can be seen through anthropomorphic interfaces as a user's representation, implementation of game for users to learn about their condition, the gamification of anthropomorphic interfaces, and game elements for users' achievements. These methods are in line with the concept of meaningful gamification that focuses on elements of play rather than mainly on the elements of scoring (Bogost, 2015; Nicholson, 2012). Consequently, the TAG framework could possibly improve the way users learn while playing, which indirectly enhances the user's motivation in the transition process.

In considering motivation, the TAG framework showed the importance of the motivational concept being included in the framework, in order to understand the motivational outcome of the application of anthropomorphic interfaces in gamification for transitional care. This inclusion has integrated the motivational influence on the gamification of anthropomorphic interfaces, anthropomorphic interfaces in healthcare, and gamification for transition. Thus, it added another positive value to the related previous work that focussed on a specific contexts, such as - anthropomorphic agents motivation (Baylor, 2009), anthropomorphic interfaces gamification (Kuramoto et al., 2013; Otake et al., 2014), anthropomorphic interfaces in healthcare (Van Vugt et al., 2009), and gamification for transition (Wilson & McDonagh, 2014). The concept of motivation could possibly provide more insights on user behaviour change, resulting from the gameplay. In particular, a user's daily health pattern or the way they perceived their condition could change from gaining some knowledge or acquiring self-care skills by playing games. This suggests that the TAG framework corroborates previous studies, such as King, Greaves, Exeter, & Darzi, (2013) and

Wilson & McDonagh (2014) that postulate the effect of gamification to encourage positive healthcare behaviour.

Consequently, the TAG framework is an integrative structure in which the concept of anthropomorphic gamification for transitional applications can be understood and supported by its factors, components, and elements that connect together. Thus, the TAG framework is considered a suitable conceptual framework for the use of anthropomorphic gamification for transition healthcare.

10.2 The Instrument

RQ2: What are the appropriate metrics to measure the gamification of anthropomorphic interfaces in transitional care applications?

A new metrics were developed, validated, and formed as an instrument to measure the amount of anthropomorphic gamification applied in games, in facilitating the users' acquisition of knowledge about his/her health condition towards self-management. The instrument, called the Transitional Anthropomorphic Gamification Scale (TAGS) was developed using the TAG framework as a reference. The goal-question-metric (GQM) approach was applied to extract each measuring item in the instrument (in Chapter 7.1). The TAGS instrument feasibly provides analysis on the application of anthropomorphic interfaces, utilisation of game elements, anthropomorphic interfaces in gamification, features of transitional care for self-care, and the motivation and learning effects when using anthropomorphic interfaces in gamification in transition care application.

As a newly developed instrument, several experiments were conducted to ensure the use of the framework in this context of the study was valid (see Chapter 8). The findings from the validation experiments demonstrated that the items were necessary and suitable (see Chapter 8.1), the items were cleared and understandable to the participant (see Chapter 8.2), and the instrument as a whole was statistically significant and showed that the instrument had measured the same related concept (see Chapter 8.3). This suggests that the TAGS had demonstrated a promising approach to measure the anthropomorphic gamification for transition healthcare in games.

As argued in Chapter 7, it is necessary to develop a new instrument in the context of this research. Previous research and available instrument do not integrate and do not fully support the TAG framework. This can be seen when referring to an anthropomorphic interface, when it is measured on users' perceptions and the effects on users' interaction, motivation, and engagement (Banks & Bowman, 2016; Bartneck et al., 2009; Heerink et al., 2009). Considering the

utilisation of game elements, the gamification was generally being measured for enjoyment, experience, and engagement (Çakiroğlu, Başibüyük, Güler, Atabay, & Memiş, 2016; Wiebe et al., 2014). For transitional process, current available instruments were measuring the level of readiness but this was not the focus of this thesis (refer manual survey e.g. Sawicki, Lukens-Bull, Yin, Demars, Huang, Livingood, & Wood, (2011)). Measuring for readiness could however, be done for future work. Meanwhile, developing and validating the TAGS instrument showed that it added a different perspective on measuring an anthropomorphic interface, added a new way to measure how the game elements should be designed for transition application, and added another apprehension about how learning about motivation would affect the transition process.

As a whole, the instrument focuses on measuring the design and features of an application. In particular it can be used to see how the anthropomorphic interface, gamification, and transition application should be designed in order to provide a standard set of design applications. This standard would be helpful for the developers, so that they could design an application that could help users gain more insight into their health condition during the transition process.

10.3 The Guideline

RQ3: What are the applicable guidelines for designing a gamified application for transitional care, implementing an anthropomorphic interface?

To practically apply the framework, a standard guideline was developed for researchers and practitioners for designing a gamified transition care application was developed (in Chapter 9). The guideline was developed with the TAG framework (in Chapter 6) and TAGS instrument (in Chapter 7 and 8) as the references. The development approach was in line with the approach applied under the previous research guideline (Isbister & Mueller, 2015; Paraskevopoulos et al., 2014). The guideline was examined and refined through a focus group discussion, involving eight experts in the fields of game and design. Positive feedback from the discussion (see Chapter 9.3.6) suggested that the guidelines made logically sense, reflecting the framework and instrument being researched that could lead to practical guidelines which researchers and practitioners would use.

Two notable issues were suggested for inclusion in the guideline (see Chapter 9.3.6). The suggestions were related to building an application on a multiplayer platform and the effect of game narrative. These two suggestions were not researched in the framework but would be worth researching in future research. Apart from that, the experts thought the graphic examples in each of the sub categories were very helpful. They suggested that this form of example should be included in any new guidelines, so that through graphic examples, users can learn and be able to visualise the concept being implemented. The finding of implementing graphic examples in a

guideline was in line with the findings of Isbister & Mueller (2015) work and supported the suggestion of a standard item contained in a guideline by Petrie & Bevan (2009).

Noticeably, the guidelines were only validated for their content. Future research will shed more light on the acceptability of the guideline. In particular, if a prototype could be designed and developed based on the guideline, and then tested for its acceptability. Thus, it will further validate the guideline. Overall, it was agreed that the set of design recommendations in the guideline should be considered as suitable and adequate, in this context of research. The guideline could positively benefit the researcher and practitioner in a future design. As of yet, there are no integrated guidelines concerning anthropomorphic gamification for transitional application. This research has provided significant evidence to support the value of using the TAG framework and the TAGS instrument in designing a transitional application.

10.4 Implications

The implication of this research is summarised based on the findings of the application of anthropomorphic interfaces in gamification for transition healthcare. The summary is presented in several areas; 1) – the effect to the research field of anthropomorphic interfaces, gamification and healthcare, 2) –propositions made to researchers and practitioners (developer or designer) related to healthcare application, and 3) - effects and suggestions to the healthcare body.

10.4.1 For the field of anthropomorphic interfaces, gamification, and transition health research

The outcome of this research presents coherent integrative perspective structured for the application of anthropomorphic interfaces in gamification in transitional care. The TAG framework could be seen as a starting point to facilitate the operationalisation of anthropomorphic interfaces in gamification particularly for those who wants to explore a tool for a transitional care application. Other healthcare applications requiring assistive tools for knowledge and self-management skills, could utilise the TAG framework. An addition to the framework could be further explored in the future.

Apart from the TAG framework, the validation of the TAGS instrument has shown that the factors can be generalised into individual factor, or the factors can be manipulated through a combination of components, selected based on the context of the investigation. This may be of value to other researchers who want to apply the instrument, exploring the factors or components as a whole or independently. The TAGS also can be utilised to analyse the current design concept in games, in particular for playful and motivational designs that are involved in anthropomorphic interfaces in gamification. These analyses could inform about the relevance of

designs, in accordance with the design requirement of TAG. Thus, it implicitly helps for the expansion of more research in game design and in healthcare applications.

By considering the TAG and TAGS, research had led to a design concept, a guideline of a transitional care application, implementing anthropomorphic interfaces. This guideline could be useful as a reference document in researching the same research context. It could also offer additional input in research in particular for those who want to develop a related design recommendation or expand the guideline in a greater context.

The research of anthropomorphic interfaces in gamification for transition care could be improved, particularly by emphasizing a theoretical foundation that demonstrates the game or application immersion, effectiveness, and user acceptance. In terms of understanding the anthropomorphic interfaces in gamification for transition care in games, there is considerable potential for more gamification of anthropomorphic interfaces being designed to promote healthcare content. Consequently, the related findings will add to the field of anthropomorphic interface theory, gamification theory, and healthcare theory.

10.4.2 For the researcher and practitioners

This research could also be useful to researchers who are conducting research in Human and Computer Interaction, in games, serious games, gamification, and in healthcare research. The earlier discussion of this study shows at least two ways for the TAG framework can be utilised to study anthropomorphic interfaces in gamification for transition care in games. One could be related to a customisation of the framework, whereby the researchers could adapt or adopt the framework into their context of study. Another possibility is that the interpretation of findings from the TAG could help the researcher to contextualize individual factors, or components, or the elements of the TAG. As a result, these findings would lead to other significant research gaps.

The framework and instrument could offer practitioners the foundation of a transitional care application. This will help them to analyse the current available design and apply it accordingly. Practitioners could value the guideline as a reference document, it provides a standard that could guide practitioners, in particular during the pre-design phase in developing a game. Similarly, in a software development lifecycle, this standard design could add value to the software requirements analysis. The guideline could be understood as a preliminary idea for the practitioners' plan and design of the game or the gamified application.

In addition, both researcher and practitioner can use the TAGS instrument as a tool to evaluate current games. The findings from the evaluation helps to inform about the suitable design, features, and content of a transitional care application. Considering the impact of the TAG

framework, the TAGS instrument, and the guideline to researchers and practitioners, in the future, it is suggested that a prototype be developed and tested for acceptance.

10.4.3 For the healthcare context

In terms of the healthcare field, the current research brings an important aspect to light, in supporting the existing healthcare processes. The research has stated that a playful gamified application plays an important role in maintaining patients' motivation. In general, the proposition of this research for the healthcare field seeks to promote a positive change to the pattern of patients' behaviour, despite only the play experience. From that, it helps the people in the healthcare context to perceive that gamified application has an influence in motivating the patients to go through their condition.

Healthcare practitioners and researchers referred to in interviews believed that the outcome of the framework would become a good communication tool between patients, their families, and the doctors, or nurses. The doctors or nurses could use the TAGS instrument to assess the suitability of a game in assisting their patient, in a transitional care context.

As for the guideline, this research is seen as a preliminary work for a more intervention tool introduced for the transitional healthcare. The guideline could be benefit the people in healthcare field, like the consultants and administration, in planning for a strategy to engage with patients during the transition process. Through continued engagement on the gamified applications, patients will learn about their condition such as what should and should not be done, should be taken, and how to manage. This will at least help the patient to develop their self-management skills. As this research focuses on a transitional care in health, transferring a patient from one care to another care, this research could be improved and applied into other gamified applications across a variety of healthcare purposes/processes.

10.5 Limitation

The focus of this thesis was to investigate the design of gamified applications that can maintain patients' motivation in a transitional healthcare. The framework uses motivational theory to illustrate the effect on the use of anthropomorphic interfaces in gamification in transition care on patient motivation. This thesis outlines several limitations. One of the limitations is that the number of games employed in this study was limited to four, consisting of two general fun games and two health related games. The chosen games were not related to transition because there were no commercially available games purposely created for transition. Even so, the games were carefully chosen, particularly for their features, in order to generalise the findings for this study. It

is possible to repeat the study employing different games with more features and characteristics in order to provide more informed views on how to generalise the findings.

Another limitation is the type of participants in the instrument validation test. All of the participants were carefully chosen. They included a computer science student at the University of Southampton who had the necessary experiences and background in designing and developing a game or a software system. However, these participants are more representative of a western-centric perspective. Having a diverse range of participants from various commercial backgrounds, different culture, or even from different nationalities, could provide different recommendations for the instrument. Culture was not considered in the experiment from the outset, as that was not the aim of the validation test. Therefore, this could be expanded in future work.

The study is also limited in terms of comparisons, as there are a limited number of available frameworks related to anthropomorphic gamification in transitional healthcare. This was because, a new programme for patients in transition was being introduced, nationally in the United Kingdom. Thus, it would be difficult to analyse the impact of the TAG framework in games compared to other frameworks. Regardless of the limitations, this thesis has formed the foundation for subsequent studies to understand the application of anthropomorphic interfaces in gamification for transition care in games.

10.6 Chapter Summary

This chapter presented the discussion of findings, its implications in research and industries, and the limitations of the study. Following the discussion in this chapter, three research questions were discussed. The discussions showed that the findings of the work in this thesis have provided insights into the use of anthropomorphic interface in gamification for transitional care in health.

This chapter suggested that from the perspective of anthropomorphic interfaces, gamification, transition features, and motivational element, the TAG framework has offers an integrative structure in which the transitional care application can be understood and applied. The new developed TAG framework was considered a suitable conceptual framework and thus, answered the first research question. This chapter also explained that every item in the TAGS instrument has been carefully created and was developed using the TAG framework as a reference. The validation processes had confirmed the importance of the items for inclusion in the instrument. Thus, answering the second research question of providing appropriate metrics to measure the gamification of anthropomorphic interfaces for transitional care in health. This instrument has shown that the framework can be used further in other contexts. The third research question looked at the applicability of the framework and the instrument. A set of guidelines containing many design recommendations was developed and validated. This chapter

discussed that the guidelines could positively benefit researchers and practitioners in their future research and design for transitional care gamified applications, in implementing anthropomorphic interfaces.

There are several implications resulting from this study. Noticeably, the implications were seen as an advancement of a research undertaken in a gamified application, anthropomorphic interfaces, and in healthcare applications. The implication reflected the research field of anthropomorphic interfaces, gamification and healthcare, the propositions offered to the researchers and practitioners related to healthcare application, and the effects to the healthcare body. The research acknowledges certain limitations, such as the number and type of games utilised in the validation experiment. However, these limitations might be worthy of consideration in future research.

Chapter 11: Conclusion and Future Work

In a transition process, patients transfer from hospital care to self-care, or from one stage of health to a better stage of health, are often have problems committing to the transition process until they are able to self-manage. During the transition process, patients are required to acquire knowledge and skills related to their condition, to prepare themselves for self-management. Eventually, changes in behaviour to one's health routine or pattern in controlling a situation, will develop. However, the transition process might take some times thus patients may lose interest. Previous studies by Field (2014) and Marape (2013) have shown that additional tools are required to support and motivate the patients' engagement throughout the transition period. One approach to support and motivate the patients is through the involvement of technology, which is playful, motivating, and it stimulates learning by playing games (Wilson & McDonagh, 2014).

When playing a game, one interesting aspect for a patient is to see how well or how badly they are progressing. This progression can be seen through his/her in-game representation, with various character designs - a character that resembles human qualities and characteristics, is referred to as an anthropomorphic interface (Khan & Sutcliffe, 2014). With this anthropomorphic character, the patient's representation can be personalised or customised according to his/her health condition. In addition, gamifying the patients' character could stimulate their motivation and thus, indirectly motivate them to keep playing the game. These situations help the patient to keep on using the game when they are in the transition process, which could develop a long-term interaction between the patient and their in-game anthropomorphic character. Considerable research has previously been conducted on; Anthropomorphic interface designs, personalisation motivating players, different designs of game elements, and gamification for motivation (e.g. in Birk, Atkins, Bowey, & Mandryk, (2016), Deterding (2012), Khan & Sutcliffe (2014)).

Playing game seems to improve patients' motivation and engagement (Baranowski, Buday, Thompson, & Baranowski, 2008; Birk et al., 2016; Kuramoto et al., 2013). An integrated design related to the use of gamified anthropomorphic interfaces in transitional care applications has not been defined. As discussed in Chapter 2, different users might bond with different types of anthropomorphic interfaces and different designs of gamified applications could yield a different motivational effect on a patient's engagement in the transitional healthcare process. Besides, there is no game or web-based application available in the market that supports patients in transitional healthcare or an application that is practically used in the transitional process. There is an evident

need to consider the design of applications for transitional healthcare, in particular, by implementing gamification of anthropomorphic interfaces.

As discussed in Chapter 3.2, among the healthcare research, there is one existing research project on the application of gamification in supporting the transitional care process (Wilson & McDonagh, 2014). However, this research focus on patient's transitional checklist and it does not focus on anthropomorphic interface design and its motivational influence on transitional healthcare. There are also relevant findings of anthropomorphic interface application in healthcare which related to personifying health through user's representation (Schmeil & Suggs, 2014), anthropomorphic character as the health advisor to help the user to change (Lisetti, Amini, Yasavur, & Rishe, 2013; Van Vugt et al., 2009), and the effect of anthropomorphic interface in healthcare website (Sah & Peng, 2015). Moreover, there are also other significant research findings on gamifying an anthropomorphic interface, in which the user's representation can be customized when certain levels or points are achieved (Kuramoto et al., 2013; Otake et al., 2014). However, they seems inconclusive when considering a gamified application of anthropomorphic interface in transitional healthcare. Therefore, this thesis has developed a conceptual framework for anthropomorphic interfaces in gamification for transitional care in health (TAG). This framework was created, validated, and applied.

This chapter concludes the research conducted for this thesis. The chapter begins with a summary of the framework, followed by the contributions this research makes, and finally, proposing potential future work directions at the end.

11.1 The TAG Framework: a summary

The research in this thesis is divided into three sections; the development of the framework, the validation of the use of the framework, and the applicability of the framework. A review of relevant literature on anthropomorphic interface research (Chapter 2), gamification research (Chapter 3.1), and transition healthcare research (Chapter 3.2) had led to the development of an integrated framework. This framework emerged from the research proposition in Chapter 5 about the application of an anthropomorphic interface in gamification for transitional healthcare. The summary of the work completed by this research is presented in Table 11-1.

11.1.1 The development of the framework

Chapter 4 discussed the newly developed *Anthropomorphic Gamification for Transition* (TAG) framework in detail. The conceptual framework was grounded in the following research areas;

Table 11-1 the summary of work conducted to complete this research

Main Research Question	Sub Research Question	Methodology & Instrument	Analysis	Result
1) *What is a suitable framework for the use of anthropomorphic interfaces in gamification for transition healthcare, transfer from hospital care to self-care?*	i. What key factors determine the use of anthropomorphic interfaces in gamification?	*Qualitative;* Interview with 15 Experts	Thematic Analysis using NVIVO	All factors in the framework were identified
	ii. How important are these factors in determining the user's motivation for the health transition care application?	*Quantitative;* Surveys with 33 participants (living with diabetes, cancer)	Frequencies, descriptive and Comparing One Sample t-test using IBM SPSS	There was a significant impact for the tested factors. Thus supporting the factors identified from the experts interview.
2) *What are the appropriate metrics to measure the gamification of anthropomorphic interfaces in transitional care applications?*		*Quantitative;* *Software Metrics (instrument) *Validation test • Content Validity (8 experts), • Pilot study (34 researchers and Software developer) • Validation experiment (75 CS students & researcher)	Factor Analysis, Correlation, Reliability, Mixed design ANOVA , Frequencies, descriptive analysis	The instrument has a significant impact towards each factor *the instruments were reliable and measure the same related concept *and it considered valid.
3) *What are the applicable guidelines for designing a gamified application for transitional care, implementing anthropomorphic interfaces?*		*Qualitative;* • Focus group discussions of 8 experts (researchers and practitioners)	Thematic Analysis using NVIVO	The guidelines were appropriate and sufficient, thus considered valid.

1) Anthropomorphic interface design characteristics,
2) Type of game elements that can increase motivation,
3) Motivation theory that supports gamification, and
4) Requirements for a deployable transitional care process.

A set of factors and components were extracted and formed as the foundation of the framework. The formulation of the framework triangulated interviews of experts and responses from people who live with certain health conditions (e.g. diabetes and cancer). The result of this triangulation showed that all the factors in the framework were regarded as important. However, a few modifications were made such as;

1) The degree of anthropomorphism is combined into the elements of anthropomorphism and named as the anthropomorphic elements. Their components were refined and pooled together.
2) The factor of motivation for young people is considered inclusive when the factor of motivational effect is in line with the motivation theory.
3) The modification also involved refactoring the elements in the components. For example, the components in the factor of anthropomorphic elements and the components in the factor of health transitional care (see Table 6-22).

For that, the final factors in the framework consisted of anthropomorphic elements, game elements in gamification, motivational element that supports gamification, and health transition care. Each of these factors is represented by several components. The revised components consist of 15 components and they are; anthropomorphic interface design type, design purpose, social responses, social presence, accessibility options, reward system, Leaderboard, levels, attention, relevance, confidence, satisfaction, stage of transition, health condition, and self-management (Chapter 6.4). The positive results from the triangulation (Chapter 6) confirmed that components of the TAG framework are theoretically sound and thus, the used of the framework could be further explored.

The TAG framework was developed to provide a structured reference point for applying the anthropomorphic interfaces in gamified applications for transitional care in health. In research, the framework can be used to understand a research problem pertaining to gamification of anthropomorphic interfaces for transitional care in health. Meanwhile in practice, the framework is expected to be utilised as a reference tool in the design process of designing a transitional care gamified application.

11.1.2 Validation of the use of the framework

The framework was further explored to see how it can be beneficial in the development of transitional care gamified application. In particular, when it can be used as a tool to evaluate the gamification design of anthropomorphic interfaces for transitional care application. With that in mind, a metric was developed to measure the extent of anthropomorphic interfaces are gamified in facilitating the users acquisition of knowledge of his/her health condition towards self-management. This metric was then validated, and they were grouped together in an instrument (Chapter 7.1) called the Transitional Anthropomorphic Gamification Scale (TAGS). The development of the items in the metrics was developed utilising the Goal-Questions-Metrics (GQM) approach using the TAG framework as a reference. Each of the items was derived from the goal defined for each TAG component and from the related questions that were created to achieve the goal.

Following the positive outcomes from the validation tests (see Chapter 8.4), the items and components of the TAGS instrument were then confirmed (see Chapter 8.4.6) and summarized as a reliable instrument proving the use of the framework. The TAGS instrument were considered valid and reliable for what they measured. The TAGS instrument is expected to be useful in informing the game developer and game designer about the applicable designs of the gamification of anthropomorphic interfaces for transitional healthcare in games. Other than that, the instrument would also enable the healthcare body to measure a suitable gamified application meant for transitional healthcare. Further work explores the applicability of the TAG framework and the TAGS instrument.

11.1.3 The applicability of the framework

Considering the TAG framework and the TAGS instrument, a set of design guideline was developed in order to further demonstrate the application of the framework and the instrument into context (see Chapter 9). The developed guidelines reflected the components in the TAG framework and they were in line with the agreeable items in the TAGS instrument. The items in the guideline are based on the purpose and design consideration of the transitional care gamified applications by implementing anthropomorphic interfaces. As a whole, a total of 52 items structured within three categories of guidelines were validated in a focus group discussion. From the focus group discussion, the items in the guidelines were discussed, revised, and modified accordingly (Chapter 9.3). The guideline was deemed adequate and considered suitable. The guideline is expected to be beneficial to the researcher as an input to developing a similar guideline or as a reference to expand the research in gamification or in transitional healthcare. As

for the practitioners, the guideline could help in generating initial ideas of a suitable design for a gamified application in healthcare.

11.2 Contributions

This research makes three contributions drawing from the development of the framework, the validation of the use of the framework, and the application of the framework. These contributions are as follows;

11.2.1 The framework for the use of anthropomorphic interfaces in gamification for transitional care in health (TAG)

The TAG framework is the main contribution of this research. During the development and validation of the framework, the aspects that related to the contribution were;

a) the integration of anthropomorphic interface research and gamification research in order to motivate the users to self-manage in the transitional healthcare
b) an analysis of different type of anthropomorphic interface design used in a gamified application or in a game
c) the different type of anthropomorphic interfaces applied in a gamified application
d) the used of motivational theory in informing the learning and motivation effect on the users' motivation as well as the effects on the transitional patients' behaviour

11.2.2 The validation of the used of the TAG framework

The TAGS instrument is another contributions of this research. The instrument is one of the outcomes from the use of the TAG framework. This instrument has demonstrated that the TAG framework can be practically used. The following aspects relate to this contribution;

a) The TAGS instrument, which could be implemented in other instruments or other research surveys and aims to analyse the design aspects related to healthcare gamified applications
b) The analysis of game design from different type of games, provides a wider perspective of the application of the anthropomorphic gamification in a healthcare setting and in the game design industry
c) Operationalisation of the TAG framework in games with the ability to customise the components or factors of TAGS when apply into context
d) The application of a widely accepted approach for instrument development

e) The application of a stepwise approach following commonly accepted methodologies to validate the instrument.

11.2.3 The application of the framework in transitional healthcare gamified application

Finally, the contribution of this research is a set of guideline for the application of the TAG framework in designing a transitional care gamified application. The aspects relating to this application are;

a) The guideline, as a combination of the TAG framework and the TAGS instrument
b) The guideline, which could be used as a reference in developing a gamified application related to healthcare
c) The understanding of design guidelines in software development

11.3 Future work

The framework has shown its potential benefit in the context of transitional healthcare. This section presents the future work, which the current research could further explore to improve the understanding of the used of the anthropomorphic interfaces in gamification for the transitional care. A continued research is planned to expand and mature the TAG framework. Thus, it could be widely accepted and used in the healthcare setting. The plans for future work could be explored as per four main areas;

1) Expanding the conceptual framework

The triangulation of literature and the research findings in confirming the framework had shown a consistency of arguments and opinions that related to the gamification of anthropomorphic interfaces for transitional healthcare. To expand the framework, more input and exploration of the components in the TAG framework should be conducted. Therefore, the future work may involve exploring the effective ways of applying the game elements in gamification. This could be done by analysing the related available games in the market. The analysis could provide more insight into the details of the relation of the game elements in the framework with the role of storylines or narratives in games. The inclusion of a storyline was suggested during the guideline study (refer Chapter 9.3). Moreover, a recent study by Birk, Atkins, Bowey, & Mandryk (2016) argued that a storyline could define the user's identification with an avatar in games and thus, further promote the user's motivation in a gameplay.

Another suggestion for the expansion of the TAG framework is to look further into the perspective of the users' change of behaviour. This behaviour change could result from being more motivated. By theoretically demonstrate how the design of anthropomorphic interfaces in

gamification could influence users' health-related behaviour, would provide more insight into the way motivations are connected to the behaviour and the effect of the TAG framework in healthcare settings. This could be seen through the lens of health-related behaviour change theories such as the theory of planned behaviour (Ajzen, 1991) or other theories.

2) Validation and Application of the instrument

The TAGS instrument was validated through series of experimental studies. These studies are deemed necessary to ensure that each of the items in the instrument measure the same related concept. For future work, the validation experiment could consider employing a wider variety of participants. For example, involving participants such as software testers, project managers, or music composers and not just people who are specialised in design and development of software and games.

Other opportunities for future work relate to the method of analysis, whereby instead of using factor analysis (as implemented in analysing the items group and relationship in Chapter 6.3), a *Rasch* Model as implemented by Brockmyer, Fox, Curtiss, McBroom, Burkhart, & Pidruzny (2009) in validating the new developed questionnaire, could be used to analyse the fitness of each item in the instrument. In terms of sustaining the TAGS instrument, more applications to measure the anthropomorphic interfaces in gamification for transition care in games should be conducted. The application can either adopt or adapt the components of the TAGS. The results will show the shared use of the instrument, which it could help in the discussion of the research findings related to this field of study.

3) Application and improvement of the guideline

The content of the developed guideline has been validated. For future work, the application of the guideline in a design process is suggested to further establish the use of the guideline in this context. This application could be realised with a pre-designed prototype. Then, a series of experiments to test this prototype should be conducted. These experiments serve to demonstrate the use of the guideline and the findings from the experiments could further strengthen the guidelines. Furthermore, the experiment could provide more practical evidences of the acceptance of the guideline, as one of a usable design tool in designing an application for healthcare settings.

Considering the suggestions from experts during the guideline validation process, future work also involves designing a multi-platform application, such as for a mobile app or a game console, and designing a multi-player application. This suggestion requires further research and

examination of the existing game models or frameworks, because it is not within the scope of the framework. Another suggestion from the experts is to promote the element of a narrative, which is one of the suggestion for future work of the framework itself.

4) Implication in a specific context

Another possible future extension of this research is to look into the perspective of cultures, which explore the effect of cultural aspects in the design of gamification for anthropomorphic interfaces and seeing how these designs could affect the patients' motivation in the transition care process. Culture through the element of skin colour, was included as one of the anthropomorphic design characteristics. However, exploration of cultural feedback has yet to be tested. It would be possible to add another measurement items related to culture as well as the other participants' demographic information (e.g. age, nationality, gender). The findings could be analysed for the impact of anthropomorphic interfaces in gamification for transitional care application, in accordance with varying participant demographics. The application of the framework could also be extended into other context of healthcare that involve the learning and self-management processes. One of them could be related to adherence to medication or adherence to treatment. The framework could be referred to understand the situation, the instrument could be used to measure the suitability of the existing game for that context, or the guideline could be adopted to develop related games for healthcare adherence. All of the possibilities for the future work are summarised in Table 11-2.

Table 11-2 Summary of the possibilities for future research

Future work	Areas	Research ideas to explore
Expanding the conceptual framework	Analysing game elements	Exploring the relation of game elements in TAG framework with the role of storyline or the narrative design in game
	Behaviour change	Embedding the theory of behaviour change
Validation and Application of the instrument	Participant background in the validation experiment	Considering different type of participants
	Method of analysis result	Implementing other methods of analysing the result (e.g. using a *Rasch Model*)
	Adaptability of the Measuring tool	Empirical results that show the instrument can be either adopted or adapted into other contexts
Application and improvement of the guideline	Application of the guideline	Initial Prototype
		Testing and validating the prototype
		Empirical results show acceptance of the guideline
	Improvement of the guideline	Considering for multiple application platforms (e.g. mobile apps, game console)

		Application to multiplayer setting
Implication in a specific context	Utilisation in other domains of healthcare related to learning and self-management	Considering the context of adherence (e.g. medication and treatment)
	Application to different types of patients	Exploring the influence of anthropomorphic interfaces in gamification on various type of participants' social background
	Exploring the cultural aspects through skin colour elements in the TAG framework	Different culture aspects influence the design of anthropomorphic interfaces
		Different cultural designs affect the way patients engage with the application

11.4 Final Remarks

This research aimed to understand the influence of anthropomorphic interfaces in a gamified application for transitional healthcare application. It is expected that the application could help to motivate patients to learn about their condition throughout the process of transition and thus, enable them to self-manage.

The TAG framework in this thesis provides a structured way of understanding the gamification of anthropomorphic interface for transitional healthcare in games through the elements of anthropomorphic interfaces, the game elements in gamification, the motivational effect of gamification and anthropomorphic interfaces, and the requirements for application in transitional healthcare. These elements help to identify the factors and its related components, and thus, they were used as a basis to construct the framework. The identified factors and components for the TAG framework were found to be important for gamifying the anthropomorphic interfaces in a transitional healthcare application.

The framework is expected to predict the extent of anthropomorphic interfaces applied in gamified application for transition healthcare in games. Consequently, the prediction will help to create a benchmark for the design of transitional healthcare applications.

The results of this research have demonstrated that the TAG framework can provide insight and analysis into a suitable design application for transitional healthcare. The outcome of the framework could inform the researchers or game practitioners when making decisions on designing and developing a transitional healthcare application. Further research should look into the effectiveness of the applications on a patient's transition process, in particular how the application could help the patient to self-manage.

Appendices

Appendix A TAGS Description

Factor	Anthropomorphic Elements
Component	Anthropomorphic interface design (AID)
Goal – To observe which type of anthropomorphic character in an application.	
Question	**Metric**
What are the type of anthropomorphic character exist in gamified applications	*Which type of anthropomorphic character best describes my character in the application?*

Factor	Anthropomorphic Elements
Component	Design Purpose (DEP)
Goal - to understand the purposes of using or applying an anthropomorphic character in an application.	
Questions	**Metrics**
Q1. How anthropomorphic character is applied? (*Ease of character customization)*	1. *I can easily customize my own character (for example; change clothes, pants, shoes, hair, add jewellery, etc.)*
	2. *I can easily customize my character's environment (for example; house, car, office, garden, etc.)*
	3. *I can easily change my character from one character to another character?*
Q2. What is the purpose of the application? (*Character as a strategy to play)*	4. *I normally use my character as a tactic to confuse other characters or opponents*
	5. *I normally do not choose a character as a strategy to win*
	6. *I am allowed to upgrade my character to be more powerful or meaningful as the application progresses*

Factor	Anthropomorphic Elements
Component	Social Response (SOR)
Goal – to understand the extent to which the anthropomorphic interfaces significantly demonstrates a convincing social response in an application.	
Questions	**Metrics**
Q1. How the element of *Giving instruction using voice* could stimulate the social response of anthropomorphic interfaces?	1. *I do better when my character gives instructions using vocal instructions, followed by text as the character speaks*
	2. *I can easily change the voice of my character. (for example; from a synthetic voice to a human voice, or from a man's voice to a woman's voice)*
Q2. How the element of Giving a flattering feedback could stimulate the social response of anthropomorphic interfaces?	3. *I find that the character offer flattering words when the user has done a great job?*
Q3. How the element of make gesture	4. *I find my character does not make gestures while*

while interacting could stimulate the social response of anthropomorphic interfaces?	*talking* 5. *I find my character make natural gestures*
Q4. How the element of appear to be ease to control could stimulate the social response of anthropomorphic interfaces?	6. *I find that my character give warnings when I am not following the right instructions* 7. *I find it is hard to control my character*
Q5. How the element of making an eye contact could stimulate the social response of anthropomorphic interfaces?	8. *I find it is strange when my character does not make an eye contact while talking*

Factor	Anthropomorphic Elements
Component	Social Presence (SOP)
Goal – to find the extent to which the anthropomorphic character offers the presence of users in an application.	
Questions	**Metrics**
Q1. How the ease of determining a gender for the character could offers the presence of users in an application?	1. *I can easily choose the gender of my character* 2. *The gender of my character is determined by default*
Q2. How the ease of changing the character's skin could offers the presence of users in an application?	3. *I can easily apply any colour to the my character's skin other than human skin colour* 4. *I am provided with certain ranges of skin colour for the character*
Q3. How the ease of choosing and modifying a body shape could offers the presence of users in an application?	5. *I can easily choose which body shape I want for my character* 6. *I am allowed to modify the body shape of my character* 7. *I am able to create the character body shape from a range of standard shapes (e.g. triangle, rectangle, round, square, etc.)*

Factor	Anthropomorphic Elements
Component	Accessibility (ACC)
Goal – The range of accessibility options for the anthropomorphic character in an application.	
Questions	**Metrics**
Q1. What are the accessible options?	1. *I can easily adjust the text size of the character's speech* 2. *I can easily change the character's speech between spoken and text* 3. *I am able to change the background colour or image of the game's environment* 4. *I am able to change the speech volume of the character* 5. *I am able to see the alternative captions of an anthropomorphic character.*

	For example; when right click, there is a caption to describe the character or there is a caption to describe the character when the character is not available due to low network bandwidth or low computer performance.

Factor	Gamification
Component	Reward System (RES)

Goal -
The extend of reward systems applied in a gamified application

Questions	**Metrics**
Q1. How points are be implemented in gamified applications?	*1. I normally spent my points more to personalize my character (hair, hats, shirt etc.) rather than to add other things (car, weapon, chair, etc.)*
	2. I do not buy additional points when my current points are not enough to be traded
Q2. What are the impact of points in a gamified application?	*3. I can easily increase my character's health/power/energy levels when getting some points through collecting charms/potions/tokens*
	4. I receive free stuff (such as weapons, pets, furniture, or new clothes for my character) upon reaching certain points in the application
	5. My points can be deducted when I am not able to complete a given task
Q3. How badges and trophies are implemented in a gamified application?	*6. Receiving a badge makes my character look stronger than before*
	7. Receiving a trophy makes my character look fabulous
Q4. How easy the process of exchanging the Points/Badges/Trophies?	*8. I can easily exchange my points/badges/trophies for other things in the applications (for example; life, food, power, dress, shoes, level, etc.)*

Factor	Gamification
Component	Leader Board (LEB)

Goal -
The range of Leaderboard utilisations in a gamified application.

Questions	**Metrics**
Q1. How Leaderboard are utilised in gamified applications?	*1. I like to be recognized for my skills and effort in the leaderboard*
	2. I find the leaderboard can increase the competition among the users in the application
Q2. How the user's Character in the leaderboard could effects on	*3. I find my character looks stronger than the other characters in the leaderboard*

the user's performance	
Q3. Does Leaderboard present enough information?	*4. Based on my position on the leaderboard, I feel I have done a great job*
	5. I think the leaderboard present enough information for me to see my progress in the application

Factor	Gamification
Component	Levels (LEV)
Goal - The extent to which levels are utilised in a gamified application.	

Questions	**Metrics**
Q1. How levels are implemented in gamified application?	*1. After completing a level, I am allowed to stop/exit the application, and continue to the next level after returning*
	2. I am not allowed to revisit the previous level when I have not completed the current level
	3. I can easily adjust the level of difficulty based on my preferences
Q2. How character affected at different level?	*4. My character changed when I progressed to the next level*
	5. My character gained more power when I progressed to the next level

Factor	Motivation
Component	Attention (ATT)
Goal - The ways to grab the user's attention (excitement, supports, and surprises) make the user to stay in the gamified applications	

Questions	**Metrics**
Q1. How the element of excitement motivate the user in a gamified application?	*1. I get excited when my character successfully performs a task*
	2. The character in the application does not make me want to continue the application
Q2. How the element of Support to problem solving motivate the user in a gamified application?	*3. I feel supported by the help functions to learn more in the application*
Q3. How the element of Surprises like random elements appear in the application could motivate the user in a gamified application?	*4. I find there are random elements which appear in the application (e.g. surprises, other tasks, additional rewards, bonuses, or new friends joining)*

Factor	Motivation
Component	Relevance (REL)

Goal -
The ways in which the contents relate to user interests; if the application can help to accomplish the user's goals, then they are more likely to be motivated to use it.

Questions	**Metrics**
Q1. How appropriate functions could reflect the element of relevance?	*1. I am being provided with appropriate choices to take action*
Q2. How the user's character is relevant and match with personal interest?	*2. I find the design of my character is relevant to the application*
	3. I am being provided with commonly used icons, objects, or symbols
Q3. How the relation between the presentation and previous experience could reflect the element of relevance?	*4. I find the other characters used in the application are in line with the objectives of the application*
	5. I find the graphical illustrations (such as the tools, settings, and backgrounds) help me to feel familiar with the application
	6. I feel comfortable when my character has been called by the name that I have set for them, rather than the default name given to them

Factor	Motivation
Component	Confidence (CON)

Goal -
What the user expect to experience in the application, so that they become confident in completing the given task.

Questions	**Metrics**
Q1. How the element of opportunities and expectation could reflect the element of confidence?	*1. I am able to choose what sub tasks (mini apps) I want to do and ignore the ones that I don't want to do*
	2. I am not given another chance to try again when I fail to complete a task
	3. I have been given an overview on what to expect upon completing the given task
Q2. How the character could increase the users' self-confidence?	*4. The character I choose for myself in the application helps to increase my confidence levels*
Q3. How receiving feedback or doing repetitive work could increase users' self-confidence?	*5. I find the feedback about my character performance can help me to further understand what must be done in order to improve*
	6. I find that the application provides a similar range of tasks that enable me to master my skills or enhance the knowledge I need

Appendix A

Factor	Motivation
Component	Satisfaction (SAT)
Goal - What the users receive when they accomplish a certain task. The users should be motivated if the task and the reward are defined, thus feel satisfied about their achievement.	
Questions	**Metrics**
Q1. How the outcomes received after playing could motivated the users?	*1. I can relate the gameplay with my current situation. Thus, I am satisfied with my performance*
	2. I enjoyed using the application that I would like to use it again
Q2. How an unexpected event in an applications could help to motivate the users?	*3. I find getting physical rewards is encouraging*
	4. When I am lost, a pop-up hint comes up
Q3. How giving feedback or evaluation could help to motivate the users?	*5. Receiving immediate feedback encourage my involvement*
	6. When I have completed a task, the application acknowledges the level or type of skill I have acquired

Factor	Transition Health
Component	Stage of transition (SOT)
Goal - The extent to which the stage of transition is applied in the application	
Questions	**Metrics**
Q1. How health related tasks in each stages of transition should be implemented?	*1. The application has a series of health related tasks - in the form of stages - in which the difficulty of the tasks will be increased* as *more stages are completed*
Q2. How the character appearance within the stages of transition should be implemented?	*2. The appearance of my character changed in accordance to the stage*
	3. My character does the same range of health task in every stage
	4. I am able to distinguish the stages through the appearance of my character

Factor	Transition Health
Component	Health condition (HEC)
Goal - The extent to which the health condition is being addressed in the application	
Questions	**Metrics**
Q1. How the user's condition are addressed in the application	*1. The application clearly shows what type of illnesses or health conditions it caters for*
	2. I find the given tasks are closely related to a specific health problem
	3. I am allowed to share or collaborate about my health problems with other users

Q2. How the user's condition can be seen through character appearance?	*4. My health condition can be seen through the appearance of my character*
	5. I find my character changed in colour or in behaviour when the health/power/energy of my character got lower

Factor	Transition Health
Component	Self-Management (SEM)

Goal -
The extent to which the application supports user's self-management for a changes towards their behaviour.

Questions	**Metrics**
Q1. What are the functions or tasks could support user's self-management in the gamified application?	*1. The application gives me a reminder or alarm to do a certain task*
	2. I can easily set my own health routine or add my own care plan in the application (for example; what medication to take, what type of exercise to do, plan for a healthier diet)
	3. I am able to organize my health goals in the application (for example; what tasks need to be done, in what order, which tasks are crucial or not)
	4. I know how to recover my character from losing their health (for example; take time off, get enough supplement (medicine, water, food), or buying more energy)

Appendix B Evaluation of the TAGS

B.1 EVALUATION DOCUMENT

PREAMBLE: NOTE TO EXPERTS FOR EVALUATION PURPOSES

Dear Sir/Madam

This document is referred to the '**Evaluation Document**'.
You have also been provided with a document referred to as the '**TAGS Instrument'**.
You have been provided with these documents because you are an expert in the field.

Please evaluate the TAGS Questionnaire using the evaluation criteria.
There are 2 parts to the evaluation: the evaluation of the questions, and the evaluation of the scale.
The questions and the scale each have their own different criteria for evaluation.

In the Evaluation Document, the evaluation criteria appear in blue and green.
The evaluation criteria for the questions appears in the blue area.
The evaluation criteria for the scale appears in the green area.
This evaluation is to get the understanding whether the questions are necessary or not and whether the scales appropriately measuring the question or not.

Thank you for your cooperation. Your help is greatly appreciated.
Yours sincerely
Alisa

Appendix B

This section explains and defines the evaluation criteria for the questions (blue) and the scale (green).

Evaluation Criteria of the Questions	**Definition**
Necessary	The question is essential to describe TAG in a gamified application. It must be included and its absence would be detrimental.
Neither necessary nor unnecessary	The question may be useful but NOT essential to describe TAG in a gamified application.
Unnecessary	The question is NOT necessary to describe TAG in a gamified application. Its absence would not affect TAG in a gamified application.

Evaluation Criteria of the Scale	**Definition**
Appropriate	The scale is appropriate to measure the TAG's item. It indicates that the scale will significantly affect the question.
Neither appropriate nor inappropriate	The scale is neither appropriate nor inappropriate to measure the TAG's question.
Inappropriate	The scale is inappropriate to measure the TAG's item. It indicates that the scales will not significantly affect the question.

Here the term 'questions' and the term 'scale' refers to the questions and the scales used in the TAGS Questionnaire document.

This table consists of TAGS element, the questions number for each element and the evaluation criteria. The questions number for each element referred to the same number and the same element in the TAGS Questionnaire.
Please evaluate the question by placing a tick (✓) in the appropriate part of the evaluation criteria.

Component	**Questions**	**Evaluation Criteria of the Questions**			**Evaluation Criteria of the Scale**		
		Necessary	**Neither necessary nor unnecessary**	**Not necessary**	**Appropriate**	**Neither appropriate nor inappropriate**	**Inappropriate**
Anthropomorphic interface design (AID)	1						
Design Purpose (DEP)	1						
	2						
	3						
	4						
	5						
	6						
Social Response (SOR)	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
Social Presence (SOP)	15						
	16						
	17						
	18						
	19						
	20						
	21						
Accessibility (ACC)	22						
	23						
	24						
	25						
	26						

Appendix B

Component	Questions	Evaluation Criteria of the Questions			Evaluation Criteria of the Scale		
		1	2	3	1	2	3
		Necessary	Neither necessary nor unnecessary	Not necessary	Appropriate	Neither appropriate nor inappropriate	Inappropriate
Reward System (RES)	27						
	28						
	29						
	30						
	31						
	32						
	33						
	34						
Leader Board (LEB)	35						
	36						
	37						
	38						
	39						
Levels (LEV)	40						
	41						
	42						
	43						
	44						
Attention (ATT)	45						
	46						
	47						
	48						
Relevance (REL)	49						
	50						
	51						
	52						
	53						
	54						
Confidence (CON)	55						
	56						
	57						
	58						
	59						
	60						
Satisfaction (SAT)	61						
	62						
	63						
	64						
	65						
	66						

Component	Questions	Evaluation Criteria of the Questions			Evaluation Criteria of the Scale		
		1	2	3	1	2	3
		Necessary	Neither necessary nor unnecessary	Not necessary	Appropriate	Neither appropriate nor inappropriate	Inappropriate
Stage of transition (SOT)	67						
	68						
	69						
	70						
Health condition (HEC)	71						
	72						
	73						
	74						
	75						
Self-Management (SEM)	76						
	77						
	78						
	79						

Do you have any comment or suggestion about the questions and the scales?

Comment/Suggestion;

Thank you very much for completing this evaluation document. Your answers will be useful to the development of this study.

B.2 The TAGS Instrument For Evaluation

PREAMBLE: NOTE TO EXPERTS FOR EVALUATION PURPOSES

Dear Sir/Madam

This document is referred to as the '**TAGS Instrument**'.

You have also been provided with a document referred to as the '**Evaluation Document**'.

You have been provided with these documents because you are an expert in the field.

Please evaluate the TAGS Questionnaire using the evaluation criteria.

The evaluation criteria are described in the Evaluation Document.

This preamble will not appear in the final version of this document.

Thank you for your cooperation. Your help is greatly appreciated.

Yours sincerely

Alisa

Instructions:

An element is a testable subject to evaluate the implementation of Transitional Anthropomorphic Gamification (TAG) in a gamified application.

Description for each element also provided to get the understanding of why the questions being asked.

Please read the questions about the implementation of the elements in a gamified application.

Each question can be answered by using the accompanying scale.

You are require to evaluate the questions and the scales in the *evaluation document*.

Appendix B

Component: Anthropomorphic interface design (AID)

The different types of anthropomorphic character applied in an application/game. Anthropomorphic character is a representation of humanlike design and its qualities into other objects. In this context, anthropomorphic character will be applied into application interfaces.

Questions	Scale (Please tick ✓ once per question)				
	Avatar (More human-like representation)	**Human Cartoon (Less human-like and more to caricature style)**	**Interface Agent (Mix between human and animal)**	**Hybrid Character (animal character or an object)**	**Abstract Character (non-figurative character)**
Which type of anthropomorphic character best describes user character in the application?					

Component: Design Purpose (DEP)

The purposes of using or applying an anthropomorphic character applied in an application/game. Research have shown that the anthropomorphic characters have a connection between motivation and achievement when the user is allowed to personalize their anthropomorphic character and make the anthropomorphic character as a strategy in the application.

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
DEP1	*I can easily customize my own character (for example; change clothes, pants, shoes, hair, add jewellery, etc.)*					
DEP2	*I can easily customize my character's environment (for example; house, car, office, garden, etc.)*					
DEP3	*I can easily change my character from one character to another character?*					
DEP4	*I normally use my character as a tactic to confuse other characters or opponents*					
DEP5	*I normally do not choose a character as a strategy to win*					
DEP6	*I am allowed to upgrade my character to be more powerful or meaningful as the application progresses*					

Component: Social Response (SOR)

The extent to which the anthropomorphic character significantly demonstrates a convincing social response in an application. Research has shown that anthropomorphism that is socially responsive has the characteristics of having eye contact, showing emotion through facial

expressions, smooth gestures, offering flattering feedback, human or synthetic voice instructions, and intelligence.

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
SOR1	*I do better when my character gives instructions using vocal instructions, followed by text as the character speaks*					
SOR2	*I can easily change the voice of my character. (for example; from a synthetic voice to a human voice, or from a man's voice to a woman's voice)*					
SOR3	*I find that the character offer flattering words when the user has done a great job?*					
SOR4	*I find my character does not make gestures while talking*					
SOR5	*I find my character make natural gestures*					
SOR6	*I find that my character give warnings when I am not following the right instructions*					
SOR7	*I find it is hard to control my character*					
SOR8	*I find it is strange when my character does not make an eye contact while talking*					

Component: Social Presence (SOP)

The extent to which the anthropomorphic character offers the presence of users in an application.

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
SOP1	*I can easily choose the gender of my character*					
SOP2	*The gender of my character is determined by default*					
SOP3	*I can easily apply any colour to the my character's skin other than human skin colour*					
SOP4	*I am provided with certain ranges of skin colour for the character*					
SOP5	*I can easily choose which body shape I want for my character*					
SOP6	*I am allowed to modify the body shape of my character*					
SOP7	*I am able to create the character body shape from a range of standard shapes (e.g. triangle, rectangle, round, square, etc.)*					

Appendix B

Component: Accessibility (ACC)

The range of accessibility options for the anthropomorphic character in an application.

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
ACC1	*I can easily adjust the text size of the character's speech*					
ACC2	*I can easily change the character's speech between spoken and text*					
ACC3	*I am able to change the background colour or image of the game's environment*					
ACC4	*I am able to change the speech volume of the character*					
ACC5	*I am able to see the alternative captions of an anthropomorphic character. For example; when right click, there is a caption to describe the character or there is a caption to describe the character when the character is not available due to low network bandwidth or low computer performance.*					

Component: Reward System (RES)

The extent of reward systems applied in a gamified application

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
RES1	*I normally spent my points more to personalize my character (hair, hats, shirt etc.) rather than to add other things (car, weapon, chair, etc.)*					
RES2	*I do not buy additional points when my current points are not enough to be traded*					
RES3	*I can easily increase my character's health/power/energy levels when getting some points through collecting charms/potions/tokens*					
RES4	*I receive free stuff (such as weapons, pets, furniture, or new clothes for my character) upon reaching certain points in the application*					
RES5	*My points can be deducted when I am not able to complete a given task*					
RES6	*Receiving a badge makes my character look stronger than before*					
RES7	*Receiving a trophy makes my character look fabulous*					
RES8	*I can easily exchange my points/badges/trophies for other things in the applications (for example; life, food, power, dress, shoes, level, etc.)*					

Component: Leader Board (LEB)

The range of Leaderboard utilisations in a gamified application.

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
LEB1	*I like to be recognized for my skills and effort in the Leaderboard*					
LEB2	*I find the Leaderboard can increase the competition among the users in the application*					
LEB3	*I find my character looks stronger than the other characters in the Leaderboard*					
LEB4	*Based on my position on the Leaderboard, I feel I have done a great job*					
LEB5	*I think the Leaderboard present enough information for me to see my progress in the application*					

Component: Levels (LEV)

The extent to which levels are utilised in a gamified application.

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
LEV1	*After completing a level, I am allowed to stop/exit the application, and continue to the next level after returning*					
LEV2	*I am not allowed to revisit the previous level when I have not completed the current level*					
LEV3	*I can easily adjust the level of difficulty based on my preferences*					
LEV4	*My character changed when I progressed to the next level*					
LEV5	*My character gained more power when I progressed to the next level*					

Component: Attention (ATT)

The ways to grab the user's attention and make the user to stay in the gamified applications

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
ATT1	*I get excited when my character successfully performs a task*					

ATT2	*The character in the application does not make me want to continue the application*					
ATT3	*I feel supported by the help functions to learn more in the application*					
ATT4	*I find there are random elements which appear in the application (e.g. surprises, other tasks, additional rewards, bonuses, or new friends joining)*					

Component: Relevance (REL)

The ways in which the contents relate to user interests; if the application can help to accomplish the user's goals, then they are more likely to be motivated to use it.

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
REL1	*I am being provided with appropriate choices to take action*					
REL2	*I find the design of my character is relevant to the application*					
REL3	*I am being provided with commonly used icons, objects, or symbols*					
REL4	*I find the other characters used in the application are in line with the objectives of the application*					
REL5	*I find the graphical illustrations (such as the tools, settings, and backgrounds) help me to feel familiar with the application*					
REL6	*I feel comfortable when my character has been called by the name that I have set for them, rather than the default name given to them*					

Component: Confidence (CON)

What the user expect to experience in the application, so that they become confident in completing the given task.

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
CON1	*I am able to choose what sub tasks (mini apps) I want to do and ignore the ones that I don't want to do*					
CON2	*I am not given another chance to try again when I fail to complete a task*					
CON3	*I have been given an overview on what to expect upon completing the given task*					
CON4	*The character I choose for myself in the application helps to increase my*					

	confidence levels					
CON5	*I find the feedback about my character performance can help me to further understand what must be done in order to improve*					
CON6	*I find that the application provides a similar range of tasks that enable me to master my skills or enhance the knowledge I need*					

Component: Satisfaction (SAT)

What the users receive when they accomplish a certain task. The users should be motivated if the task and the reward are defined, thus feel satisfied about their achievement.

ID	**Questions**	**Scale (Please tick ✓ once per question)**				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
SAT1	*I can relate the gameplay with my current situation. Thus, I am satisfied with my performance*					
SAT2	*I enjoyed using the application that I would like to use it again*					
SAT3	*I find getting physical rewards is encouraging*					
SAT4	*When I am lost, a pop-up hint comes up*					
SAT5	*Receiving immediate feedback encourage my involvement*					
SAT6	*When I have completed a task, the application acknowledges the level or type of skill I have acquired*					

Component: Stage of transition (SOT)

The extent to which the stage of transition is applied in the application

ID	**Questions**	**Scale (Please tick ✓ once per question)**				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
SOT1	*The application has a series of health related tasks - in the form of stages - in which the difficulty of the tasks will be increased* as *more stages are completed*					
SOT2	*The appearance of my character changed in accordance to the stage*					
SOT3	*My character does the same range of health task in every stage*					
SOT4	*I am able to distinguish the stages through the appearance of my character*					

Appendix B

Component: Health condition (HEC)

The extent to which the health condition is being addressed in the application

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
HEC1	*The application clearly shows what type of illnesses or health conditions it caters for*					
HEC2	*I find the given tasks are closely related to a specific health problem*					
HEC3	*I am allowed to share or collaborate about my health problems with other users*					
HEC4	*My health condition can be seen through the appearance of my character*					
HEC5	*I find my character changed in colour or in behaviour when the health/power/energy of my character got lower*					

Component: Self-Management (SEM)

The extent to which the application supports user's self-management of their condition

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
SEM1	*The application gives me a reminder or alarm to do a certain task*					
SEM2	*I can easily set my own health routine or add my own care plan in the application (for example; what medication to take, what type of exercise to do, plan for a healthier diet)*					
SEM3	*I am able to organize my health goals in the application (for example; what tasks need to be done, in what order, which tasks are crucial or not)*					
SEM4	*I know how to recover my character from losing their health (for example; take time off, get enough supplement (medicine, water, food), or buying more energy)*					

B.3 The TAGS Instrument After The Evaluation

Questions	**Type (Please tick ✓ once per question)**				
	Avatar (More human-like representation)	**Human Cartoon (Less human-like and more like caricature)**	**Interface Agent (A mix between human and animal)**	**Hybrid Character (An animal character or an object)**	**Abstract Character (non-figurative character)**
Which type of anthropomorphic character best describes user character in the application?					

ID	**Questions**	**Scale (Please tick ✓ once per question)**				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
DEP1	*I can easily customize my own character (for example; change cloths, pants, shoes, hair, add jewellery, etc.)*					
DEP2	*I can easily customize my character's environment (for example; house, car, office, garden, etc.)*					
DEP3	*I normally use my character as a tactic to confuse other characters or opponents*					
DEP4	*I normally do not choose a character as a strategy to win*					
DEP5	*I am allowed to upgrade my character to be more powerful or meaningful as the application progresses*					

ID	**Questions**	**Scale (Please tick ✓ once per question)**				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
SOR1	*I do better when my character gives instructions using vocal instructions, followed by text as the character speaks*					
SOR2	*I can easily change the voice of my character. (for example; from a synthetic voice to a human voice, or from a man's voice to a woman's voice)*					

SOR3	*I find my character cheering me after excellently completing a given task*					
SOR4	*I find my character does not make gestures while talking*					
SOR5	*I find it is hard to control my character, so it does what I want*					
SOR6	*I find it is strange when my character does not make an eye contact while talking*					

ID	**Questions**	**Scale (Please tick ✓ once per question)**				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
SOP1	*I can easily choose the gender of my character*					
SOP2	*The gender of my character is determined by default*					
SOP3	*I can easily change my character's skin colour to something other than human skin colour*					
SOP4	*I am provided with certain ranges of skin colour for the character*					
SOP5	*I can easily choose which body shape I want for my character*					
SOP6	*I am allowed to modify the body shape of my character*					

ID	**Questions**	**Scale (Please tick ✓ once per question)**				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
ACC1	*I can easily adjust the text size of the character's speech*					
ACC2	*I can easily change the character's speech between spoken and text*					
ACC3	*I am able to change the background colour or image of the game's environment*					
ACC4	*I am able to change the speech volume of the character*					

ID	**Questions**	**Scale (Please tick ✓ once per question)**

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
RES1	*I normally spent most of my points to personalize my character (hair, hats, shirt etc.) rather than to add other things (car, weapon, chair, etc.)*					
RES2	*I do not buy additional points when my current points are not enough to be traded*					
RES3	*Receiving a badge makes my character look stronger than before*					
RES4	*Receiving a trophy makes my character look fabulous*					
RES5	*I can easily increase my character's health/power/energy levels when earning some points through collection of charms/potions/tokens*					
RES6	*I can easily exchange my points/badges/trophies for other things in the applications (for example; life, food, power, dress, shoes, level, etc.)*					
RES7	*I receive free stuff (such as weapons, pets, furniture, or new clothes for my character) upon reaching certain points in the application*					

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
LEB1	*I like to be recognized for my skills and effort in the leaderboard*					
LEB2	*I find the leaderboard can increase the competition among the users in the application*					
LEB3	*Based on my position on the leaderboard, I feel I have done a great job*					
LEB4	*I find my character looks stronger than the other characters in the leaderboard*					
LEB5	*I think the leaderboard does not present enough information for me to see my progress in the application*					

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
LEV1	*After completing a level, I am allowed to stop/exit the application, and continue to the next level after returning*					
LEV2	*I am not allowed to revisit the previous level even after I have completed it*					
LEV3	*I can easily adjust the level of difficulty based on my preferences*					
LEV4	*My character changed when I progressed to the next level*					
LEV5	*My character gained more power when I progressed to the next level*					

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
ATT1	*I get excited when my character successfully performs a task*					
ATT2	*The character in the application does not make me want to continue the application*					
ATT3	*I feel supported by the help functions to learn more in the application*					
ATT4	*I find there are random elements which appear in the application (e.g. surprises, other tasks, additional rewards, bonuses, or new friends joining)*					

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
REL1	*I am being provided with appropriate choices to take action*					
REL2	*I find the design of my character is relevant to the application*					
REL3	*I find the other characters used in the application are in line with the*					

	objectives of the application					
REL4	*I find the graphical illustrations (such as the tools, settings, and backgrounds) help me to feel familiar with the application*					
REL5	*I feel comfortable when my character is referred with the name that I have set for them, rather than the default name given to them*					

ID	**Questions**	**Scale (Please tick ✓ once per question)**				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
CON1	*I am able to choose what sub tasks (mini apps) I want to do and ignore the ones that I don't want to do*					
CON2	*The character I choose for myself in the application helps to increase my confidence levels*					
CON3	*I am not given another chance to try again when I fail to complete a task*					
CON4	*I find the feedback about my character performance can help me to further understand what must be done in order to improve*					
CON5	*I find that the application provides a similar range of tasks that enable me to master my skills or enhance the knowledge I need*					

ID	**Questions**	**Scale (Please tick ✓ once per question)**				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
SAT1	*I am not satisfied with my performance*					
SAT2	*I find getting physical rewards is encouraging*					
SAT3	*When I am lost, a pop-up hint comes up*					
SAT4	*I am allowed to evaluate or give feedback about the application*					

SAT5	*When I have completed a task, the application acknowledges the level or type of skill I have acquired*					
SAT6	*I am interested in using the application again*					

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
SOT1	*The application has a series of health related tasks - in the form of stages - in which the difficulty of the tasks will be increased* as *more stages are completed*					
SOT2	*The appearance of my character changed in every stage*					
SOT3	*My character does the same range of health task in every stage*					
SOT4	*I am able to distinguish the stages through the appearance of my character*					

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
HEC1	*The application clearly shows what type of illnesses or health conditions it caters for*					
HEC2	*I find the given tasks are closely related to a specific health problem*					
HEC3	*My health condition can be seen through the appearance of my character*					
HEC4	*I find my character changed in colour or in behaviour when the health/power/energy of my character got lower*					

ID	Questions	Scale (Please tick ✓ once per question)				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
SEM1	*The application gives me a reminder or alarm to do a certain task*					
SEM2	*I can easily set my own health routine or add my own care plan in the application*					

	(for example; what medication to take, what type of exercise to do, plan for a healthier diet)					
SEM3	*I am able to organize my health goals in the application (for example; what tasks need to be done, in what order, which tasks are crucial or not)*					
SEM4	*I know how to recover my character from losing their health* *(for example; take time off, get enough supplement (medicine, water, food), or buying more energy)*					

Appendix C Reliability Test Result For Pre-Test

Steps to analyse;

- Reverse negative Component (record into the same value)
  - DEP4, SOR2, SOR4, SOR5, SOP2, RES1, RES2, LEV2, SAT1, SAT2 (refer the items in Appendix B.3)
- reliability test run for each Component
- Component reduction is based on negative/low effect (<.30) inter item correlation matrix and higher effect on if item is deleted

~~*Removed*~~ ~~*Item is removed*~~

Result;

1) Internal Consistency for the Design Purpose (DEP) component

The Cronbach's α = .54 shown in table C-1, is considered acceptable for indicating the internal consistency of five items in DEP. Based on the item total statistics in table C-2, item No.4 – choose a character as a strategy to win has a negative *Corrected Item-Total Correlation.* This shows that the item not correlated well with the other item. The corresponding value for *Cronbach's Alpha if Item Deleted* for item no.4 indicates that deleting it would significantly increase the total reliability to α = .67. For item no.3 - tactic to confuse other characters, the item has a lower *Corrected Item-Total Correlation* but deleting it will not significantly increase the total alpha. Thus, only item no. 4 will be deleted from the component.

Table C 1 Reliability Statistics for Design Purpose (DEP) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.538	.489	5

Table C 2 Item-Total Statistics for Design Purpose (DEP) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Customize own character	14.7059	5.426	.400	.342	.416
2. Customize character's environment	14.5588	5.284	.585	.522	.269
3. Tactic to confuse other characters	14.7647	8.488	.145	.311	.558
4. Choose a character as a strategy to win	*14.9706*	*9.787*	*-.122*	*.193*	*.667*
5. Upgrade character to be more powerful	14.2941	6.214	.561	.358	.330

2) Internal Consistency for the Social Response (SOR) component

The SOR subscale consisted of six items (α = .53) indicating an acceptable level of reliability (see table C-3). In table C-4, the statistic of items show that the item no. 3 and no. 4 show a low *Corrected Item-Total Correlations* (< .30) but the *Cronbach's Alpha if Item Deleted* are less than the total reliability value. Thus, deleting item no. 3 and no. 4 will not significantly increase the

internal consistency of the component. For item no. 2 - *Ease of changing character's voice,* the statistic shows that the item has a very low *Corrected Item-Total Correlations* (.01) and the *Cronbach's Alpha if Item Deleted* is significantly higher than the total reliability value (α = .61). When referring to the TAGS pool description in Appendix A, there are two items measuring the same metrics; item no. 1 and no. 2. Deleting one would not undermine the content being measured. Since item no. 2 is not supported statistically, it is decided that the item is removed from the component.

Table C 3 Reliability Statistics for Social Response (SOR) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.529	.545	6

Table C 4 Item-Total Statistics for Social Response (SOR) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Instructions using vocal and text	14.76	5.39	.469	.314	.361
2. Ease of changing character's voice	*15.50*	*8.20*	*.011*	*.142*	*.651*
3. Cheering after completing a given task	*14.88*	*7.20*	*.244*	*.089*	*.498*
4. Making gesture while talking	*15.88*	*7.68*	*.124*	*.202*	*.556*
5. Ease of controlling character	15.76	6.00	.605	.442	.324
6. Making eye contact while talking	16.00	7.58	.334	.197	.471

3) Internal Consistency for the Social Presence (SOP) component

Results in table C-5 indicating a good level of reliability of five items in SOP (α = .66). The item total statistics in table C-6 shows the *Corrected Item-Total Correlation* for items no. 2 – Gender determine by default, is less than .30. It shows that the item is not well correlated to the other item in the component. Further analysis on the *Cronbach's Alpha if Item deleted* for item no. 2 shows a significant increase to the total reliability (α = .83). When looking into the TAGS pool description in Appendix A, item no. 1 and no. 2 are measuring the same metrics. If the non-significant item is deleted, it would not affect the validity of the content. Thus, due to insignificant correlation, item no.2 is decided to be removed from the SOP component.

Table C 5 Reliability Statistics for Social Presence (SOP) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.659	.642	5

Table C 6 Item-Total Statistics for Social Presence (SOP) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Choosing a gender for a character	12.29	9.73	.381	.362	.621
2. Gender determine by default	*12.79*	*14.53*	*.212*	*.213*	*.833*
3. Changing the character's skin colour	12.88	8.83	.566	.410	.532
4. Choosing the character's body shape	13.26	7.89	.733	.689	.442
5. Modify the character's body shape	13.35	7.45	.772	.679	.410

4) Internal Consistency for the Accessibility (ACC) component

Table C-7 shows the reliability of accessibility components (four items; α = .78). The results indicate that the items in ACC component are internally consistent. Based on the *Cronbach's Alpha if Item Deleted* in table C-8, removing one of the items would not significantly increase the total reliability. Moreover, all the *Corrected Item-Total Correlation* in table C-8 are more than .30. Thus, all items are remained.

Table C 7 Reliability Statistics for Accessibility (ACC) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.782	.785	4

Table C 8 Item-Total Statistics for Accessibility (ACC) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Ability to adjust the character's text speech	8.94	5.63	.619	.487	.713
2. Ability to change between spoken and text	8.91	5.78	.618	.486	.715
3. Ability to change the game's background	8.68	5.44	.557	.346	.747
4. Ability to adjust speech volume	8.15	5.71	.564	.348	.741

5) Internal Consistency for the Reward System (RES) component

Table C-9 shows the reliability of accessibility components (seven items; α = .61). Basically, the results indicate that the items in RES component are internally consistent.
Based on the item-total statistics in table C-10, item no. 1, no. 2, and no. 7 showed a low value for the *Corrected Item-Total Correlation*. For item no.1 and no. 2, the reliability if the item is deleted are significantly higher than the total reliability. Based on the TAGS pool description in appendix A, item no. 1 and item no. 2 are measuring the same metrics and deleting both of them will affect the validity of the content. On further analysis, item no. 2 has a higher correlated item than item no. 1 (see table C-10). Thus, due to insignificant, item no. 1 is decided to be removed from the component.
For item no. 7, as the *Corrected Item-Total Correlation* is less than .30, it's indicate that the item is not correlated well with the other items in the component. Deleting the item may slightly increase the total reliability (α = .69). According to the TAGS pool description in appendix A, item no. 7 is one of the items that measuring one particular metric. With low statistical impact, item no. 7 is decided to be removed from the component.

Table C 9 **Reliability Statistics for Reward System (RES) component**

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.611	.633	7

Table C 10 Item-Total Statistics for Reward System (RES) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Spending points to personalize character	23.06	13.75	.071	.026	.758
2. Intention buying additional points	24.44	12.86	.117	.131	.768
3. Receiving a badge	23.06	10.91	.669	.847	.623
4. Receiving a trophy	23.00	10.98	.637	.846	.628
5. Increasing character's power	22.00	11.52	.479	.452	.664
6. Exchanging points for others	23.12	10.29	.613	.600	.624
7. Received free stuff upon reaching points	23.21	10.84	.155	.145	.743

6) Internal Consistency for the Leaderboard (LEB) component

The Cronbach's α for five subscale items in LEB is .64, indicating a good level of reliability (see table C-11). The item-total statistics in table C-12 shows that the *Corrected Item-Total Correlations* for item no. 5 - *Sufficient information in leaderboard* is less than .30, and the *Cronbach's Alpha if Item Deleted* shows if item no. 5 is deleted, the total reliability will increased to α = .78. According to the TAGS pool description in appendix A and the validity result in table 10-1, removing the item will not undermine the validity of content. Due to insignificant correlated item, item no. 5 is decided to be removed.

Table C 11 Reliability Statistics for Leaderboard (LEB) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.640	.645	5

Table C 12 Item-Total Statistics for Leaderboard (LEB) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Recognizing skills and effort	14.85	6.01	.568	.402	.671
2. Increase competition among users	15.03	5.91	.511	.428	.692
3. Position in leaderboard	15.09	6.20	.586	.482	.669
4. Character's appearance in leaderboard	15.26	5.53	.622	.490	.646
5. Sufficient information in leaderboard	15.76	6.91	.071	.145	.780

7) Internal Consistency for the Level (LEV) component

The LEV subscale consisted of five items (α = .44) has an acceptable level of reliability (see table C-13). The item-total statistics in table C-14 shows that item no. 2 and no. 3 have not correlated well with the other items in the component. When these items are deleted, the total reliability of the component is significantly increased to α = .65. By referring the TAGS pool document in Appendix A, and the content validity result in table 10-1, deleting these items would not affect the content being measured.

Table C 13 Reliability Statistics for Level (LEV) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.442	.461	5

Table C 14 Item-Total Statistics for Level (LEV) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Complete a level and allow to continue	13.50	6.38	.384	.172	.291
2. Allow to revisit previous level after completed	14.68	8.77	-.156	.166	.654
3. Able to adjust level difficulty	14.26	7.17	.159	.166	.436
4. Character's appearance within level	14.44	5.04	.496	.478	.152
5. Gaining more power when progressing to the next level	13.82	5.73	.425	.507	.237

8) Internal Consistency for the Attention (ATT) component

The results for Cronbach's α for the ATT component in table C-15 indicate an acceptable level of reliability (4 items; α = .59). The item-total statistics in table C-16 shows the *Corrected Item-Total Correlation* for item no. 2 is very low (<.30) and the *Cronbach's Alpha if Item Deleted* has showed a significant increased to total reliability (α = .68). Thus, item no. 2 – *The character make to continue the application* is considered to be removed.

Table C 15 Reliability Statistics for Attention (ATT) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.592	.602	4

Table C 16 Item-Total Statistics for Attention (ATT) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Excited when successfully performs a task	11.06	3.39	.389	.179	.579
2. The character make to continue the application	11.97	2.89	.104	.167	.676
3. Supported by the help functions	11.21	3.32	.489	.258	.520
4. Random elements in the applications	11.21	3.14	.390	.192	.579

9) Internal Consistency for the Relevance (REL) component

Table C-17 shows Cronbach's α for REL (5 items; α = .61). The result indicates that the component has a good level of reliability. The item-total statistics in table C-18 shows that if item no. 5 - *Referring the character with the name set to them* is deleted, the total reliability will be increased to α = .76. The item no. 5 has a very low *Corrected Item-Total Correlation* which indicate that it is not correlated well with the other items in the component. Referring to the TAGS pool document and validity of the content, removing item no. 5 will not undermine the content being measured and substantially increased the reliability of the component.

Table C 17 Reliability Statistics for Relevance (REL) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.614	.661	5

Table C 18 Item-Total Statistics for Relevance (REL) component

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Provided with appropriate choices	15.47	4.19	.488	.408	.490
2. Character is applicable	15.44	4.62	.472	.265	.509
3. Objectivity of the other characters	15.35	4.48	.578	.438	.461
4. Getting familiar with the graphics	15.29	5.06	.455	.533	.531
5. Referring the character with the name set to them	15.62	5.58	.035	.187	.760

10) Internal Consistency for the Confidence (CON) component

The results of Cronbach's α in table C-19 indicate that CON has an acceptable level of reliability (α = .40). In table C-20, the item no. 3 - *Giving another chance to try again* shows an increase in the total reliability if the item is deleted (α = .73). The item also has low effect on the *Corrected Item-Total Correlation* (.12). When referring to the TAGS pool document, this item is one of the items that measuring a particular metrics. Thus, removing it would not affect the content being measured.

Table C 19 Reliability Statistics for Confidence (CON) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.403	.719	5

Table C 20 Item-Total Statistics for Confidence (CON) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Able to choose mini apps	14.29	7.42	.555	.347	.616
2. Chosen character increase confidence	14.06	9.33	.397	.243	.683
3. Giving another chance to try again	*14.50*	*9.04*	*.122*	*.140*	*.722*
4. Giving feedback on character's performance	14.24	9.52	.530	.312	.645
5. Enhanced knowledge through similar tasks	14.21	8.29	.577	.368	.611

11) Internal Consistency for the Satisfaction (SAT) component

The result in table C-21 indicate that the SAT subscale consisted of six items has an acceptable level of reliability (α = .49). The *Cronbach's Alpha if Item Deleted* for item no. 1 and no. 2 in table C-22 shows a higher reliability (α = .63 / α = .62) when these two items are deleted. On further analysis, the item no. 1 and no. 2 have a very low value for *Corrected Item-Total Correlation* which indicating these two items not correlated well with the other items in the component. When referring to TAGS pool document, item no. 1 and no. 2 are measuring different metrics and within the same metrics, there are other items as well. Thus, deleting these two items would not affect the validity of the content.

Table C 21 Reliability Statistics for Satisfaction (SAT) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.486	.511	6

Table C 22 Item-Total Statistics for Satisfaction (SAT) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Feel satisfied with performance	18.47	9.05	-.119	.100	.631
2. Getting physical rewards is encouraging	17.53	9.89	.012	.081	.621
3. Hints come up when getting lost	17.71	7.31	.257	.226	.435
4. Receiving feedback is encouragement	18.26	6.63	.357	.451	.377
5. Skills acknowledgement from application	17.79	6.65	.477	.525	.329
6. Like to use the application again	17.74	5.72	.577	.420	.238

12) Internal Consistency for the Stage of Transaction (SOT) component

The results of SOT in table C-23 is found to be reliable (4 item; α = .45). The item-total statistics (see table C-24) indicate that the *Corrected Item-Total Correlation* for item no. 4 - *Able to distinguish the stages through character's appearance* is less than .30, and the *Cronbach's Alpha if Item Deleted* for this item will significantly increase the total reliability to α = .66. According to the TAGS pool document, there are other items that measuring the same metrics. Deleting item no. 4 may not risk the component validity. Thus, due to insignificant, item no. 4 is removed.

Table C 23 Reliability Statistics for Stage of Transaction (SOT) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.449	.420	4

Table C 24 Item-Total Statistics for Stage of Transaction (SOT) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. A series of health related tasks form in stages	9.38	3.27	.347	.335	.270
2. Appearance of character in every stage	9.06	4.36	.370	.161	.278
3. Doing the same range of health task in every stage	9.26	3.59	.508	.381	.104
4. Able to distinguish the stages through character's appearance	9.18	6.45	-.132	.062	.656

13) Internal Consistency for the Health Condition (HEC) component

The HEC subscales consisted of four items has α = .64, which indicate a good level of reliability (see table C-25). The item-total statistics in table C-26 shows that the item no. 4 - *Character changed in colour or in behaviour* has a very low value for *corrected item-total correlation not correlated*. This shows that the item is not correlated well with the other items in the component. Moreover, the *Cronbach's Alpha if Item Deleted* for item no. 4 shows a significant increase to total reliability if the item is deleted (α = .76). When considering the TAGS pool document, there are

other items in measuring the same metrics. Thus, due to insignificant, the item no. 4 is removed from the component.

Table C 25 Reliability Statistics for Health Condition (HEC) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.637	.643	4

Table C 26 Item-Total Statistics for Health Condition (HEC) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Type of illnesses shows in the application	9.71	5.24	.465	.609	.531
2. Tasks are related to the illnesses	9.71	5.31	.603	.598	.439
3. Health condition appear in the character	9.44	5.35	.540	.308	.478
4. Character changed in colour or in behaviour	9.09	7.17	.026	.201	.757

14) Internal Consistency for the Self-Management (SEM) component

The results of Cronbach's α for SEM is .73 (see table C-27). It is considered highly reliable, where all items are measuring the same content. In table C-28, the item-total statistics show the *Corrected Item-Total Correlation* for all items are more than .30, and the *Cronbach's Alpha if Item Deleted* for all items are less than the total reliability. Thus, all the items are remained.

Table C 27 Reliability Statistics for Self-Management (SEM) component

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.729	.731	4

Table C 28 Item-Total Statistics for Self-Management (SEM) component

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
1. Reminder to do certain task	8.62	7.274	.598	.474	.623
2. Ability to set health routine	9.18	7.544	.518	.435	.668
3. Ability to organize health goals	9.03	7.484	.511	.421	.672
4. Recognize character's recovery	8.65	7.508	.455	.421	.708

Appendix D The TAGS Instrument

About the Game;

Game title: _____

The type of anthropomorphic character best describes my character in the application:

☐ Avatar (More human-like representation)

☐ Human Cartoon (Less human-like and more like caricature)

☐ Interface Agent (A mix between human and animal)

☐ Hybrid Character (An animal character or an object)

☐ Abstract Character (non-figurative character)

Instruction:

Read the following statement about the game you just played and then, please tick (✓) one per item, how much do you agree or disagree with each of the item

ID	Items	Scale (Please tick ✓ once per item)				
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
DEP1.	*I can easily customize my own character (for example; change cloths, pants, shoes, hair, add jewellery, etc.)*					
DEP2.	*I can easily customize my character's environment (for example; house, car, office, garden, etc.)*					
DEP3.	*I normally use my character as a tactic to confuse other characters or opponents*					
DEP4.	*I am allowed to upgrade my character to be more powerful or meaningful as the application progresses*					
SOR1.	*I do better when my character gives instructions using vocal instructions, followed by text as the character speaks*					
SOR2.	*I find my character cheering me after excellently completing a given task*					
SOR3.	*I find my character does not make gestures while talking*					
SOR4.	*I find it is hard to control my character, so it does what I want*					
SOR5.	*I find it is strange when my character does not make an eye contact while talking*					
SOP1.	*I can easily choose the gender of my character*					

SOP2.	*I can easily change my character's skin colour to something other than human skin colour*					
SOP3.	*I can easily choose which body shape I want for my character*					
SOP4.	*I am allowed to modify the body shape of my character*					
ACC1.	*I can easily adjust the text size of the character's speech*					
ACC2.	*I can easily change the character's speech between spoken and text*					
ACC3.	*I am able to change the background colour or image of the game's environment*					
ACC4.	*I am able to change the speech volume of the character*					
RES1.	*I do not buy additional points when my current points are not enough to be traded*					
RES2.	*Receiving a badge makes my character look stronger than before*					
RES3.	*Receiving a trophy makes my character look fabulous*					
RES4.	*I can easily increase my character's health/power/energy levels when earning some points through collection of charms/potions/tokens*					
RES5.	*I can easily exchange my points/badges/trophies for other things in the applications (for example; life, food, power, dress, shoes, level, etc.)*					
LEB1.	*I like to be recognized for my skills and effort in the leaderboard*					
LEB2.	*I find the leaderboard can increase the competition among the users in the application*					
LEB3.	*Based on my position on the leaderboard, I feel I have done a great job*					
LEB4.	*I find my character looks stronger than the other characters in the leaderboard*					
LEV1.	*After completing a level, I am allowed to stop/exit the application, and continue to the next level after returning*					
LEV2.	*My character changed when I progressed to the next level*					
LEV3.	*My character gained more power when I progressed to the next level*					

ATT1.	*I get excited when my character successfully performs a task*					
ATT2.	*I feel supported by the help functions or tutorials given in the application*					
ATT3.	*I find there are random elements which appear in the application (e.g. surprises, other tasks, additional rewards, bonuses, or new friends joining)*					
REL1.	*I am being provided with appropriate choices to take action*					
REL2.	*I find the design of my character is relevant to the application*					
REL3.	*I find the graphical illustrations (such as the tools, settings, and backgrounds) help me to feel familiar with the application*					
REL4.	*I find the other characters used in the application are in line with the objectives of the application*					
CON1	*I am able to choose what sub tasks (mini apps) I want to do and ignore the ones that I don't want to do*					
CON2	*The character I choose for myself in the application helps to increase my confidence levels*					
CON3	*I find the feedback about my character performance can help me to further understand what must be done in order to improve*					
CON4	*I find that the application provides a similar range of tasks that enable me to master my skills or enhance the knowledge I need*					
SAT1.	*When I am lost, a pop-up hint comes up*					
SAT2.	*Receiving immediate feedback encourage my involvement*					
SAT3.	*When I have completed a task, the application acknowledges the level or type of skill I have acquired*					
SAT4.	*I enjoyed using the application that I would like to use it again*					
SOT1.	*The application has a series of health related tasks - in the form of stages - in which the difficulty of the tasks will be increased* as *more stages are completed*					

SOT2.	*The appearance of my character changed in accordance to the stage that reflect my health condition*					
SOT3.	*My character does the same range of health task in every stage*					
HEC1.	*The application clearly shows what type of illnesses or health conditions it caters for*					
HEC2.	*I find the given tasks are closely related to a specific health problem*					
HEC3.	*My health condition can be seen through the appearance of my character*					
SEM1	*The application gives me a reminder or alarm to do a certain task*					
SEM2	*I can easily set my own health routine or add my own care plan in the application (for example; what medication to take, what type of exercise to do, plan for a healthier diet)*					
SEM3	*I am able to organize my health goals in the application (for example; what tasks need to be done, in what order, which tasks are crucial or not)*					
SEM4	*I know how to recover my character from losing their health (for example; take time off, get enough supplement (medicine, water, food), or buying more energy)*					

Thank you for completing this questionnaire. Your responses will be very useful to the research. If you have any questions related to the research study, please contact the following researcher; Nooralisa Mohd Tuah (N.Mohd-Tuah@soton.ac.uk) or Gary B Wills (gbw@ecs.stotn.ac.uk) or Ashok Ranchhod (A.Ranchhod@soton.ac.uk)

Appendix E Results for the analysis of games

Table E 1 Game Frequency

Games		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Club Penguin	15	44.1	44.1	44.1
	Pirate101	5	14.7	14.7	58.8
	Monster Manor	7	20.6	20.6	79.4
	Re-Misson2	7	20.6	20.6	100.0
	Total	34	100.0	100.0	

Table E 2 Mean Score Game vs TAG component

	Anthropomorphic Interface	Gamification	Motivation	Transition
Club Penguin	3.41	3.87	3.86	3.78
Pirate 101	3.43	3.97	3.84	2.67
Monster Manor	3.23	3.79	3.63	4.01
Re-Mission 2	3.13	3.73	3.71	3.40

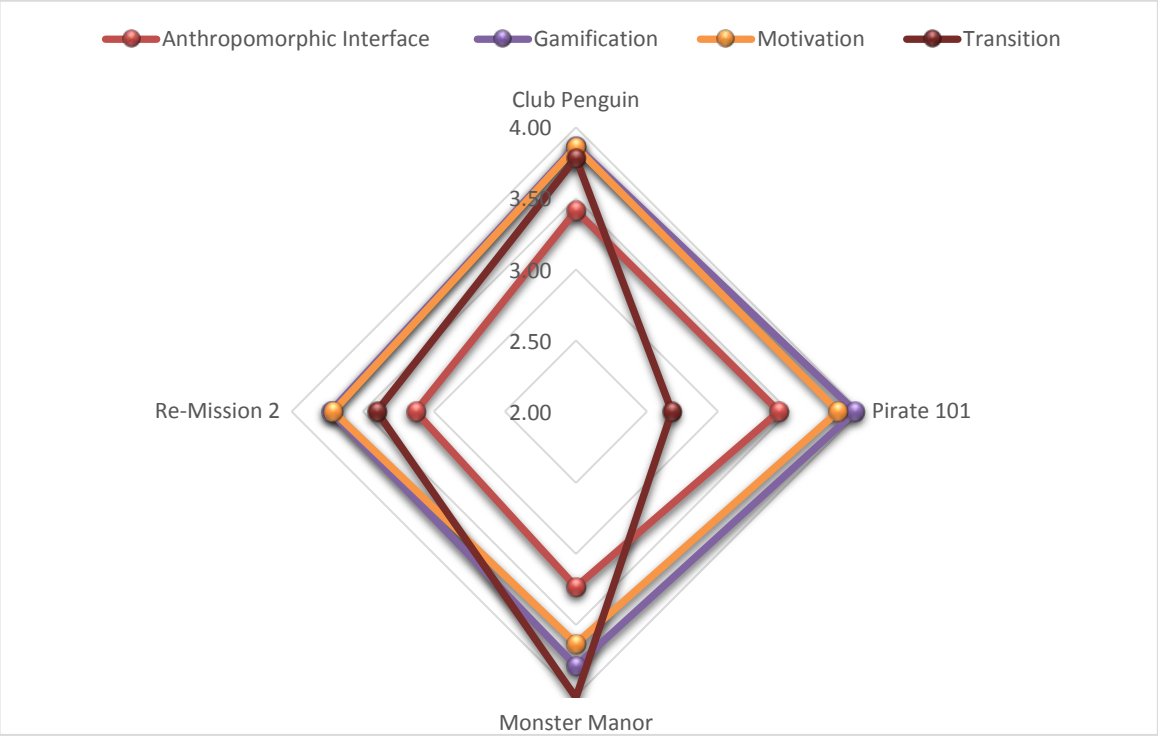


Figure E 1 Radar Diagram Games vs Average Mean of AGT

Appendix F Results for The Factor Analysis

F.1 Anthropomorphic Elements

Results as in the report refer Chapter 8.3.4.1.1, Factor analysis for Anthropomorphic Elements.

F.2 Gamification

Table F2-1 Initial Run of FA for Gamification - Rotated Component Matrix[a]

Items		Communalities	Component 1	2	3
RES2	Receiving a badge	.756	.857		
RES3	Receiving a trophy	.720	.822		
RES1	Intention buying additional points	.471	.671		
RES5	Exchanging points for others	.365	.581		
RES4	*Increasing character's power*	*.128*	*.348*		
LEB2	Increase competition among users	.599		.760	
LEB1	*Recognizing skills and effort*	*.596*		*.685*	*-.302*
LEB4	Character's appearance in leaderboard	.451		.614	
LEV1	Complete a level and allow to continue	.605		.579	.491
LEB3	Position in leaderboard	.349		.578	
LEV2	Character's appearance within level	.717			.844
LEV3	Gaining more power when progressing to the next level	.660			.795
Eigenvalue			3.02	1.76	1.63
% of Variance			25.19	14.70	13.58
Total Variance Explained		53.47%			
KMO		.668			
Barlett's Test of Sphericity		448.63			
Significant		.000			

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
[a]Rotation converged in 4 iterations.

F.3 Motivation

Table F3-1 Initial Run of FA for Motivation - Rotated Component Matrix[a]

Items		Communalities	Component 1	2	3	4
SAT4	Like to use the application again	.572	.731			
SAT3	Skills acknowledgement from application	.594	.730			
SAT2	Receive feedback is encouragement	.533	.722			
SAT1	Hints come up when getting lost	.584	.719			
REL4	Getting familiar with the graphics	.539		.679		
REL1	Provided with appropriate choices	.510		.647		
ATT2	Supported by the help functions	.468		.640		
ATT3	Random elements in the applications	.437		.597		
ATT1	Excited when successfully performs a task	.452		.568		
REL3	*Objectivity of the other characters*	*.488*		*.524*	*.458*	
CON2	Chosen character increase confidence	.686			.789	
CON3	Giving feedback on character's performance	.500			.697	
CON4	Enhanced knowledge through similar tasks	.489			.610	
REL2	Character is applicable	.793				.859
CON1	*Able to choose mini apps*	*.685*			*.552*	*.587*
Eigenvalue			3.35	2.42	1.47	1.09
% of Variance			22.32	16.13	9.77	7.30
Total Variance Explained		55.52%				
KMO		.627				
Barlett's Test of Sphericity		592.40				
Significant		.000				

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
[a]Rotation converged in 5 iterations.

F.4 Transitional Health

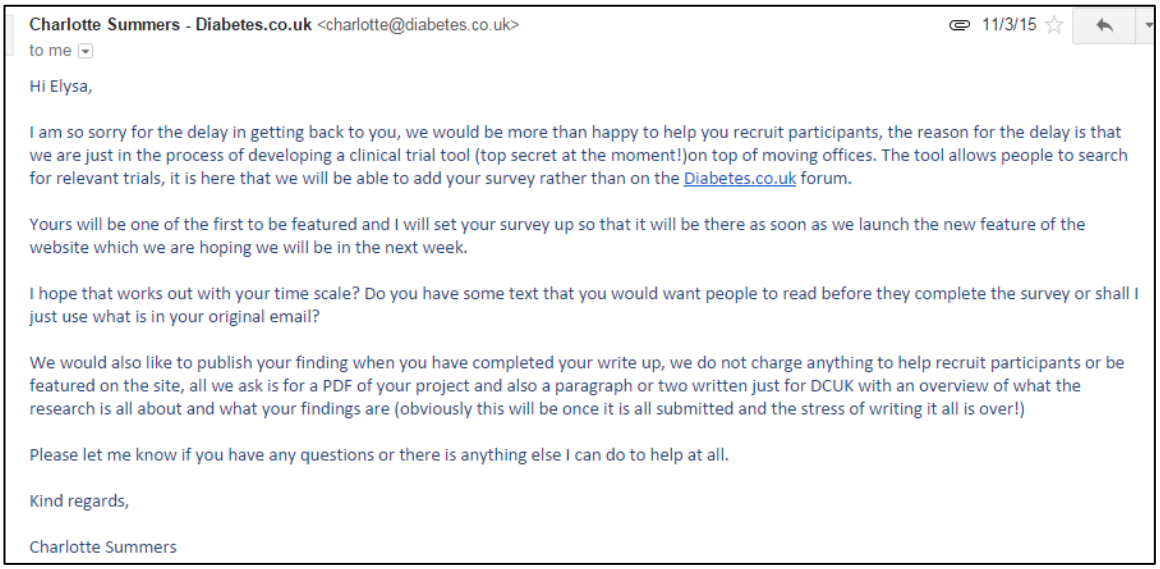
Table F4-1 Initial Run of FA for Health Transition - Rotated Component Matrix[a]

Items		Communalities	Component 1	2	3
SEM2	Ability to set health routine	.673	.807		
SEM4	Recognize character's recovery	.664	.787		
SEM3	Ability to organize health goals	.599	.762		
SEM1	Reminder to do certain task	.296	.397		.365
SOT1	A series of health related tasks form in stages	.713		.833	
SOT3	Doing the same range of health task in every stage	.702		.811	
SOT2	Appearance of character in every stage	.647		.791	
HEC3	Health condition appear in the character	.738			.857
HEC2	Tasks are related to the illnesses	.701			.821
HEC1	Type of illnesses shows in the application	.570	.332	.326	.595
Eigenvalue			3.39	1.59	1.31
% of Variance			33.99	15.98	13.06
Total Variance Explained		63.03%			
KMO		.763			
Barlett's Test of Sphericity		408.87			
Significant		.000			

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
[a]Rotation converged in 4 iterations.

Appendix G Survey Forum Screenshots

G.1 Diabetes Contact



Charlotte Summers - Diabetes.co.uk <charlotte@diabetes.co.uk> 11/3/15
to me

Hi Elysa,

I am so sorry for the delay in getting back to you, we would be more than happy to help you recruit participants, the reason for the delay is that we are just in the process of developing a clinical trial tool (top secret at the moment!)on top of moving offices. The tool allows people to search for relevant trials, it is here that we will be able to add your survey rather than on the Diabetes.co.uk forum.

Yours will be one of the first to be featured and I will set your survey up so that it will be there as soon as we launch the new feature of the website which we are hoping we will be in the next week.

I hope that works out with your time scale? Do you have some text that you would want people to read before they complete the survey or shall I just use what is in your original email?

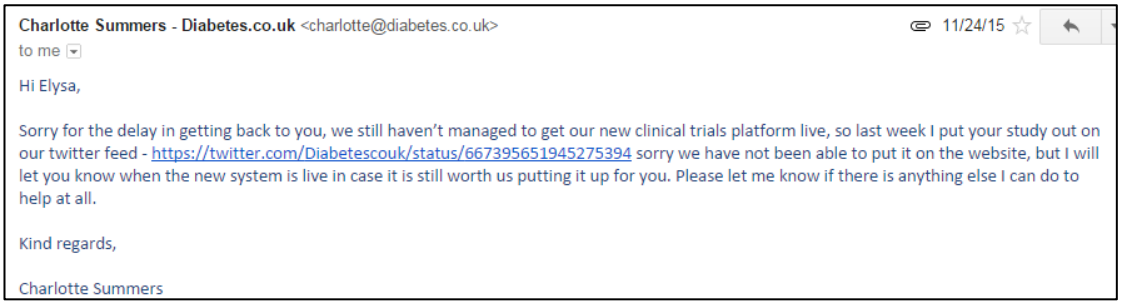
We would also like to publish your finding when you have completed your write up, we do not charge anything to help recruit participants or be featured on the site, all we ask is for a PDF of your project and also a paragraph or two written just for DCUK with an overview of what the research is all about and what your findings are (obviously this will be once it is all submitted and the stress of writing it all is over!)

Please let me know if you have any questions or there is anything else I can do to help at all.

Kind regards,

Charlotte Summers

Figure G. 1 Screenshot 1 – Approval to put up the survey on diabetes.co.uk website



Charlotte Summers - Diabetes.co.uk <charlotte@diabetes.co.uk> 11/24/15
to me

Hi Elysa,

Sorry for the delay in getting back to you, we still haven't managed to get our new clinical trials platform live, so last week I put your study out on our twitter feed - https://twitter.com/Diabetescouk/status/667395651945275394 sorry we have not been able to put it on the website, but I will let you know when the new system is live in case it is still worth us putting it up for you. Please let me know if there is anything else I can do to help at all.

Kind regards,

Charlotte Summers

Figure G. 2 Screenshot 2- Survey to upload on diabetes twitter

Figure G. 3 Screenshot 3 – Survey link uploaded on the twitter newsfeed

G.2 Kidney Forum

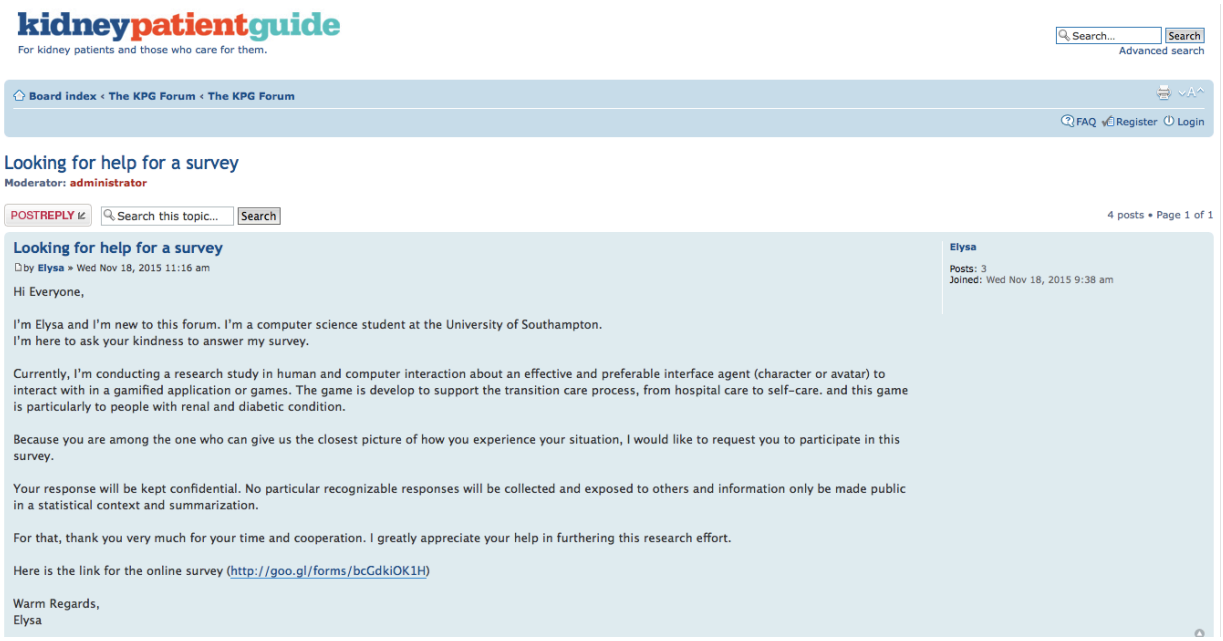


Figure G. 4 Screenshot4 - Posted a post in a forum of kidneypatientguide

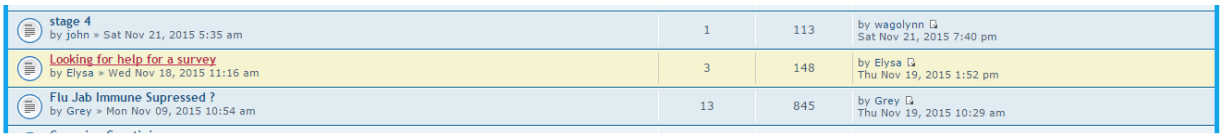


Figure G. 5 Screenshot5 – Number of views and comments of the post made in the forum

Appendix H NVIVO word frequencies search

Word	Count
games	82
application	72
think	64
user	54
character	53
motivation	44
human	43
gamification	39
healthcare	39
avatar	36
interaction	32
characters	31
effect	30
design	29
improve	27
young	25
health	24
fun	24
people	23
research	23
adult	22
experience	21
related	19
rewards	18
good	17
encouraging	17
utilising	17
appearance	17
representation	16
system	15

Figure H. 1 Screenshot words cloud

Glossary of Terms

Anthropomorphic Interfaces – A human form representation with human qualities and characteristics in computer applications

Engagement – A state of behaviour continuing involvement in interacting with a computer application

Effect Size – the differences in the means between the investigate groups and the control condition/group as stated in the standard deviation

Gamification – A concept to make a non-gaming environment into one more game like.

Motivation – A desire that stimulate and sustain a patient's behaviour throughout the transition process.

Transition Healthcare – A process in healthcare to transfer a patient from hospital care to self-care.

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