VIRTUAL AGENT DESIGN MODEL FOR A HIGHER EDUCATION INSTITUTION: A KANSEI APPROACH

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VIRTUAL AGENT DESIGN MODEL FOR A HIGHER EDUCATION INSTITUTION: A KANSEI APPROACH

ABSTRACT

The rapid growth of Internet users and the diversity in application technologies have motivated research scholars and educators to design intelligent tools such as virtual agents as effective learning tools. However, the success of a learning tool relies primarily on the level of acceptance of the tool by the learners and the effectiveness of the tool itself. It must be noted that the first year experience is important to new learners as failing to optimize learners' satisfaction can lead to higher attrition rate and it is proven that effective teaching tools are essential to retain these stakeholders in a Higher Education Institution (HEI). This research addresses the gap in the evidence on effective and affective design specifications of a teaching and learning tool that deploys virtual agents. To add on, the presence of design specific stereotypes that is very inclined to certain community does not adhere to the heterogeneous community of learners in Higher Education Institution. Therefore, this research aims to design and validate a Virtual Agent Design Model (VADM) using the Kansei approach to enhance learning in a Virtual Learning Environment (VLE) deployed in HEI that fosters multiculturalism. This research adapts the Kansei Engineering approach which is an emerging technology used to explore and validate the learner's satisfaction. Further, this research highlights and validates the learner's emotional experience based on the positive Kansei value of the designed virtual agents. The outcome proposes an affective design model for virtual agent design that caters to heterogeneous community in a HEI.

Keywords: Kansei Engineering, Virtual Agents, Higher Education Institution, Virtual Agent Design Model

ABSTRAK

Pertumbuhan pesat pengguna Internet dan kepelbagaian dalam informasi teknologi telah membuat para penyelidik dan pendidik untuk mengklasifikasikan alat pintar seperti ejen maya sebagai alat pembelajaran yang efektif. Walau bagaimanapun, penggunaan alat pembelajaran secara luas bergantung terutamanya kepada tahap penerimaan alat oleh pelajar dan keberkesanan alat itu sendiri. Selain itu, pengalaman pelajar semasa di tahun pertama pengajian gagal mengoptimumkan kadar kepuasan belajar di kalangan pelajar di Institusi Pengajian Tinggi (IPT). Kesannya, ia membawa kepada kadar keciciran yang lebih tinggi dan ia terbukti bahawa alat pengajaran yang berkesan adalah salah satu komponen penting untuk mengatasi masalah di Institusi Pengajian Tinggi. Tambahan pula, tidak banyak penyelidikan dijalankan berkaitan dengan reka bentuk ejen maya yang digunakan dalam medium pengajaran. Di samping itu, wujudnya reka bentuk khusus atau stereotaip yang sangat cenderung untuk sesuatu masyarakat tertentu dan tidak mengutamakan komuniti heterogen. Oleh itu, kajian ini bertujuan untuk mereka bentuk agen maya afektif yang memainkan peranan sebagai tenaga pengajar dalam Persekitaran Maya Pembelajaran di Institusi Pengajian Tinggi yang memupuk kepelbagaian budaya. Kajian ini menggunakan pendekatan Kansei Engineering, teknologi baru yang digunakan untuk meneroka dan mengesahkan kadar kepuasan pelajar. Tambahan pula, kajian ini mengesahkan pengalaman emosi pelajar berdasarkan nilai Kansei positif ejen maya yang direka menggunakan model ejen maya (VADM). Hasil daripada kajian ini adalah satu model reka bentuk ejen maya (VADM) yang afektif yang memenuhi keperluan masyarakat heterogen dalam IPT.

Kata kunci: Kansei Engineering, Agen Maya, Institusi Pengajian Tinggi, Model Reka Bentuk Ejen Maya

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"***God does not create a lock without its key and God does not give you problems without its solutions***"

~Sri Sai Baba

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LIST OF SYMBOLS AND ABBREVIATIONS

KE	:	Kansei Engineering
KW	:	Kansei Keyword
VLE	:	Virtual Learning Environment
UX	:	User Experience
EM	:	Experience of Meaning
AE	:	Aesthetic Experience
EX	:	Emotional Experience
VADM	:	Virtual Agent Design Model
WBL	:	Web-Based Learning
OCC	:	Ortony, Clore & Collins
PAD	:	Pleasure-Arousal-Dominance
OCC	:	Ortony, Clore & Collins
ToER	:	Theory of Emotion Regulation
TOM	:	Theory of Mind
HCI	:	Human Computer Interaction
LMS	:	Learning Management System
EEG	:	Electroencephalography
ECG	:	Electrocardiography
PPITF	:	Participatory Playful Interaction Theoretical Framework
FA	:	Factor Analysis
PCA	:	Principal Component Analysis
KDM	:	Kansei Design Model

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

This chapter defines the research study, elaborates the background of the study related to Kansei Engineering (KE) and virtual agents, and identifies the research problems. It also highlights the aims of this research study and formulates the research questions that was addressed in later chapters. Besides that, the scope and limitation of this study on emotional experience of learners towards the virtual agents are also emphasized. The chapter ends with an overview of the chapters in the thesis.

1.1 Background of Study

Internet technology has evolved dramatically over the past decade and has changed the way we live and communicate with each other. According to Statistical Summaries for Academic Libraries (2000, p3), *"[i]nformation technology skills enable an individual to use computers, software applications, databases and other technologies to achieve a wide variety of academic, work-related and personal goals*". This advancement in information technology has also provided opportunities for changes in the field of education. As a result, currently, *e*-learning tools play an important role in the Higher Education Institutions (HEIs). The wide acceptability of such a tool has implicitly changed the learning styles among the students. Today, e-learning tool is one of the emerging needs of information age whereby it replaces the traditional teaching method for the distant learners and simultaneously encourages collaborative learning (McArdle et al., 2004; Barak, 2016; Cobb & Jackson, 2011). It is also noticed that one of the recent and successful tool adapted in the new e-learning era is the virtual reality based learning tools.

Virtual Reality (VR) is a way for humans to visualize, manipulate and interact with complex data. The most prevalent application of virtual reality application is in the Virtual Learning Environment (VLE). This virtual world offers the learners a three-dimensional learning environment equipped with 3D object viewing. Hence, it increases the learners'

attention and interactivity with the objects like in the real world. However, the success of a virtual reality based learning tool depends on the duration it can capture the attention of the learners and the lifespan of the tool itself.

On another note, Page (2014) has highlighted that enjoyment and pleasure are the primary reasons for the attachment between the consumer and a new product. His research has proven that besides facets like appearance and reliability of a product, the designers should also consider the emotional aspects of the users to enhance the sustainability of the designed product. Prior to this, Mahlke and Thuring (2007) have also highlighted that emotional aspects should be given high importance when designing any interactive system. To be able to understand the emotional aspect of a product design, the designer must be able to define and explore the various dimensions of emotion.

Emotion is defined as a physical and psychological state associated with a wide variety of feelings, thoughts and measures (Russell, 1980). Traditionally, emotion measurement originated from the field of psychology and sociology. However, the study on emotion has evolved lately into other domains of study. The study on emotion and product design correlation known as affective engineering was introduced in Japan. The objective was to enhance product designs by translating users' psychological feelings, emotions and needs into the product designed. This new advancement of technology enables the process of emotion measurement using the self-report instruments and other self-report channels (Nagamachi, 2010, Nagamachi, 2016; Lokman et al., 2006). Nevertheless, emotion measurement is not an easy task as it can be very onerous because the designer and consumer must be able to characterize and distinguish each and every state of emotion.

As highlighted by Nagamachi and Lokman (2016), affective engineering known as Kansei Engineering (KE) is an emerging technology to measure Kansei which is a Japanese term that refers to the psychological feelings and images held in the mind

towards artefact, situation and surrounding. Although the initial aim of KE is to enhance product design by considering the various facets of emotion, the findings of the research vary from one domain of research to another. To add on, KE was originally established as a method of designing new products that enable the assimilation of human feelings and emotions into the product (Nagamachi, 1999). This method was also designed to capture subjective consumer insights, synthesize the findings with the actual product design specification and map the association between the Kansei and the design specification (Nagamachi, 2016). As a result, the new product is designed by embedding consumers' emotions. Lokman and Noor (2009) have highlighted that KE has been successfully used to incorporate the emotional appeal in the product design ranging from physical consumer products to IT artefacts due to its success in making the connection between product designers and consumers.

Though KE is gaining widespread popularity, in the context of Human Computer Interaction (HCI), adaptation of KE is still at its infancy. In the recent decade, there is continuous discussion in HCI on the development of virtual learning environment and its benefits to enhancing learners' emotional engagement. In line with this development, the current research addresses the learners' emotional experiences in relation to the deployment of virtual agents in a higher education institution in Malaysia that comprises of a diversified community. This is because the deployment of virtual agents has been seen to effectively capture learners' attention at first sight and motivate them to engage actively in a lifelong learning process. Existing literature has highlighted the positive functionality and the usability of the virtual learning space that comprises the virtual agent (Savin, 2013; Nikolaou & Tsolakidis, 2013; Gil Ortega & Falconer, 2015; Bello et al., 2014; Strange & Banning, 2015; Fitzsimons, 2012; Kopp et al., 2005; Tomlinson & Blumberg, 2003; Bates, 1994; Luck & Aylett, 2000; Baylor, 2009; Gratch, & Marsella, 2004; Morgado & Gaspar, 2003; Bosse et al., 2007; Khan & Sutcliffe, 2014). These

findings also support the notion that modelling emotions into a learning environment is important to capture learners' attention. Further, this research also evaluates the learners' affective responses towards the virtual agents using the KE method. The association between learners' emotional responses and the virtual agents are further analyzed to produce specific design elements for the development of virtual agents that evoke targeted emotions.

1.2 Statement of Problem

According to Levy (2013), over the past decades, two questions that have dominated discussions among researchers and academicians related to Kansei Engineering (KE) are the meaning of the word itself as well as the ideology behind KE. He also stated that KE has been developed as a productive research discipline, highly connected to the industrial world, claiming numerous innovations and market successes for nearly four decades. He highlighted that KE has been used extensively and successfully in the car industry (e.g., Mazda, Nissan, Ford, Saab, Volvo…) as well as other industrial domains such as textiles (e.g., Wacoal and Goldwin), food (e.g., Nestle), electronics and home appliances (e.g., Sharp, Panasonic, Samsung, Electrolux…) and cosmetics (e.g., Shiseido, Milbon). Since Kansei Engineering specifically aims to improve product design, researchers have begun to address the product design issues and apply KE in the areas of e-commerce, virtual reality system and gaming technology. However, in the field of education or specifically Virtual Learning Environment (VLE), the effectiveness of KE has not been researched in depth despite the belief that the teaching and learning process is enhanced when KE is incorporated into e-learning tools (Taharim et al., 2013; 2015).

In Malaysia, a study on the effectiveness of virtual agent deployment in a VLE using the KE approach is highly crucial as the current education system focuses on a curriculum that emphasize in developing students with positive attitude which can only be obtained through an effective pedagogy that captures learners' emotions. Further, according to

Choi and Hannafin (1995), this new VLE intervention has a high potential to reach a large number of educators and learners and effectively change the teaching and learning process. The goal of Malaysia's education system to produce holistic graduates can be achieved more comprehensively because this new intervention (VLE) provides simulations and real world learning experiences which explicitly develop the learners' cognitive thinking by extending the learning process.

In addition, empirical studies have confirmed that virtual learning environments are also beneficial in many ways such as they lower drop-out rates and provide other positive motivational outcomes (Keller & Suzuki, 2004) as well as enhance, motivate and stimulate learners' understanding of certain events, especially for those where the traditional instructional learning has proven inappropriate or difficult (Pan et al., 2006). There is a crucial need for Malaysia to adopt this new approach in the teaching due to the concern on the increasing attrition rate in the HEIs which has been proven in a number of researches carried out in Malaysian HEIs (Lim et al., 2011; Nagaraj et al., 2016; Rasiah, 2015). Research on the First-Year Experience (FYE) of students in various HEIs in Malaysia has identified that the niche area in FYE is the teaching and learning tool. It has been proven that this can help alleviate the attrition rate (Paramo et al., 2015; McCarthy, 2010). Therefore, it is crucial to deploy an effective learning tool that maximizes learners' satisfaction.

A research on the Web-Based Learning (WBL) at eight universities in Malaysia has identified that interactive application and technology or system as two out of the five main factors that influence the effectiveness of the online learning process (Poon et al., 2004). The research also went on to propose there is a need to improve the quality of WBL due to the differences in adaptation styles of learners in the process. Since virtual learning environment is also a part of web based learning, it can be concluded the concerns raised

in terms of interactive application and visual attention in the empirical studies on WBL are also applicable for VLE.

In addition, since how learners respond emotionally to virtual agents deployed in VLE and the design specifications are important, there is a need to design virtual agents that capture learners' emotional experience in order to enhance learning experience. It must be noted that most of the existing virtual design specifications for virtual agents focus on cognitive functionality and usability from the perspective of the designers (Khan et al., 2007; Hertzum et al., 2002; Gabbard, 1997; Bentivegna et al., 2001; Abbattista et al., 2002; Ivan & Ciurea, 2009; Dieterle & Clarke, 2007; Wu et al., 2014; Kramer et al., 2013; Khan & Sutcliffe, 2014). Furthermore, the existing designs too are very stereotype and inclined towards certain community. Past researches conducted by Khan and Angeli (2007) as well as Tan et al. (2013) show evidence that there has been stereotype in the design specifications of the existing virtual agents.

The findings from the past have not proposed a robust design that caters to a heterogeneous community. Therefore, it is vital to overcome this limitation in design to produce design specifications that can contribute to the global society. Thus, this research aims to address the concerns raised on the effectiveness of VLE and to fill in the gap in the design specifications of virtual agent design by investigating associations between learners' emotional and virtual agents developed using the design approach and propose the Virtual Agent Design Model (VADM) for designing virtual agents that contribute to a higher level of satisfaction among learners.

1.3 Objectives of Study

The aim of this research was to evaluate whether Kansei Engineering can be used to design virtual agents that have aesthetic values in a Virtual Learning Environment (VLE). Besides this, the research also explored the learners' emotional experiences towards

virtual agent deployment in a Higher Education Institution and coherently contributed to the design model of a Kansei virtual agent that embeds learners' emotions. Hence, the final Kansei product is targeted to stimulate emotional stickiness that influences user judgement (Lokman & Nagamachi, 2009; Westbrook, 1987). In order to achieve the aim of this research study, the specific objectives that were designed are as follows:

- Objective 1: To identify the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment.
- Objective 2: To develop a Virtual Agent Design Model (VADM) that caters to the heterogeneous community using the Kansei design approach.
- Objective 3: To validate whether the VADM designed has high emotional appeal and enhances learners' satisfaction.

Listed are the detailed elaborations on the identified research objectives.

(a) ***To identify the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment.***

To be able to design the Kansei virtual agent for this research, the researcher first determined the various factors that affected the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment. This was to provide the direction of the research from past studies. Besides that, this objective also identified the expectation of the learners in the HEI. Since KE is targeted to design products that maximize users' satisfaction, identification of the factors was crucial. Upon identifying the crucial factors from previous validated studies, the researcher also conducted an empirical study specifically related to the design factors identified using the Kansei approach. This approach enabled the researcher to design products using the influencing factors to ensure the virtual agents designed have rich Kansei value that enhances learners' satisfaction.

(b) ***To develop a Virtual Agent Design Model (VADM) that caters to the heterogeneous community using the Kansei design approach.***

As a contribution to the 21st Century's teaching approaches that promote learning beyond the classroom, this study proposes a Virtual Agent Design Model (VADM) to enable the design of a pedagogical virtual agent that can be deployed in VLE in Malaysian HEIs that comprises of a heterogeneous community (students of different nationality, culture, religious beliefs, practices, and norms). This identified virtual agent design embeds the identified emotions as defined by Kansei Engineering (KE). The KE is known for its capability to transform users' psychological feelings into a successful product design. Hence, the proposed novel VADM model would be able to facilitate the designers of the virtual agent product design to enhance emotional stickiness between the heterogeneous learners and virtual agents. The development of VADM is done via identifying the virtual agent design elements identified using the Kansei approach.

(c) ***To validate whether the VADM designed has high emotional appeal and enhances learners' satisfaction.***

The VADM validation is essential to support the aims of this research study. The developed virtual agents using the VADM was validated by learners to ensure that the design optimizes learners' satisfaction and enhances emotional stickiness.

1.4 Research Questions

In order to achieve the identified research objectives, the research began with acquiring answers to the research questions designed as follows:

(a) ***Objective 1: To identify the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment.***

Research Question 1 (RQ1):

What are the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment?

Although there are various literature reviews that outline the factors that affect the learners in a HEI but the findings were not specific for learners from HEIs in Malaysia who are heterogeneous in composition. Thus, using the findings from the existing literature alone did not address the objectives of this study. Therefore, the specific factors related to heterogeneous community in Malaysia were identified as it contributes to the effectiveness of virtual agent designed.

Research Question 2 (RQ2):

What are the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment using the Kansei design approach?

The research identifies the various factors that can explicitly contribute to the learners' satisfaction in the private HEI. This is only attainable using the Kansei approach as proven in past studies. The answers from the empirical study determined the considerations or factors for an effective product design that enhances the emotional stickiness between the learners and a Virtual Learning Environment (VLE). Hence, it addressed the young learners' needs and provided positive emotional experiences for the learners.

(b) ***Objective 2: To develop a Virtual Agent Design Model (VADM) that caters to the heterogeneous community using the Kansei design approach.***

Research Question 3 (RQ3):

What are the Virtual Agent Design Model (VADM) design specifications needed for an effective design of virtual agents to capture learners' satisfaction using the Kansei design approach?

This question determines the design specifications of a virtual agent and the impact on the emotional experiences of the learners. To address this question, knowledge on design specification was essential as the designer must be able to identify and categorize the various design specifications obtained from the findings of the study. The researcher adapted the Kansei Engineering approach and conducted an empirical study to determine the factors. Thus, it facilitated the formulation of effective design elements that is specific for Kansei virtual agents that embeded the emotional aspects of the learners from a heterogeneous community. The design specifications derived contributed to the structuring of the VADM model.

(c) ***Objective 3: To validate whether the VADM using the case study has high emotional appeal and enhances learners' satisfaction.***

Research Question (RQ4):

Do virtual agents designed using the Virtual Agent Design Model (VADM) have high emotional appeal and enhance learners' satisfaction?

This question attains to answer whether the virtual agents designed using the VADM embeds the needs of the 21st century leaners and maximize learners' satisfaction. The answer verified the effectiveness of VADM implemented in this study and determined the success of the designed virtual agent as a pedagogical agent in a VLE.

1.5 Significance of Study

This research on Kansei design approach in designing virtual agents in Virtual Learning Environment primarily contributes to the scarce information on the existing research related to Human Computer Interaction (HCI). Furthermore, this research study will assist designers, researchers and educators to create an effective educational resource through the VADM given for a better design of virtual agents which adapts the Kansei design approach. Hence, researchers will scrutinize the design specifications of the virtual agent deployed in a VLE to enhance emotional experience of the learners from diversified cultures and backgrounds.

On another note, this research study also implicitly creates awareness and understanding to the virtual agent designers on the importance of Kansei design approach that embeds the affective elements of a product design to optimize learners' satisfaction. The product designed in this research using the VADM model has the capacity to design virtual agents for a heterogeneous community by overcoming the existing stereotype design. Further, since the focus of the research is on the effectiveness of Kansei virtual agents and aimed to produce design information that contributes to the development of virtual agent with aesthetic values and simultaneously promote emotional stickiness between the learners and the designed virtual agent, this research strengthens the educational platform that deploys virtual agents. In addition, this research being a case study on a HEI in Malaysia, the findings of the study contribute significantly to the development of virtual agents deployed in a VLE using the VADM modeled by the designers for a heterogeneous community.

1.6 Scope of Study

Figure 1.1 depicts the scope of study of this research which comprises of Virtual Learning Environment (VLE), Emotion and Kansei Engineering.

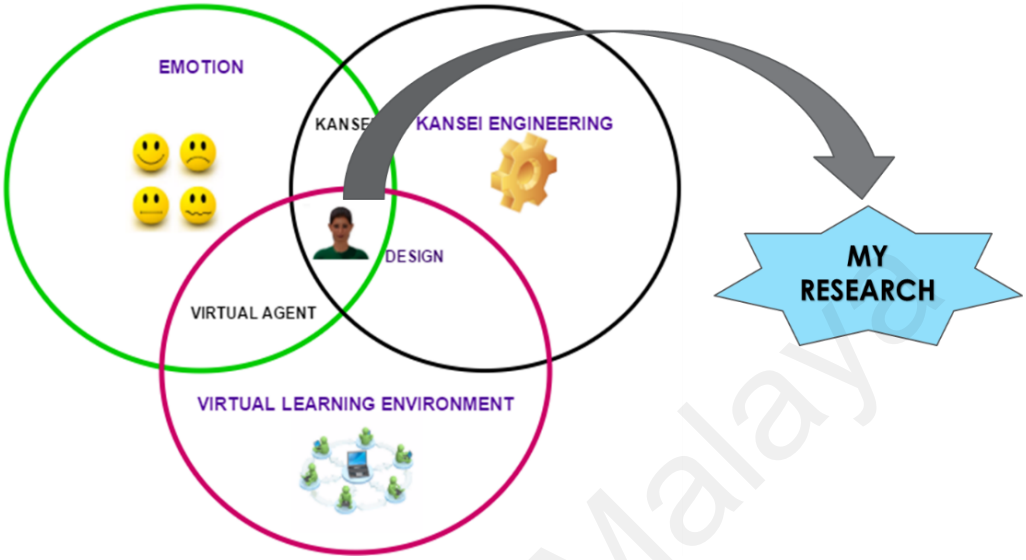


Figure 1.1: The Research Scope

As depicted in Figure 1.1, this is a multi-disciplinary research that incorporates a Japanese approach known as Kansei Engineering (KE) to design virtual agents that addresses learners' emotional needs. To address the aim of this study, this research explored the learners' emotional experience and maximized the learner's satisfaction towards the virtual agent deployed in a VLE. The research investigated these mentioned goals related to virtual agent design to develop a product to address the heterogeneous learners' needs in a HEI.

This case study is restricted to undergraduate students from a private HEI from an American Degree Program (ADP). The virtual agent testing was incorporated as a lab activity in a computing course in the program. Three batches of students from three semesters (Spring, Summer and Fall) were used as the sample to ensure reliability and validity of the data collected.

1.7 Limitation of Study

There are many definitions and methods defined by the scholars and psychologists in this domain of research, but the emotional dimension addressed in this research adapts the Kansei Engineering approach. The notion of the emotion investigated in this study of virtual agent design is confined to the visceral factor which is an outcome from a response triggered by external stimuli (Norman, 2004; Ochsner & Gross, 2005). This is in line with the research study that targets to capture the learner's affective response to the external stimuli or product. The emotion measurement was limited to 24 keywords selected by the subject experts (this will be elaborated in Chapter 3) and therefore, the model developed is confined to these identified dimensions. Adding on, the design specifications in this research specifically addressed only the demographic features of the virtual agents and do not cover the voice of the virtual agents, clothing and the Virtual Learning Environment.

Notably, this is a case study for a HEI in Malaysia but the theoretical assumptions, methodological recommendations and most of the empirical results are transferable to other higher education institutions with similar heterogeneous student population. However, the virtual agent design may not be universal and require further review on the diversity of the HEI to generalize its applicability.

1.8 Research Contribution

This research related to virtual agents makes methodological, theoretical, empirical and practical contributions to the virtual learning design literature in the Human Computer Interaction discipline. An overview of the contributions are discussed further.

1.8.1 Methodological Contribution

The novel Virtual Agent Design Model (VADM) provides a platform to design virtual agents that address the needs of the learners by enhancing the emotional appeal of the virtual agents. This proposed VADM is in the form of translation from the concept of emotion to virtual agent design specifications. The developed model embeds the design specifications to enable the virtual learning environment designers, researchers and educators to strategize the design of effective virtual agents.

1.8.2 Theoretical Contribution

The Virtual Agent Design Model aims to facilitate the design phase of effective virtual agents. This output is important and can be adapted by designers, researchers and educators to enhance the emotional experience of the learners. Although the model is seen to be specific to the case study domain, it offers a basis to the extension of existing scheme on virtual agent design which is very stereotype.

1.8.3 Empirical Contribution

The research findings in relation to emotional or affective response to virtual agent can be quantified. The results can also be used hypothetically to prove that the design specifications integrated in VADM is valid. The findings are important in providing a balanced, well-placed and appropriate combination of virtual agent design specifications. Hence, this model will facilitate designers, researchers and educators to have a reference in determining strategies in developing virtual agents for a virtual learning environment that addresses the emotional aspects of the learners.

1.8.4 Practical Contribution

The findings from this research have implications to the designers as well as the individual learners as there is clear awareness on embedding emotions into a virtual agent design. They facilitate designers to identify the needs of the learners and the association between the learners and product design. Furthermore, the model is designed for a heterogeneous community and it is not inclined towards a specific community. In addition, the implementation of the designed model will enable designers to devise strategies to produce an interface design that captures positive emotional experiences that will result in positive user experiences.

These four contributions benefit the various stakeholders involved in the development and deployment of the Virtual Agent Design Model as well as the virtual agent prototypes. A good rule of thumb for the design of virtual agents are to integrate the design factors identified in the VADM. This is due to the fact that the VADM designed meets the many requirements identified by the various stakeholders. The stakeholders analyzed in this research are students, lecturers, designers and society itself. The virtual agent designed using the VADM has the capacity to increase emotional stickiness between the students and the Virtual Agents. This means that the design integrated the emotional aspects of the students as addressed in many Kansei researches to maximize the user's satisfaction. As a result, the students are engaged in a positive learning environment and enhances their learning curves.

Since the virtual agent is a user centric design, it has the capacity to retain students' attention and cultivate a positive learning culture among the students from the Higher Education Institutions. On the other hand, the lecturer can deploy the existing virtual agent identified into the identified learning platform to promote learning beyond the classroom which is the ideology of the 21st Century Learning Framework. The identified

virtual agent had been tested and caters to the heterogeneous group of learners. Henceforth, the virtual agent can be deployed in a similar student demographic environment.

Besides that, the VADM model can be implemented by the VR designers to design virtual agents for HEIs in Malaysia or any other Asian countries with similar demographics. The model can be adapted to design new or enhanced virtual agent prototypes. The most prevalent of the research contribution is towards society in providing an effective as well as a balanced teaching learning tool. Since the VADM model addressed the heterogeneity issue in a Higher Education Institution, the design elements of virtual agents are more holistic and does not incline towards certain groups of society. This overcomes the stereotype issues which is an added advantage for HEIs as education has become more globalized and internationalized. Hence, students can adapt better in a more harmonized environment that focusses on a holistic education approach.

1.9 Operational Definitions

Table 1.1 gives the definitions of terminologies used in this research study. The definitions are provided to ease the understanding process to the terms used in the chapters.

Table 1.1: Definition of Key Terms

Terms	Definition
Emotion	A mental and psychological state associated with a wide variety of feelings, thoughts and behavior (Ekman, 1999; Russell, 1980).
Kansei	A term originated from Japan that refers to psychological feelings and images held in the mind towards artefact, situation and surrounding (Nagamachi, 1999).
Kansei Engineering	A technology or method used in a new product development that enables the measurement and association of Kansei into design specification (Nagamachi, 1999, Nagamachi & Lokman, 2016; Lokman, 2010).
Kansei Virtual Agent	A new term introduced by the researcher to describe virtual agent that maximizes learners' satisfactions.
Kansei Keyword (KW)	Keywords used to represent emotional impression towards a specific product, situation or surrounding (Nagamachi, 1999).
Kansei Value	Emotion provoked in users via respective products or a service that emphasizes its value known as affective/ Kansei value (Nagashima et al., 2008).
Virtual Learning Environment (VLE)	VLE is a self-contained system that increases learners' attention and interactivity with objects like in the real world (Piccoli et al., 2001).
User Experience (UX)	A term used to describe the experience as a result of interactions with a particular product, application or system (Albert et al., 2013).
Experience of Meaning (EM)	A term that defines the cognitive process such as interpretation, memory retrieval and associations that enable users to identify metaphors assigned to personality and weigh the significance of the product design (Desmet & Hekkert, 2007).
Aesthetic Experience (AE)	A term that defines the level in which one or more sensory modalities are elated (Desmet & Hekkert, 2007).
Emotional Experience (EX)	The satisfaction user experiences in response to human-product interaction (Desmet & Hekkert, 2007).
Design specification	The design specifications that compose the visual design of a product.
Virtual Agent Design Model (VADM)	A model proposed by the researcher to design a virtual agent that has high emotional appeal and increases learners' satisfaction.

1.10 Organization of Thesis

This thesis is structured into 6 Chapters as depicted in Figure 1.2. The chapters are categorized based on the research flow of this study.

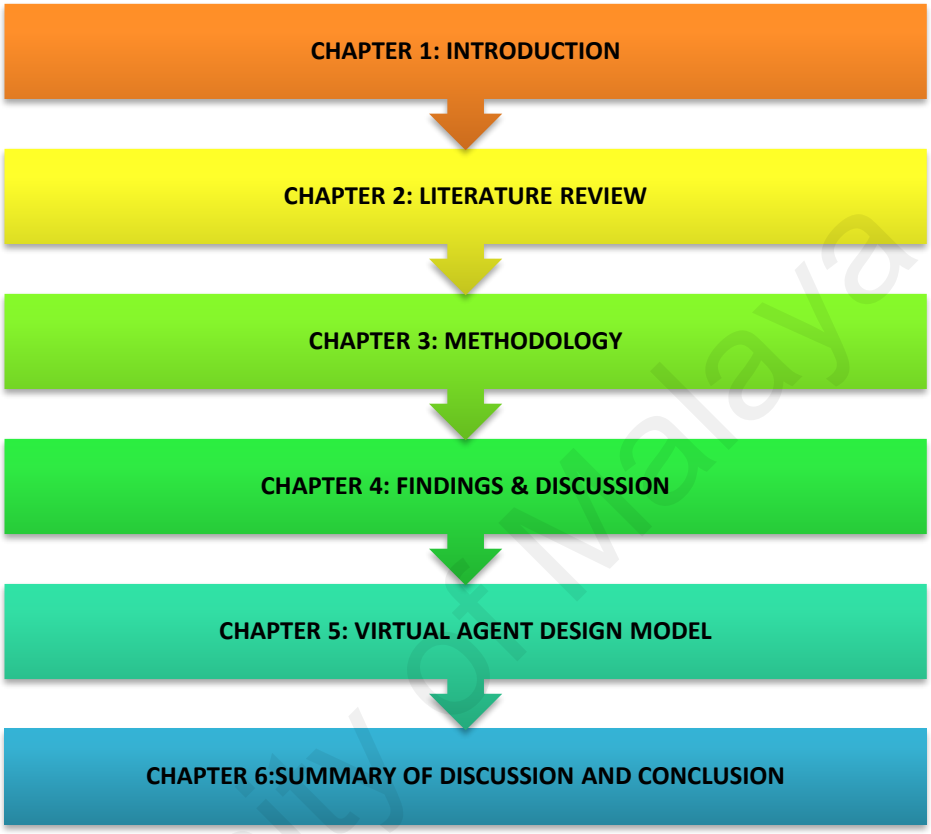


Figure 1.2: Organization of Thesis

As illustrated in Figure 1.2, the research thesis comprises of 6 main chapters. Chapter 1 provides an overview to the thesis, identifying the aims and direction of the research as well as provides an introduction of the chapters incorporated in the thesis. This chapter highlights the research ideas and summarizes the importance of the identified research to fill the gap in the existing studies. Adding on, this chapter also indicates the statement of problem, research objectives, research questions and limitations.

Chapter 2 discusses the review of literature on related issues in virtual learning environment, virtual agent designs, psychology and emotion, evolution and advancements of Kansei Engineering (KE) and special highlights on virtual agent design. This chapter identifies the research gap and provides the rationale for the current research.

Chapter 3 presents the methodology or the research framework and describes the experimental procedures in detail. The researcher elaborates on the instruments, participants and experimental approach used in the research study. The chapter also provides detailed analysis on the selection of specimens, KE design approach and the prototype design. It concludes with a set of 18 valid specimens and a Kansei checklist to be used in the experimental procedure.

Chapter 4 presents the results of exploratory and confirmatory study which is the main experimental procedure in the measurement of affective responses to virtual agent design. The chapter describes details of the experiment results and the outcome. To add on, the results from the pilot study performed and justification of the research instruments as well as the developed research framework are also reported in this chapter. The result is then described through elaboration of the concept of emotion in the virtual agent design. In the confirmatory study section, the findings from the exploratory study are validated. This section describes the selection of five concepts of emotion or Kansei words from the proposed model and development of the virtual agents. It then describes the selection of ten good subjects from the exploratory study to attain a more coherent result. The chapter concludes with justification of the success of the designed Virtual Agent Design Model (VADM).

Chapter 5 elaborates the developed VADM model and the structure of the VADM model. The model design justifications are supported with the evidence reported in chapter 4. The chapter concludes with a comparative argument on the existing models and VADM.

Chapter 6 summarizes the research findings and discussions, providing the research implications, challenges and limitations. The chapter concludes with several recommendations for future research.

CHAPTER 2: LITERATURE REVIEW

This chapter elaborates the virtual learning environment and the various Kansei Engineering (KE) applications in Human Computer Interaction (HCI) application which is the highlight of this research as indicated in Chapter 1. The first section reviews the virtual learning environment and the deployment of virtual agents. The second section reviews the advancements of Kansei Engineering and the various applications in HCI namely on instructional design, e-learning, mobile learning and game avatar. The chapter ends with the summary of literature review.

2.1 Virtual Learning Environment

Virtual Learning is a new trend in education that is within the global reach and is increasingly becoming popular in Higher Education Institutions (HEIs). The heart of virtual learning lies in the process of taking learning out of the classroom or by bringing the outside environment into the classroom through virtual means. In other words, this virtual learning environment (VLE) is a set of teaching and learning tools designed to enhance students' learning experiences by including computers and the internet in the learning process with the ultimate aim of making learning more realistic via virtual world. It has also been asserted that this form of learning supports ideation and communication between the instructor and the students (Thorsteinsson, 2013).

Past literature has shown that Virtual Learning Environments (VLEs) developed under constructivism and embedded personalization learning functions have the potential to meet different requirements of different learners and thus increase e-Learning effectiveness (Xu et al., 2014). Due to this beneficial outcome, VLEs have become commonplace and are used in educational processes. As a result, classes using Virtual Learning Environments (VLEs) have become a high priority project for many educational

institutions (Thorsteinsson, 2013). However, the diversity of their implementation architectures is as varied as their application domains (Karsakov et al., 2014).

2.2 Virtual Learning Environments in HEIs in Malaysia

Since virtual learning has become a new trend, Malaysia has shown a positive movement to adopt this. As a result, virtual classrooms, e-learning and blended learning are slowly gaining momentum in Malaysia due to the advancement in ICT that has changed the delivery style of teaching and learning (Grapragasem et al., 2014). Many students and instructors have started to explore and accept the use of social media technologies or virtual learning as a tool for engaging with their institution and their peers as well as for teaching and learning purposes (See et al., 2014). Virtual Learning Environments (VLE) are effective as they provide online interactions of various kinds which can take place between learners and tutors, including online learning when the students and lecturers are in different places but at the same time. Research has advocated that the implementation of virtual learning environment in universities leads to better learning performance (Ahmed et al., 2014). On another note, Tayebinik et al. (2014) projected a bright future for the role of virtual learning in education as they consider it as an efficient approach of distance learning in terms of students' learning experience, student-student interaction as well as student-instructor interaction which is likely to emerge as the predominant education model in the future.

Researchers in Malaysia in numerous fields have established the effectiveness of VLE. A recent research conducted among nurses in Malaysia showed evidence that Web-based simulation was effective in improving nursing practice especially in cases comprising of patients whose health was deteriorating (Liaw et al., 2016). The researchers concluded that Web-based simulations can be used as an educational tool to address the needs of the nursing practice in large hospitals for dealing with patients having clinical deterioration.

Similarly, another research carried out by Ahmad (2016) among English as First Language (EFL) learners proved that Technology Assisted Language Learning (TALL) is useful in improving listening / speaking skills, pronunciation, extensive vocabulary and grammatical accuracy. The research went on to establish that this too is highly effective in motivating learning among students by providing opportunities for them to immerse completely in the learning process. Ng et al. (2016) in a research conducted using the Augmented Reality (AR), a technology similar to VLE found that individualized learning is heighten for this approach provides an avenue for social communication which in the long run enhances the effectiveness and attractiveness of the students' learning environment in a real world scenario.

2.3 Virtual Agents

A discussion on virtual learning and virtual classrooms are not complete without an in-depth understanding of virtual agents. Virtual agents are digital assistants that are displayed on the screen to guide and assist users in a virtual environment. Among the features of virtual agents are that they can engage users in a personalized conversation via live chat or vocal recognition to address users' requests. Further, these agents have the learning capabilities to grow smarter with every new conversation. The advantages of virtual agent deployment was highlighted in a research conducted by Soda et al. (2012). According to Soda et al. (2012), the integration of various lightweight learning companions such as virtual agents in a VLE can potentially enhance immersion by realizing interactions that are challenging or expensive to achieve in the real world. Researchers too have claimed that virtual agents' deployment in education serve a variety of purposes such as being adaptable and versatile; engendering realistic simulations; addressing learners' sociocultural needs; fostering engagement, motivation and responsibility; and improving learning as well as performance (Feng et al.,2012; Veletsianos, 2014). According to Heller and Procter (2014), virtual agents provide an

extraordinary opportunity to create engaging simulations and game–based learning opportunities. On the same note, Kim et al. (2007) claims that virtual agents help overcome some of the constraints of conventional computer-based learning. Kramer and Bente (2010) went on to conclude that deployment of virtual agents is widely expected to increase learners' motivation resulting in effective learning.

In the context of Human Computer Interaction (HCI), the study on embodied agents is gaining wide popularity because they are perceived as a powerful learning medium which has the potential to become a highly natural HCI device (Doumanis, 2013; Gerhad, 2003; McIlhagga & George, 1999). Virtual agents too have received special attention in the domain of education due to their potentials in terms of non - verbal communication and social relations which are the core aspects of a good virtual tutor. Despite these potentials, Miksatko et al. (2010) have drawn attention for the need to identify and design virtual agents that can cultivate a personal relationship with users embodying richer interactions.

According to Bickmore and Picard (2005), the deployment of virtual agents has benefited many research areas. It has been advocated that the choice of agent design reflects the social perceptions such as competency and appeal which in turn promote or hinder learning (Heidig & Clarebout, 2011; Harley et al., 2016; May & Keay, 2017). Cowell and Stanley (2003) claimed that there is an assumption by designers that young minds prefer to stay connected with agents of a similar age group. In addition, Moreno and Flowerday (2006) asserted that the choice of virtual agents is affected by culture where agents with similar ethnicity and colour with the user is preferred. A study conducted in 2016 by Kim and Baylor supports this argument. The findings indicated that students had a preferred inclination for agents whose gender and ethnicity matched their own (Kim & Baylor, 2016). In line with this, Khan and Angeli (2007) asserted that the function and role of an agent must be identified before the development stage of an agent.

They asserted that agent designers should take greater care when choosing the virtual representation in terms of agent's ethnicity, gender, and realism. In addition to this, Rickel (2001) argues that virtual worlds should be enriched with intelligent virtual agents that support face to face interactions in a variety of roles.

As indicated in Chapter 1, past literature on virtual agents have proven the positive functionality and the usability of the virtual learning space that comprises of virtual agents (Bello et al., 2014; Strange & Banning, 2015; Fitzsimons, 2012; Gratch, & Marsella, 2004; Morgado & Gaspar, 2003; Khan & Sutcliffe, 2014). Ijaz et al. (2016) carried out a research to prove that the application of virtual reality and artificial intelligence (AI) in combination has the potential to improve the learning experience of modern generation of students. They used three different samples; the first was taught using a historical text, the second was a documentary video and the third were provided a virtual platform which allowed interactions with the virtual inhabitants. The findings of the study showed better outcomes with the sample giving more positive qualitative feedback on their learning experience. In addition they also performed better in the post exam that was conducted (20% better than the first two groups). Further, Johnson et al. (2016), in a survey on interactive learning environment using animated pedagogical agents argued that they allow learners to interact in natural human like ways to achieve better learning outcomes.

2.4 Emotions and Psychology

As discussed under section 2.3, the use of virtual agents create an interactive learning environment which impact learning in a positive way as it provides emotional experiences. These emotions that are triggered can be linked to the psychological theories. Psychology can be defined as a scientific study that investigates the soul and mind (mental functions and behavior) of humans and animals. Theories about the soul have been in existence since the times of Plato and Aristotle in Ancient Greek. Plato divides the soul

into three distinctive components: cognition, emotion/affect/passion, conation/motivation (cited in Scherer, 1994). On the other hand, Aristotle, inspired by Plato defines, explicates compares and contrasts various emotions, and characterizes emotions (cited in Leighton, 1982). In many of his work, Aristotle defined emotion as things through which people who undergo changes differ in respect to their judgments which are accompanied by pleasure and pain (Broadie, 1991; Knuuttila, 2004).

Research in psychology seeks to understand and explain thought, emotion, and behavior. Past literature has indicated that many theorists have incorporated multiple perspectives of emotion in their work. Among these were Barrett (2006) who specializes in affective science and human emotion, Ekman (1972) who specializes in the study of emotions and their relation to facial expressions, Frijda (1986) who specializes in human emotions, especially facial expressions, Scherer (1994) who specializes in the psychology of emotion and De Sousa (2004; 2010) who specializes in the philosophy of emotions, philosophy of mind and philosophy of biology. It must be noted that arguments on how emotions should be classified had been contentious issues since Plato (Leighton, 1982; Scherer, 1994). Consequently, emotional research domain has developed into two distinctive sets of emotional dimensions: basic or primary emotions and secondary emotions (Griffiths, 2002; Ekman, 1999; Russell, 1980; Russell, 2003; Tractinsky, 2004). Basic or primary emotions refer to emotions that are generic to all human races including some animals such as feelings of sadness, fear and anger while secondary emotions are multifaceted and the emotions surface from the primary emotions that evolves through external stimuli.

Emotion is the subjective experiences of individuals' point of views. According to Norman (2005), emotion plays a crucial role for it determines the ability to understand new things in the world. He added that the formation of an emotional connection with the

object determines the users' affinity and appeal for the object (Norman, 2004). Spillers (2004) claims emotion as one of the strongest distinguishing element in user experience because it elicits unconscious responses to a product. This makes the analyses of the emotion more complex. Hekkert et al. (2003) claim that the characteristics of every product have an impact based on the users' experiences making it complex and multidimensional. Desmet and Hekkert (2007) identified three levels of product experience: aesthetic pleasure, attribution of meaning, and emotional response. They elaborated these succinctly as:

> "*…the entire set of affects that is elicited by the interaction between a user and a product, including the degree to which all our senses are gratified (aesthetic experience), the meanings we attach to the product (experience of meaning) and the feelings and emotions that are elicited (emotional experience) …"* (Desmet and Hekkert, 2007)

Along similar lines, Russell (2003) developed a circumplex model which can illustrate the dimensions of emotions in a form of a bipolar dimension of valence (pleasure-displeasure) and arousal (sleep-arousal). These two-dimensional bipolar dimensions can be identified by eight variables placed at a different arbitrary such as pleasant (0 degree), exciting (45 degrees), arousing (9 degrees), distressing (135 degrees), unpleasant (180 degrees), gloomy (225 degrees), sleepy (270 degrees) and relaxing (315 degrees). This model is an expansion from the research on emotion conducted by Ekman (1999) whereby he has categorized emotions into basic and complex categories. The term basic emotion defines the six fundamental emotions that can be easily distinguished from one another such as anger, disgust, fear, happiness, sadness and surprise (Ekman, 1999).

The representation of emotions in the form of a two-dimensional wheel and a conical three-dimensional version was also adopted by Plutchik (1980). The aim of this representation was to function as a tool to understand the psycho evolutionary emotion theories (Plutchik, 1980; Plutchik, & Kellerman, 2013). Plutchik (1980) outlined eight

primary emotions and coordinated them in opposite pairs. The identified pairs are joy vs sadness, trust vs disgust, fear vs anger, and anticipation vs surprise. Besides this, the proposed circumplex model by Plutchik (1980) also describes the association between the eight emotions and the dimension of intensity as well as the degrees of commonality among the emotions. Figure 2.1 below depicts the Three Dimensional Circumplex Model.

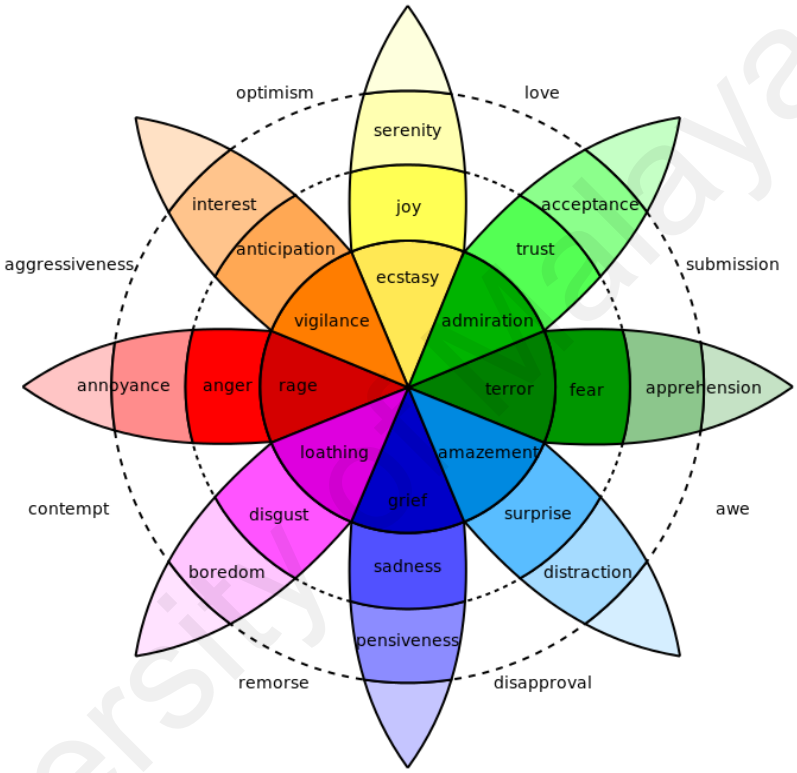


Figure 2.1: Three Dimensional Circumplex Model (Plutchik, 1980)

The model in Figure 2.1 describes the association between the emotion concepts, which correlates to the colors on the color wheel of the Three Dimensional Circumplex Model. Adding on, the cone's vertical dimension symbolizes the intensity while the circles depict the degrees of similarity between the emotions. The eight sectors in the model indicated represents the eight primary emotion dimensions and it is arranged in

four opposite pairs. In the outer exploded model, the emotions captured in the blank space are known as the primary emotions and the rest are mixtures of two primary emotions.

Psychologist, Scherer (2005) reviewed emotions within a more general category known as the affective state that includes emotion related facets such as pleasure and pain, motivational states, moods, dispositions and traits. Similarly, researchers have asserted that emotions are elicited when an incident occurs, having an explicit bearing on its needs, goals, values and general well-being of the individual (Scherer, 2005; Frijda, 2007; Smith et al., 2016; Gillioz et al., 2016).

From the multitude outcomes of the studies by Scherer (2005), Frijda (2007) and Gillioz et al. (2016), it is justifiable to conclude that the design of a product affects human emotion and good product design has an emotional appeal. Norman (2004) supports these findings by claiming that users get attracted to certain products if the products ignite emotional connectivity with them. Among the emotional theories explicated by the above scholars, Russell's circumplex model of affect is the primary model deployed by researchers to investigate the various emotional dimensions. The model proposed by Russell has two-dimension spaces: valence (pleasure-displeasure) and arousal (sleep-arousal). The two dimensions are in continuity ranging from one profound facet of emotions to its opposite.

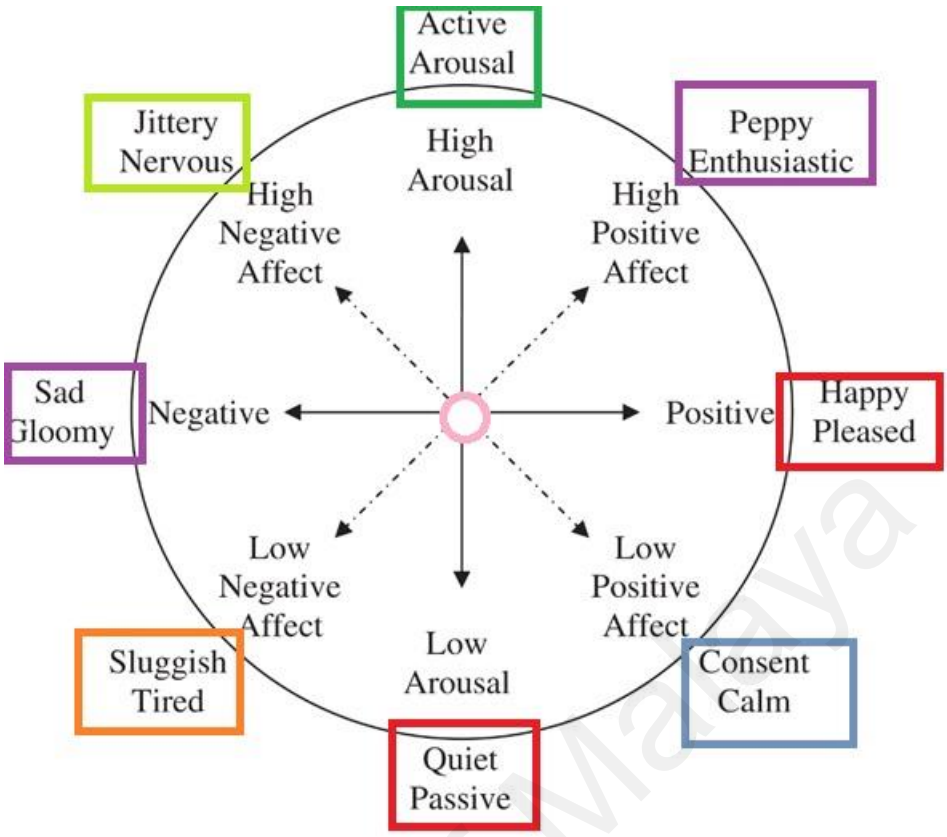


Figure 2.2: Russell's Circumplex Model

The model shown in Figure 2.2 was also integrated in a research conducted by Zhang and Li (2005) that investigated emotion within the dimension of both valences and arousal in response to an e-Commerce website. In this study, Zhang and Li (2005) studied the influencing factors of website characteristic to users' Perceive Affective Quality. The researchers asserted that the most affective feelings can be interpreted in this space. They posited both dimensions as the underlying components of affective constructs in an e-commerce website evaluation study. Similar to this Russell's Circumplex Model, many emotional models have been developed to support various research study which is elaborated in the next section.

2.5 Emotion Models

There are several core models that correlate to the study of emotions. The emotion models developed aims to conceptualize human emotions into various dimensions and to tie it with the theory of emotion itself.

2.5.1 Orthony, Clore and Collins (OOC) Model

Ortony et al. (1990) believed that emotions comprise of many facets; feelings and experiences; physiology and behavior as well as cognition and conceptualizations. Therefore, they developed a computational emotion model to ease the study on emotions known as the Orthony, Clore and Collins (OCC) model (Ortony et al., 1990). This model has been adapted as the standard model for emotion synthesis in various studies.

The OOC model comprises of twenty-two categories for emotions (Joy, Pride, Admiration, Hate…) based on the offset reactions to the current phenomena. This is constructed either from a goal-relevant events or triggered by attractiveness of the objects. The notion of this model is that it offers a structure for the variables such as probability of an event or the familiarity of an object that determines the intensity or depth of the identified emotions. Further research was done on this model and the emotional tag derived from the OCC model was used as the source for the Mood Vector Space (MVS) model (Pena et al., 2011). MVS represents the two major items of the emotional behavior models which are the emotions and the emotional state identified as the mood.

2.5.2 Pleasure–Arousal–Dominance Emotional and Temperament Models

The Pleasure-Arousal-Dominance (PAD) is notably general, yet very specific for the measurement and description of various state of emotions. The PAD model uses three parameters for classifying, measuring and applying emotions and temperaments highlighted by Mehrabian (1996; 1997). The researcher proposed a framework for the representation of emotional states and temperaments of an individual person.

Mehrabain's (1997) findings has proven that emotions can be classified in a three-dimensional space incorporating pleasure-displeasure, arousability and dominance-submissiveness which can also include a more distinct emotional state defined as mood.

The pleasure-displeasure trait refers to the relative predominance of an individual's positive affective states over negative states. On the other hand, arousability trait refers to the individual's arousal reactions to any complex situations. Arousability trait can also be interpreted as the strength of an individual's reactions to both positive and negative surroundings and situations. The final trait identified as dominance-submissiveness represents the characteristic feelings of control and influence over an occurrence versus the primary feelings of being influenced and controlled by external factors such as the surroundings (Mehrabain, 1996). These contributions of Mahrabian postulate that PAD model is accurate for representing emotions as a vital and isolated event where else the emotional states known as moods represent the information gathered over a longer duration of time.

2.5.3 Computational models

OCC model and PAD have laid the foundation for various computational models. Computational models are specifically designed for emotional agents and the influence on the agent's behavior. The integration of OOC and PAD models are used as a basis for the analysis of emotion and also as a projection model.

In the Fearnot AffecTIve Mind Architecture (FAtiMA) model by Dias et al. (2014), the OCC is adapted as a foundation for the agent architecture. FAtiMA has built-in capabilities that use the emotions and personality to influence an agent's behavior. The original OOC model is used as the core model and each tag separates the diversified emotions and each emotion has an intensity derived by the parameters linked with the conceived emotion.

There are also other approaches that have deployed OCC as the groundwork such as the WASABI Affect Simulation for Agents with Believable Integrity (Becker-Asano, 2008) and Emotion-Belief-Desire-Intention (EBDI) (Jiang et al., 2006) models. These two computational models use the projection of OCC emotions into a three dimensional PAD emotion space. In WASABI, emotions are managed differently depending on whether the emotions are classified as primary or secondary. Conversely, in EBDI, the projection of the identified OCC emotions into PAD emotion space makes the agents change the rational strategy to a more emotional strategy in accordance to the pleasure, arousal and dominance parameters (Jiang & Vidal, 2006).

Besides these models, according to Marsella et al. (2014), Emotion and Adaptation (EMA) model and Fuzzy Logic Adaptive Model of Emotions (FLAME) computational models also deploy OCC model as the basis. The EMA model uses the simplified decomposition of desirability, appealing and praiseworthy as claimed by researcher Gratch et al. (2004). On the other hand, the FLAME approach deploys the fuzzy estimation of the desirability of an event occurrence and investigates the possible emotions in accordance to the custom set of rules (Gratch et al., 2004; 2013). To add on, El Nasr et al. (2000) also stated that FLAME is an OCC inspired appraisal model that determines the behavior of the characters in an interactive environment.

Gebhard (2005) went on and reviewed an additional computational model identified as the ALMA model. According to Gebhard (2005), ALMA was designed as a common programming tool that permits application developers to design new computational models for various applications. Unlike EMA and FLAME, ALMA does not address any appraisal derivation. Marsella et al. (2014) elaborated that the ALMA model uses OCC model as a guide for the emotions triggered towards an agent by the surroundings and these emotions are transformed in the PAD components. Adding on, the core approach of

this model is to estimate the current mood of the agent. In summary, the OCC and PAD models are the key sources for various computational models of emotions.

2.5.4 Theory of Emotion Regulation (ToER)

ToER model elaborates the cognitive process of a virtual agent. To apply this model to another agent's theory of mind, recursive modeling is applied (Marsella et al., 2014). Therefore, in ToER model, the beliefs that the agents have about each other are in the form of a recursive manner. To conclude, ToER describes the method on how an agent reacts to the surroundings based on the beliefs, desires and intentions of users (Bosse & Lange, 2008).

2.5.5 Theory of Mind

Theory of Mind (ToM) is defined as the capability to attribute various mental states such as beliefs, knowledge, desires, thoughts and emotions to oneself and at the same time understand the mental states of others from different perspectives (Premack & Woodruff, 1978). Similarly, Goldman (2012) highlighted that ToM refers to the cognitive ability to attribute mental states to individuals and others. Along similar lines, Sodian and Kristen (2010) defined ToM as a belief-desire psychology since humans rely on two main concepts known as the predictions and the human actions.

Table 2.1 summarizes the various emotion models discussed in this chapter. The descriptions provide information regarding the diversified emotion models.

Table 2.1: Emotion Models

Emotion Model	Description
OCC MODEL Ortony, Clore & Collins	OCC model considers emotions to arise from affective reactions.
PAD EMOTIONAL MODEL Pleasure-Arousal-Dominance	PAD is suitable to capture the complexity of everyday emotions conveyed by very rich sources of information. PAD model can be used to study behavior of virtual agents in a VLE.
COMPUTATIONAL MODEL	Computational Models incorporates concepts, processes and metaphors drawn from computation for emotional displays in virtual agents.
ToER Theory of Emotion Regulation	ToER describes the cognitive processes of a single agent. The identified agent with the ToER will make use of the externally observable behavior of the other agent.
ToM Theory of Mind	ToM enhances the capability to attribute mental states to others and to rationalize about these. There are two purposes of ToM which is to anticipate the behavior of other agents and to manipulate the actions.

2.6 Kansei Design Approach

In this section, the key aspects of the Kansei design which is also an approach related to emotions similar to the models from section 2.5 approach are discussed. It starts with the introduction of the term itself which is followed by a discussion on Kansei Engineering, Kansei product evolution, Kansei Engineering in Human Computer Interactions and ends with a summary of the discussion.

2.6.1 Kansei

Over the years, Kansei, a technology which originated from Japan has gained wide popularity in many Europe and Asian countries. The founder of Kansei Engineering (KE), Nagamachi (2010) asserted that many researchers have attempted to redefine Kansei in different ways, but they failed. Thus, the definition of Kansei remains as a form of

psychological feeling an individual has with specific product, situations or surroundings (Nagamachi, 1995; Nagamachi & Lokman, 2016). Adding on, Nagamachi (2003) in his research defined Kansei as a mental state where knowledge, emotions and sentiments are harmonized and rich Kansei value indicates the richness in emotions and sentiments. Along a similar line, Harada (1998) described Kansei as a mental function of the brain, which is implicit and the Kansei process begins with the gathering of information related to sensory functions such as feelings, emotions and intuitions.

The theory of Kansei science was first proposed by Harada (1998) during the same period as the creation of KE. While KE is a correlation between Kansei and engineering, Kansei science is a trans-disciplinary that unites Kansei and cognitive sciences. The research initiated by Harada (1998) aimed at describing users' cognitive processes related to preferences and choices of products holistically. The research clearly elaborates the outcome of an effective product design that is influenced by users' preferences and needs.

In Nagamachi's (2016) article review, Kansei science was defined as a built upon brain science, mostly cognitive neuroscience and psychophysiology and relies on related philosophies. This was also supported by Thagard's (2011) study which found that human's thinking and resulting behaviors can be understood by implementing a model involving mental representational structures and mental procedures that operate on these structures (Thagard, 2011). These identified models and structures can be studied by psychophysiological approaches that deploy the study of Kansei (Yagi, 2000). Yagi's (2000) research on engineering psychophysiological in Japan defines Kansei as sensitivity and feelings. Therefore, the term 'kaitekansei' was introduced by Yagi (2000) to classify new products of high quality that have the capacity to stimulate the Kansei of a consumer.

In this academic context, Kansei science research targets to characterize and evaluate emotional experiences and creativity to contribute to a better understanding of the mind based on physiological and psychological approaches. Moreover, Kansei science has very high relevance to design research as it provides a platform for developing new conjoint methods to produce good designs (Levy, 2013). The Kansei science scope is very broad as claimed by Levy (2013) because there is vivid evidence that Kansei can be applied in various domains from the use of knowledge output to a scientific study on human behaviors and perceptions.

Numerous studies in the past have underlined Kansei as being implicit and that it cannot be measured directly (Nagamachi, 1992; Harada, 1998; Nagamachi, 1999; Nagasawa, 2004; Lokman et al., 2016). Hence, Kansei measurement is done indirectly by measuring sense activities, internal factors and psycho-physiological and behavioral responses of the respondents towards an object or product. As an extension to the Kansei study, Lokman (2010) pointed out that Kansei measurement can be done either physiologically or psychologically. Physiological measure aims to capture consumer behaviors, responses and body expressions namely sensory actions. Conversely, psychological measure captures the human mental state using self-reporting systems such as Differential Emotional Scale (DES), Semantic Differential (SD) Scale or free labeling system. Lokman (2010) also identified simplicity as being the core advantage of psychological measurement as it provides easy adaptation in various research domains.

2.6.2 Kansei Engineering

Kansei Engineering (KE) is a technology used to measure Kansei science that refers to psychological feelings and images held in the mind towards artifact, situation and surrounding as defined by Nagamachi and Lokman (2016). The past reviews support the aim of the KE that unites Kansei into engineering that allows the assimilation of human

Kansei into an affective product design that has high emotional appeal to the consumer (Nagamachi, 2016; Nagamachi and Lokman, 2015; Lokman et al., 2016; Ishihara et al., 2010). Hence, it enhances consumer satisfaction.

According to the founder of the theory Nagamachi (1995), KE is a scientific discipline that develops product technologically which gives maximum satisfaction to the consumers. This approach is executed by collecting consumers' Kansei experience using a list of Kansei Words (KW) or adjectives related to the specific product design. Once the KW is identified, a mathematical prediction model is established to relate Kansei to the product design. These refined steps are aligned with the target of KE to improve the quality of human life by addressing the emotional aspects of the product designed.

Researchers in the area of KE believe that this is the era when product design movement has entered a new horizon, the consumer oriented design (Lokman et al., 2015; Harada, 1998; Nagamachi, 1999; Nagasawa, 2004; Levy, 2013). On the other hand, Saeed and Nagashima (2012) are very much concerned with the interaction between the user oriented product designs or services provided and the users themselves. Therefore, these researchers are more inclined towards biometric measurement to identify the richness of Kansei in the product. Furthermore, biometric measurement such as face recognition for KE is more common as this provides many opportunities to the KE researchers and organizations to design products with aesthetic values that have a high Kansei value (Saeed & Nagashima, 2012; Nagashima, 2013; Nagashima et al., 2008).

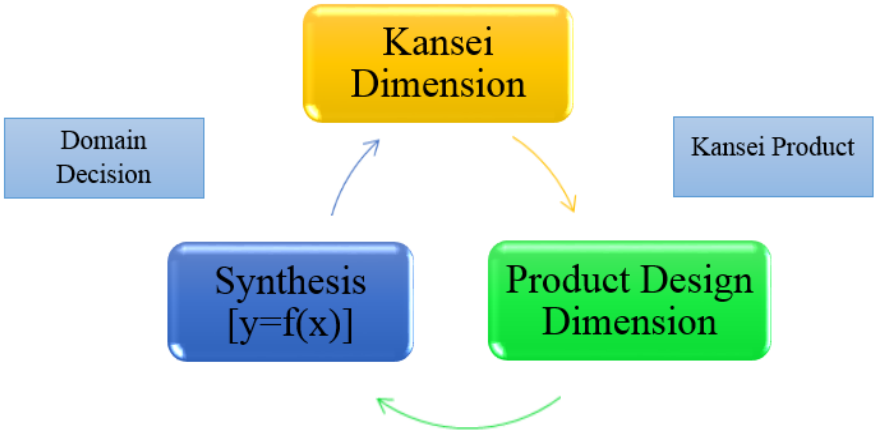
KE is an entity of engineering methods aiming at translating users' feelings into tangible product design parameters. However, Schutte et al. (2005) clearly explains that KE does not develop new theories or tools. It is merely a methodology containing rules on how various tools can interact with each other in order to quantify the impact of the product's trait on the users' perceptions. This explains the evolution of KE and the

feasibility of KE not only in the discipline of product engineering but also in other niche areas such as marketing and robotics.

In order to gain a comprehensive understanding of KE, one must be familiar with the highlighted terminologies in KE. Among the terms used in KE are trend-related Kansei and fundamental Kansei. The trend-related Kansei changes with the trend unlike the fundamental Kansei that remains unchanged (Nagamachi & Lokman, 2016). Besides these terms, the diversity in culture and social behavior also contributes to the variance in Kansei itself (Ishihara & Nagamachi, 1999; Matsubara et al., 1998; Nagamachi, 2003). Therefore, issues related to culture and timeliness are some of the subtle matters that need to be considered when applying KE in various domains of research.

2.6.2.1 Types of Kansei Engineering

Past review on Kansei Engineering has clearly identified KE as an emerging technology that combines Kansei and Engineering realms to assimilate human Kansei into a specific product design that addresses the enjoyment and the level of satisfaction of consumers (Lokman et al., 2009). To add on, the concept of Kansei is also domain specific and is closely connected to affective, emotional values of human beings (Schutte et al., 2005). In a research conducted by Lokman (2010), the various types of KE were elaborated. It is proven that KE is very flexible and therefore various methods can be adapted in order to design a product that can fulfill consumers' feelings and desires (Lokman et al., 2010; Nagamachi & Lokman, 2015). Figure 2.3 illustrates the framework of KE developed by Lokman (2010).



KE Type I: Category Classification	KE Type II: KE System	KE Type III: KE Modelling	KE Type IV: Hybrid KE
KE Type V: Virtual KE	KE Type VI: Collaborative KE	KE Type VII: Concurrent KE	KE Type VIII: Rough Set KE

Figure 2.3: Types of KE (Lokman et al., 2010)

Figure 2.3 shows the various types of Kansei Engineering which is elaborated further in the sub sections.

(a) ***KE Type I: Category Classification***

Type I classifies the various techniques from a targeted concept for a new product development associated with the identified design elements.

(b) ***KE Type II: KE System***

KE System in type II is a computer aided system that comprises of the databases and the component of the expert system known as the inference engine to support a computerized system that handles the process of interpreting consumers' emotions or Kansei to the conceptual design elements of the Kansei product.

(c) ***KE Type III: KE Modelling***

Type III KE utilizes mathematical modeling as logic in a computerized system. This type of KE is adapted to handle fuzzy logic computation to form the machine intelligence or Artificial Intelligence (AI).

(d) ***KE Type IV: Hybrid KE***

The hybrid KE deploys the Forward KE System and Backward KE System to form a Hybrid KE System. This type of KE concept enables iterative process from design element to consumer's emotion.

(e) ***KE Type V: Virtual KE***

Virtual KE incorporates KE techniques into Virtual Reality and enables consumers to examine Kansei product in a virtual world. Nagamachi (2002) has highlighted the success of Virtual KE to design a product and simultaneously allow the customers to have a virtual experience in Kansei space to determine the appropriateness of design specifications (Matsuba & Nagamachi, 1997). The research on virtual kitchen system validates the use of virtual KE (Nagamachi, 1995).

(f) ***KE Type VI: Collaborative KE***

The highlight of this KE approach is that it allows collaboration between designers or customers who are geographically dispersed to use the mutual Kansei database and collaborate via network to design a new Kansei product. Hence, it allows a team that is well spread to collaborate in order to produce a mutual design.

(g) ***KE Type VII: Concurrent KE***

For the Concurrent KE, the representatives from the different departments participate in the evaluation phase of Kansei evaluation and analysis. This will assist in producing a product that is user centric. However, the evaluation can also be done by experts from the specific domain to outline the targeted concept of the new product design. This is a holistic approach and the application of such KE can be seen in the research conducted by Nagamachi (2002).

(h) ***KE Type VIII: Rough Set KE***

According to Nagamachi et al. (2006), this Rough Set KE is claimed to be the most outstanding KE as this approach is adapted to evaluate the ambiguous and uncertain Kansei. By deploying this method, Kansei which is known for its nonlinear characteristics can be treated independently. Thus, by using this method, various decision rules can be generated from the Kansei data. Ahmady (2010) claimed that a rough set KE is vital to determine the most important product characteristics and generate the "if-then" design rules. This approach using Rough Set KE was adapted by Okamoto (2007) in the comparative study of the various beer can designs from Mexico and Japan.

2.6.2.2 Kansei Product Evolution

The KE ideology emerged in the early 1970s as a result from the evolution of consumers' role in the market. Based on previous literature regarding the evolution of quality of product (Schutte, 2005; Childs et al., 2006; Ishihara et al., 2005; Nagamachi, 2003), this research also projects the trend of Kansei product according to its chronological order, describing the evolution of product design over a period of time as shown in Figure 2.4.

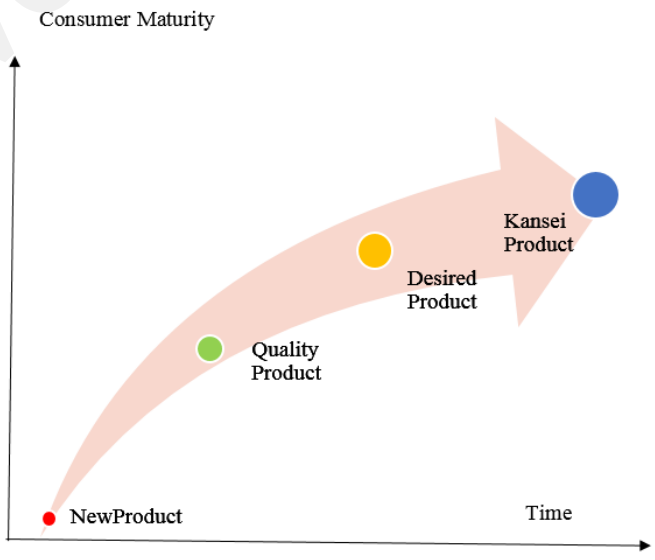


Figure 2.4: Kansei Product Evolution by Consumer Maturity over Time

The descriptions of the stages depicted in Figure 2.4 are described in the sub sections (a) to (d).

(a) ***New Product***

New product is the stage where a new product enters the market. In this initial stage, the product is designed solely using the blueprint of the designer's inspiration and consumers are fascinated to view the newly introduced product. This is also the time period where there is less competition due to fewer types of products with similar design specifications. Consumers purchase these products due to the trend and peer pressure.

(b) ***Quality Product***

In this stage known as Quality Product, the highlight of the design is more on the usability and functionality of the product. Consumers will consume products that have better quality and cater to their needs. The developers will start recognizing the consumers' needs and preferences and battle to improvise the quality of the product to sustain the marketability of their product.

(c) ***Desired Product***

From the term desire, it is clear that the desired products are the outcome of the consumers' voices. Since the previous stage that prioritizes quality had led to longer lifetime of the product, there is a reduction in the buying momentum. Hence, the need arises to identify new paradigms of product quality to motivate buyers to continue purchasing the product. This scenario has impacted businesses to improvise the product development method to enable them to produce products that are desired by consumers. This action leads to a more customized product design that can successfully sustain their product in the market.

(d) ***Kansei Product***

A Kansei product is known as a product that has embedded emotion in the design of the stated product. Professor Mitsuo Nagamachi of Hiroshima University was inspired at that time to establish a product development method that understood consumers' feelings and satisfy their emotional needs. He pioneered the new initiative to design and engineer a product based on consumers' feelings and desires. In his article, Nagamachi (2002) asserted that businesses will not be able to sustain if the designers do not produce products that are sensitive to the diversified consumers. Inspired by the ideology of Kansei science, Nagamachi (2003) developed a technology that enables the incorporation of consumers' feelings and emotions into product design termed as Kansei Engineering (KE). The target of KE is to develop a Kansei product to assimilate human feelings and emotions into its physical traits such as shape and colour via the implementation of KE.

2.6.2.3 KE Production Scheme

The goal of KE is to enrich the quality of our daily life through new production technologies from users' perspectives (Nagashima, 2008). This is solely because the perspectives of the users ensure the designed product satisfies their requirements and preferences (Saeed & Nagashima, 2012; Nagashima, 2013; Nagashima et al., 2008).

To address the goal of KE, Nagashima (2013) designed a new production scheme known as co-creation between the designers and users where they collaborate together and simultaneously share a common value identified as the Kansei value of a specific product. Nagashima's (2013) research on the fundamental KE is depicted in his new production scheme as shown in Figure 2.5.

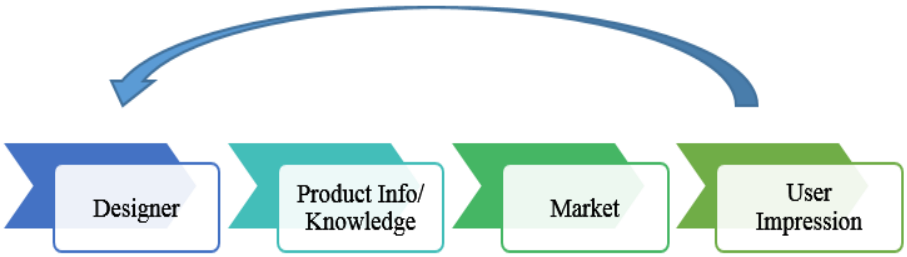


Figure 2.5: New adopted production scheme of KE (Nagashima, 2013)

As shown in Figure 2.5, four major components are required to attain the goals of KE. The figure depicts the product in the market and information on the user preference is transferred back to the designer to enhance the existing design of a specific product. The reverse arrow at the top represents the feedback loop in the production scheme. Nagashima (2013) has always given high importance to the interaction process between the designers and users. He affirms that it is crucial to have positive communication between the designers and users as it plays an important role for achieving a satisfactory level of the product quality. As a result, the communications involved in the developing process of a Kansei product establishes an important step in the co-creation process.

It is found that Nagashima's (2013) research outcome is in line with Nagamachi's (1995) ideology of Kansei. It is evident that in KE, the knowledge is sought through direct interaction with the users and the product and this direct interaction leads to the construction of the Kansei product.

2.6.3 Kansei Engineering in Human Computer Interaction

Kansei Engineering plays an important role in the field of Human Computer Interaction. The key areas are discussed further in the sub topics.

2.6.3.1 Instructional Design

Kansei Engineering is a proven methodology for translating human feelings into a product design. It is capable of enhancing users' satisfaction on a product by analyzing the relationships between their feelings and design parameters. In recent years, instructional designers have paid increasing attention to affective issues in improving learners' learning experiences. In line with this, Chuah et al. (2008) proposed a model for KE implementation in instructional design for teaching and learning as shown in Figure 2.6.

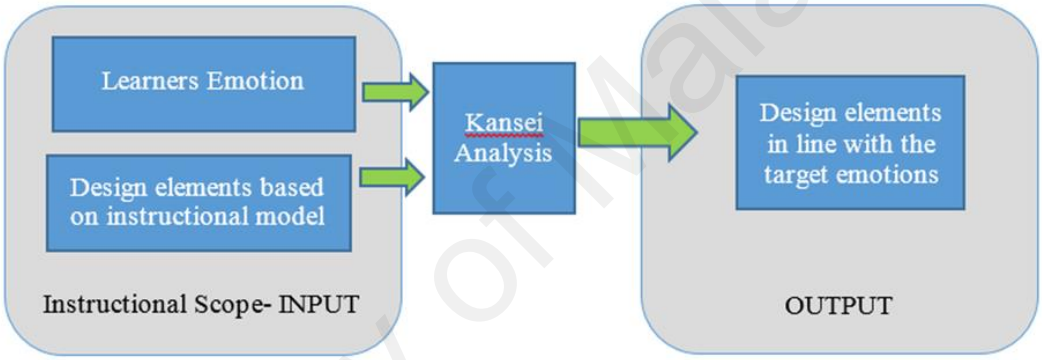


Figure 2.6: KE Approach Design for Instructional Design

The instructional design model shown in Figure 2.6 comprises a set of practical procedures which takes into account principles of human learning for the design of effective instructions (Reigeluth, 1999). In designing instructional materials, a designer would commonly select a guiding model based on the scope of the instructional materials. This scope covers the descriptions of target learners, subject matter as well as learning objectives. After an instructional design model is chosen, the designer would proceed by generating design elements based on the prescribed methods or components of the model. To investigate whether the design elements are emotionally sound, it is then presented to the learners for Kansei evaluation. The analysis process using statistical methods in KE can create a linkage between learners' emotions and design elements and thus form

groups of design element linked with specific feelings. In other words, instructional designers will be able to identify the design elements related to the component of the chosen instructional design model that can generate positive emotions. Hence, the final version of the instructional material that suit learners' desire and emotional needs can be created.

2.6.3.2 Kansei Engineering and e-Learning

Referring to past literature, e-learning studies do not only generate good learning outcomes but also better engaged learners in the learning process (Shen et al., 2009). According Keller and Suzuki (2004), there are four factors that influence the success of an e-learning platform in sustaining student motivation. The identified factors are attention, relevance, confidence and success. The four factors are depicted in Keller's (1987) model named the ARCS model. This idea was adapted by Charoenpit et al. (2013) in her study and a new framework for e-learning was designed as shown in Figure 2.7.

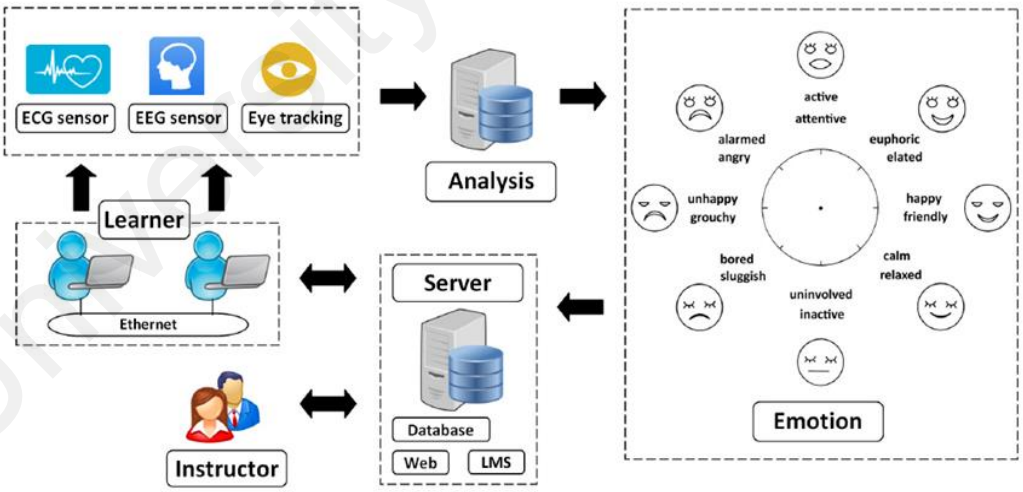


Figure 2.7: e-Learning Framework with Emotional Consideration

In reference to Figure 2.7, the e-learning system framework design consists of five modules: learners, instructors, servers, biological sensors and an analysis of learners'

emotions (Charoenpit et al., 2013). The first module is known as the learners. Learners are individuals who select e-learning by registering with the e-learning system. They can choose an array of courses provided by the Learning Management System (LMS). Next, the instructor module allows for the creation and design of courses, content, tests, quizzes and evaluations in the LMS. The Server module integrates the World Wide Web and the database servers with the deployed LMS. In this module, the web server dispenses web pages upon receiving the request from the LMS and the database server provides database services to the LMS. Therefore, in this server module, the LMS plays the role of a web based, high technology medium for planning, implementing and assessing a specific learning process.

The fourth component is the biological sensors that include Electroencephalography (EEG), Electrocardiography (ECG) and eye tracking devices to measure the emotions of learners. Charoenpeit et al. (2013) claim that the EEG captures the human brain activities and provides information on an individual's mental activities and emotional state. This signal is captured using the electrodes on the scalp. It has been noted that the EEG is the best signal for emotion recognition. However, it is very sensitive to electrical signals from facial muscles while emotions are being elicited. On the other hand, an ECG sensor measures the heart's electrical activity over a time frame. The user wears the ECG's electrodes that collect data from the heart's movement. Then, the data is analyzed. It must be noted that the outcomes differs from one individual to another as different emotions are connected with different physiological data features. Another biological sensor device is the eye tracker that is widely used to measure the user's gaze point. The spotted gaze point will determine the position of the eye or the motion of an eye relative to the head.

The final module is the analysis of the learners' emotions. In this module, the system design is a reflective preference of the learners. The design complies with learner's

expectations and needs. There is a need to understand how learners' emotions evolve during the learning process so as to develop learning systems that recognize and respond appropriately to learners' emotional transitions.

2.6.3.3 Kansei Engineering and Mobile learning

Mobile learning has notably become the trend among the young learners of the 21st century. It is a vital tool for educators in the ubiquitous learning environment. With the increased in the number of mobile users, there is anticipation for rapid growth of mobile learning (M-learning) applications in the education domain. According to Taharim et al. (2015), the increasing number of mobile users and the mobile device affordability in Malaysia have provided the opportunity to implement mobile learning in education institutions. In Taharim et al.'s (2015) study that adapts the KE for mobile learning, it was found that the infusion of KE into the mobile learning framework enhances student's learning experience. The author affirms that the developed mobile learning framework is an effective guideline to construct a fun learning environment without compromising on the quality of teaching and learning.

In this KE related study, designing interactivity with M-learning is crucial for both learners and educators. Therefore, the designers are required to determine the core elements and relevant methodologies when designing an interactive M-Learning application. This is due to the fact that M-learning creates positive engagement in terms of knowledge sharing and enhances the two-way communications between the learners and educators (Ramachandiran, 2011). The integration of the three dimensions identified with KE from valid theories serve as a guideline for the framework development. As a result, it produces successful learning beyond the classroom. Furthermore, a similar research to Taharim (2015) was conducted in Singapore where the researchers adopted M-learning in a science lesson for the third grade. The results indicated that learners from

the M-Learning environment performed better compared to their peers from a tradition classroom learning environment (Looi et al., 2010).

Along similar line, Taharim et al. (2014) developed the Participatory Playful Interaction Theoretical Framework (PPITF) that aims to integrate aesthetic element into the M-learning. In PPITF, the researchers divided the research into four phases comprising of the Preparatory of Research Instrument (Phase I), Development of PPITF (Phase II), Evaluation and Testing (Phase III) and Explanatory (Phase IV). The four phases are depicted in Figure 2.8.

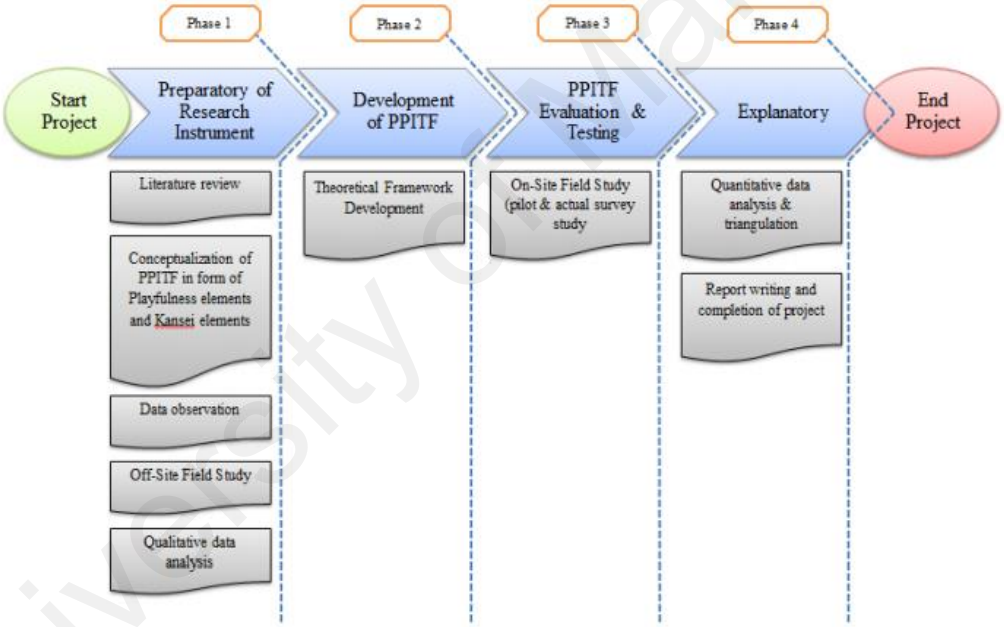


Figure 2.8: Participatory Playful Interaction Theoretical Framework (Taharim, et al, 2014)

Figure 2.8 shows the four phases adopted in the study conducted by Taharim et al. (2014). The four phases are elaborated further in (a) to (d).

(a) ***Phase I: Preparatory of Research Instrument***

In this phase, the researchers identify a suitable concept and apply it on various dimensions to finalize the best fit concept. It is also in this stage where the themes and

trends that are feasible in this context are ruled out to identify the gaps in the finalized concept. The literature review for this research includes the narrative findings on mobile playful interaction design, digital history, participatory mobile learning and possible model, theory, framework and methodology for playful interaction in the M-learning environment.

The conceptualization of the PPITF that integrates the Playfulness Theory and Kansei elements are derived from the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Jeffery et al., 2011; Kallaya et al., 2009). On another note, the two models Theory of Playfulness in Human Computer Interaction (HCI) by Korhonen et al. (2009) and Costello and Edmonds Framework (Costello & Edmonds, 2009) are focused on creating playful interactions. The actual Kansei elements used in this study were derived from the KE. The affective engineering method, KE has proven to be the best-fit for this study due to its feasibility and it is well accepted among the researchers and designers in Japan and Korea (Lokman & Nagamachi, 2009).

The data is collected from various sources such as book and artefacts. It is a process of data collection that provides sufficient information to the researcher. Next, the off-site field study is conducted amidst the focus group for the data collection. To add on, unlike the process of conceptualization and development of the theoretical framework that uses the qualitative data, the quantitative data analysis is based on the findings on the teaching pedagogy, student's needs and the interaction process.

(b) *Phase II: Development of PPITF*

In this phase, the ladder of the analytical abstraction is used for the theoretical development process. This phase aims to map the research structure into an explanatory work that fits the domain of research (Fincher & Petre, 2001). The ladder is adapted to

capture the research progression in order to assist the PPITF development. Based on the developed PPITF, prototypes will be designed to be tested in Phase III.

(c) ***Phase III: PPITF Evaluation and Testing***

In this phase, the on-site field study is conducted by the researchers. The outcome from Phase 2, theoretical framework result is implemented and evaluated. The finding from this Phase is then further analyzed to determine the efficacy of the playful interaction design digital history.

(d) ***Phase IV: Explanatory***

The explanatory phase is divided into two sub categories identified as the quantitative data analysis and triangulation category and report writing category. The quantitative data analysis and triangulation adapts the triangulation method by Vaishnavi and Kuechler (2015). A multi method approach is deployed as the process of balancing realism and control from the usage of multiple methods can increase the accuracy of the findings via the triangulation process (Fincher & Petre, 2004). To sum up, triangulation is defined as a combination technique to summarize the gaps from previous studies as claimed by Fincher and Petre (2004). In this phase of study, the researcher used Gephi as a tool for data analysis. Gephi, an open source tool is used to determine the pattern and the research hypothesis. To analyze the results, a pivot table was used. On the other hand, the report writing marks the completion of the project.

2.6.3.4 Game Avatar Design

According to the KE specialist, Lokman et al. (2014), video games have been identified as a propaganda tool to influence people from various communities. Therefore, in the study conducted by Lokman et al. (2014), it was found that the design of game's character plays an important role for an effective gaming environment. It must be noted that most of the existing video games in existence currently are designed merely for

amusement. Previous literature has indicated that numerous researchers have agreed that video games are now an important medium used by all groups of people to implicitly influence people's thinking and attitude (Leonard, 2004; Lokman et al., 2014).

Findings from a recent research on games avatar shows that it is crucial to explore the emotional impression of users as it facilitates a better understanding of users' experiences which leads to healthier design strategies (Lokman et al., 2014). Lokman et al.'s (2014) study was performed to explore the emotional structure that is outlined by the avatar design characteristics. These game avatars and emotion measurements were independent from demographic and cultural context and from types of games such as of fantasy, propaganda and educational. However, the researchers felt that the findings are very hypothetical and require further investigations. The research findings in relation to the game avatars are projected in Figure 2.9.

Figure 2.9: Avatar and Kansei Influence

The results as shown in Figure 2.9 depict how the avatar characteristics are categorized based on the different kinds of emotional impressions to online gamers. This visualization provides supportive information to game developers on the types of avatar to design that evokes certain types of emotional responses. To conclude, these findings also provided a guideline to determine design specifications for game avatars that have the capacity to influence the users.

2.7 Kansei Approach in Malaysia

It is crucial to note that Malaysia is not lagging behind in research related to Kansei Engineering. There are several studies that have adapted the Kansei approach in HCI. The focus of these researches includes game avatars, e-learning and virtual learning environment. Researchers Redzuan et al. (2011) affirm that positive emotion is important to promote learning. The research adapted KE technique and it translates the users' Kansei into the design elements of an online course. The research highlighted the importance of a good emotional design and proposed an effective model for positive emotional experience in online learning. However, the research did not highlight the importance of the pedagogical agent but more on the entire design of the learning environment. The findings suggest that the most influential design elements in the virtual learning environment are the environment richness and coaching. Similar to the current research, other researchers have also adapted the Kansei approach in the Virtual Reality based Learning environment (Chuah et al.,2008; Taharim et al.,2015; Kumar et al.,2016).

In another research on video-based learning by Adnan and Redzuan (2016), the findings revealed that there are five pillars to the Kansei semantic space of emotions for video-based e-learning materials. The identified pillars are professional-motivated, fun, joking-humorous, deceptive and puzzled. Along similar lines, Yong et al. (2016) claim

that visual design principles have positive impact on classical aesthetics and this is adopted in the web-based learning platforms.

2.8 Summary

In a nutshell, the literature review discussed shows that there is an extensive array of researches conducted throughout the world except in the field of HCI which is still scarce. Norman (2004) has emphasized on the emotional power of products and it has been validated that emotion plays an important role in marketing and advertising as claimed by Nagamachi (2003). Numerous research studies have proven that many skilled designers understand the powerful appeal of emotions and have used their intuitions and creativity to exploit the emotional appeal of the products. However, despite the strong emotional appeal, emotions have played a very minimal role as an ideal characteristic for product design by professionals (Desmet, 2002; Hekkert et al., 2003; Norman, 2004). Moreover, in the domain of engineering and the disciplines of Human-Computer Interaction and Cognitive Ergonomics, emotions are seldom mentioned (Desmet, 2002; Norman, 2004). Though there are many researchers who have successfully incorporated emotions as an important criterion for the product design, it is still at its infancy stage and thus, further research is required.

It is evident that in the HCI design literature, the crucial argument has always been the user-experience (Nielsen, 2013; Marcus, 2015; Johnson, 2013) and it is also proven that most designers fail to understand the users' needs (Powell, 2002). Therefore, it is crucial to identify the emotional user experience to design an effective product that has aesthetic value. Research related to emotional user experience offers a new perspective on the user-oriented design that can maximize user satisfaction. KE that addresses this issue provides an effective solution for the designers to ensure the sustainability of a product in the

market for a longer period of time as the design caters to the needs of the user and it was developed based on their preferences.

Past research by Mahlke and Thüring (2007) asserted that emotion is an important component of users' experiences with interactive systems. This research has provided a platform for researches that aim to infuse emotional aspects into the interactive system design process. Similarly, Desmet (2003) posited that emotions influence both our well-being and our purchase decisions of any product. It is clear that both knowledge on product design that elicits emotion and emotion evaluation tools can be adapted for better and enhanced product design practices. However, Desmet (2003) and Norman (2004) agree that there is insufficient information on how people will respond emotionally to the specific product design and their reaction towards the product.

This chapter has given insights to understand the Kansei science with detailed discussion on key niche areas such as Virtual Learning Environment (VLE), VLE in HEIs in Malaysia, Virtual Agents and role of emotion from a psychological perspective. It also elaborates on the emotional models, Kansei design approach, Kansei Engineering and Kansei product evolution. The chapter ends with a comprehensive discussion on KE in Human Computer Interaction (HCI) specifically in e-learning and M-Learning.

CHAPTER 3: RESEARCH METHODOLOGY

This chapter defines the research methodology used in this research to fulfill the research objectives and questions listed in Chapter 1. It begins with the discussion on the methods used to gather data thus giving illustrations as to researcher's choice of sampling, data collection, data analysis, the validity and reliability of the study. The discussion also gives details about the pilot study carried out to test the feasibility of the instrument used in this research.

3.1 Purpose of Study and Research Questions

The purpose of this research was to establish how Kansei Engineering can be used to design virtual agents that have aesthetic values in a Virtual Learning Environment (VLE). In addition, the research also sought to identify learners' emotional experience towards virtual agent deployment in a Higher Education Institution in order to design a model using Kansei virtual agents that coherently capture learners' emotion to enhance the learning process that takes place. In line with this, the research aimed to answer the following research questions which have been constructed:

RQ1: What are the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment?

RQ2: What are the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment using the Kansei design approach?

RQ3: What are the Virtual Agent Design Model (VADM) design specifications needed for an effective design of virtual agents to capture learners' satisfaction using the Kansei design approach?

RQ4: Do the virtual agents designed using the Virtual Agent Design Model (VADM) have high emotional appeal and enhance learners' satisfaction?

3.2 Validity and Reliability of Research

For a research to be accepted and applied further, it is crucial to ensure the data is valid. To do this, two key concepts must be established; validity and reliability. Validity can be divided further into internal and external validity. According to Wiersma (2000), internal validity is the extent to which results can be interpreted accurately while external validity indicates the extent to which the results of a research can be generalized to conditions, situations and populations. On the other hand, reliability refers to the consistency of the research findings in terms of how they can be replicated. Internal reliability refers to the identification of whether the data collected, analyzed and interpreted are consistent and the interpretation of this by another researcher would reveal similar findings. In the case of external reliability, it refers to the extent to which independent researcher can reproduce a study and obtain similar results.

In this research, both validity and reliability were established through a number of methods suitable for the respective methods of data collection adopted to answer the four research questions. This will be discussed in length under the relevant research methods deployed.

3.3 Research Design

This research adopted a purely quantitative research method. According to Krathwohl (1993), quantitative research describes phenomena in numbers and measures using statistical analysis. In essence, quantitative research tends to be based on numerical measurements of specific aspects of phenomena. It abstracts from particular instances to seek general description or to test causal hypotheses and also seeks measurements and analyses that are easily replicable by other researchers (Riff et al., 2014). The researcher

opted to use the quantitative method for it is generally accepted that findings in a quantitative research is more objective and can be applicable to a larger population without any doubts on their validity and reliability.

Using the quantitative method, the research design was constructed and is illustrated in Figure 3.1.

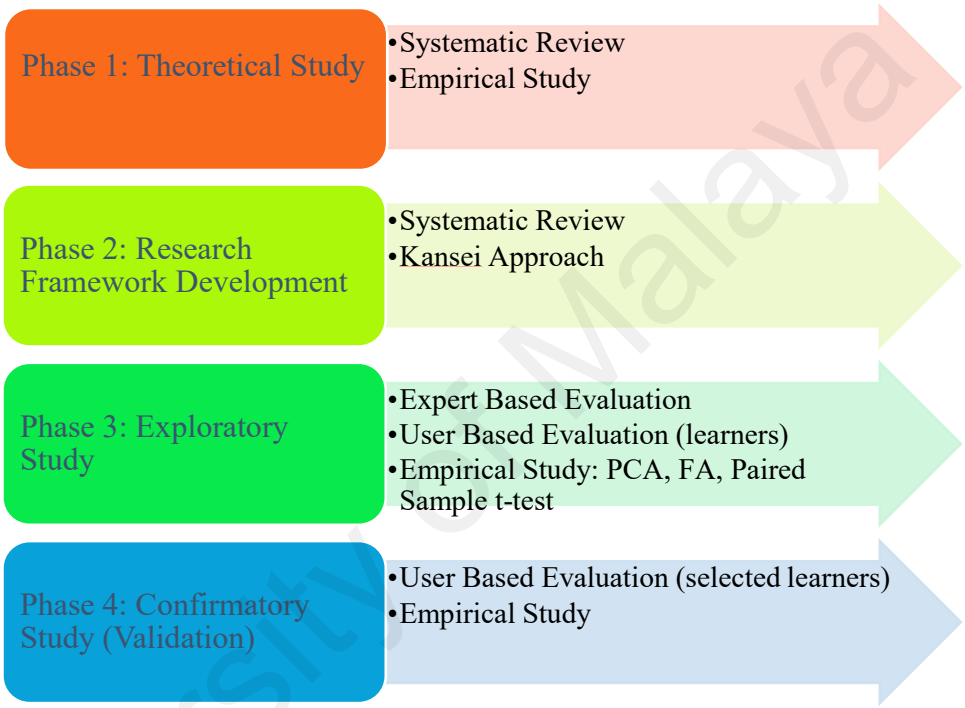


Figure 3.1: Research Methodology

The four phases of the research design encompass data collection to answer the four research questions formulated for this research. As depicted in Figure 3.1, Phase 1 was the theoretical study phase. In this phase, a systematic review of factors relating to virtual agent design was conducted through an in-depth document analyses on all theories and past researches which was then tested using statistical analysis. On the other hand, Phase 2 deployed a similar approach but it focused on the Kansei Engineering (KE) approach. The research framework was developed in this phase. This was followed by the

Exploratory Study which is Phase 3 where experts' and users' evaluations were explored and analyzed. An empirical study was also conducted on the findings of this phase and a Virtual Agent Design Model was developed. In Phase 4, the researcher validated the model developed in Phase 3 using respondents comprising of selected learners through an empirical study.

3.4 Theoretical Framework

The term experience has been used interchangeably in various disciplines but the term product experience specifically refers to an experience that is affective. According to Desmet and Hekkert (2007), product experience is a multi-faceted phenomenon which involves the feelings, behavioral reactions, expressive reactions and also physiological reactions. In this context, three components of product experience were identified by the researches derived from Hekkert's original study in 2006. The three components are identified as aesthetic pleasure, attribution of meaning and emotional response. Thus, the definition of product experience is as "the entire set of affects that is elicited by the interaction between users and a product, including the degree to which all our senses are gratified (aesthetic experience), the meanings we attach to the product (experience of meaning) and the feelings and emotions that are elicited (emotional experience)" (Hekkert, 2006, p. 160). The following Figure 3.2 depicts the components of the product experience in a user-product interaction.

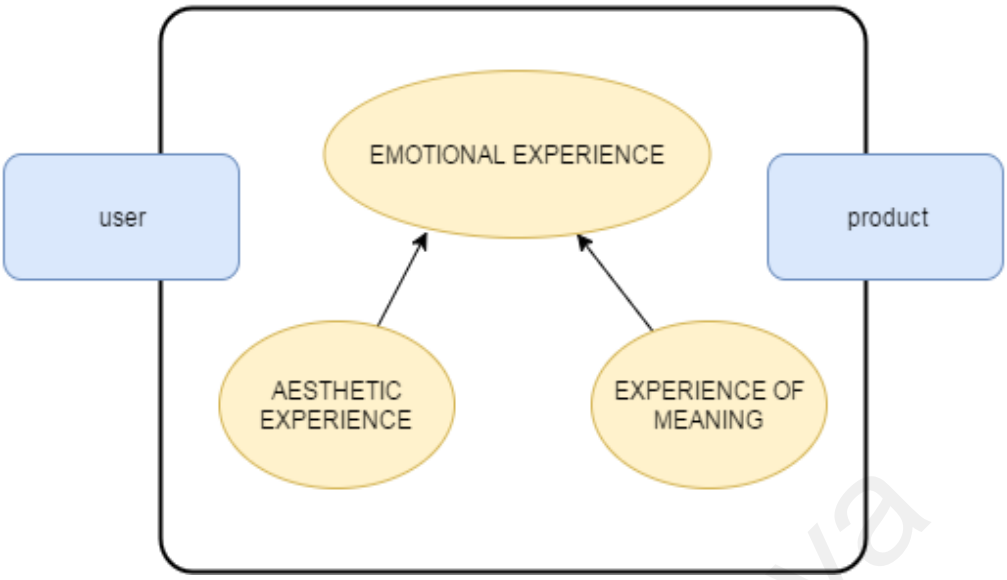


Figure 3.2: Desmet and Hekkert's (2007) Framework on Product Experience

Figure 3.2 depicts the framework that comprises of three components of product experience adapted from Desmet and Hekkert (2007). Aesthetic experience is the enjoyment the user experiences while using the product. On the other hand, experience of meaning occurs when the users have a strong attachment to the product due to sentiments. Finally, emotional experience is the satisfaction the users experience when the product meets the needs of the users. Each of the three components is elaborated below.

- *Aesthetic Experience (AE)*

The aesthetic level is considered a level in which one or more sensory modalities are elated. The physical appearance of a product can be attractive, and trigger positive feelings and good sensory stimuli. However, the degree to which a perceptual system identifies the structure, order or coherence and assesses a product's novelty determines the effect generated by the product (Artacho-Ramirez et al., 2008; Hekkert et al., 2003). Alternatively, researchers Ramachandran and Hirstein (1999) argue that such effects can be explained by examining the evolutionary basis of our perceptual systems. Adding on,

Ramachandran and Hirstein's eight laws of art focus on images created using computer graphics. The eight laws are:

- The Peak Shift Principle
- Grouping and Binding
- Isolation of a Single Visual Module
- Problem Solving
- Contrast Extraction
- Symmetry
- Generic Viewpoint
- Use of Metaphor

On the same note, Norman (2005) defines AE as a visceral level of emotional design which was defined as the cognitive response category or aesthetic impression by Crilly et al. (2004). Their study focused on the aesthetic, semantic and symbolic aspects of cognitive responses towards a specific design.

- *Experience of Meaning (EM)*

In this level of product experience, cognition plays an important role in determining the experience of meaning in the user–product interaction environment. By adapting the cognitive process such as interpretation, memory retrieval and associations, users can identify metaphors, assign personality and assess the significance of the product design (Desmet & Hekkert, 2007). These components are aligned with the cognitive responses identified by Crilly et al.'s (2004) known as the semantic interpretation. It is clearly stated that the cognitive processes involved are vulnerable to specific individual needs and the cultural diversity. In a recent research, it is also highlighted that humans play a major role in understanding linguistic and figurative expressions of a product (Gibbs, 2003; Van Rompay et al., 2005). Some of the identified examples of EM are luxury and attachment

whereby the experience of luxury represents a symbolic value of a comfortable lifestyle in relation to specific products (Reinmoeller, 2002). In accordance to the findings by Reinmoeller (2002), luxury products are developed using material, processes, packaging, distribution of products, and promotional activities that exceeds the basic level of standard products to allow for pleasure of use and the attachment refers to the connection between the spirit of humanism and the underpinnings of the product design.

- Emotional Experience (EX)

The basic affective phenomenon that is typically considered in emotion psychology in regards to emotions is highlighted in this EX. Most theorists view emotions as coherent, organized and functional systems (Smith & Kirby, 2001). On another note, Fridja et al. (1986) stated that emotions are functional because they establish our position in the environment, pulling us toward certain people, objects, action and ideas as well as pushing us away from others. This is a basic principle that applies to all emotions experienced by the users. It is also highlighted that pleasant emotions pull us to products that are beneficial whereas unpleasant emotions will push us from those that are detrimental to us (Desmet et al., 2001).

3.5 Kansei Design Model

Although there are different types of Kansei Engineering, for the purpose of this research, the Kansei Design Model (KDM) developed to facilitate the implementation of KE procedure to design a Kansei rich product by Lokman and Nagamachi (2009) was adapted and enhanced. Figure 3.3 depicts the systematic approach of KDM that was implemented in this study. The reason the researcher adapted and enhanced this model is because it has been successfully used by various researchers in other domains of study.

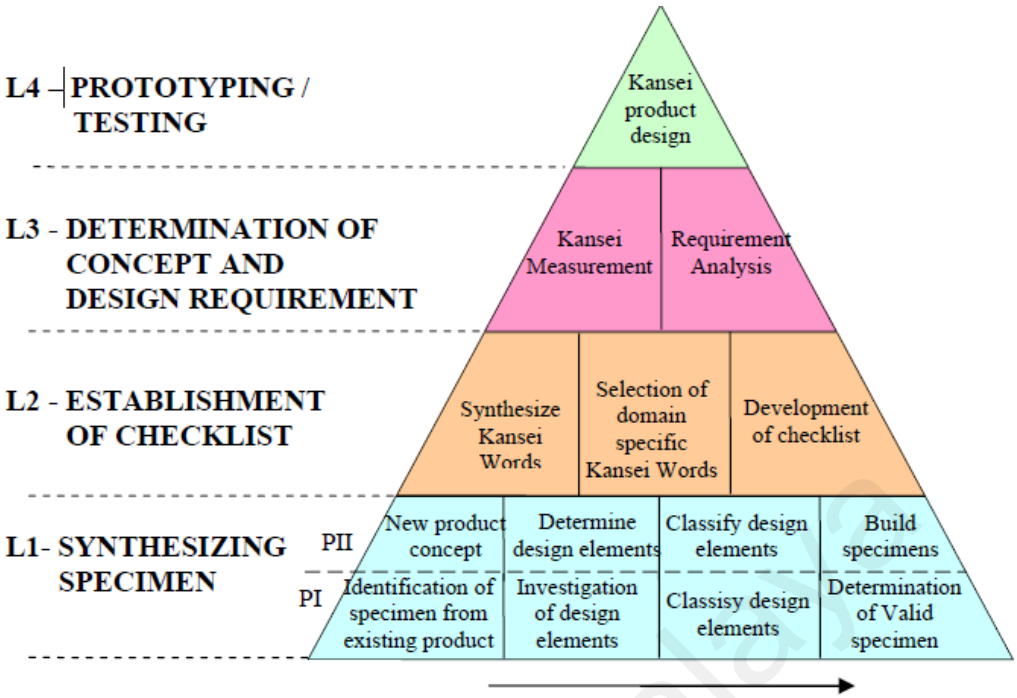


Figure 3.3: Kansei Design Model (Lokman & Nagamachi, 2009)

Before discussing how Lokman's KDM model was adapted and enhanced in this research, a comprehensive overview of the model is given for better understanding. The KDM as shown in Figure 3.3 is a useful tool for designers and researchers to ease the product development phase that embeds users' emotions. There are 4 levels identified in KDM and they are L1 synthesizing specimen, L2 establishment of checklist, L3 determination of concept and design requirement and finally L4 prototyping or testing phase. The four levels are defined further in the sub sections.

(a) ***L1: Synthesizing Specimen***

This level elaborates the various processes of synthesizing the specimens. The level is divided into two prominent sub levels. They are the PI and PII. Lokman and Nagamachi (2009) has clearly identified PI for the existing product in the market that requires enhancement from the designers or researchers and PII as for new applications developed to meet the requirements of designers or researchers.

The PI procedure begins with the collection of specimens with existing samples with prominent differences. The choice of specimens is based on the experimental design proposed by the researcher. Next, the samples are analyzed to identify the design elements of the specific product. Simultaneously, the researcher or designer must be able to narrow down the quantity of chosen design elements for a specific specimen. This will enable more objective measurement. On another note, including all identified elements from the users' point of views could result in a more accurate measurement or product design. This method is believed to produce higher accuracy in design elements. The more design elements identified, the higher the possibility to match the users' emotional responses. Another important procedure in level 1 is the classification of design elements. Once the design elements are identified, the collection of design elements are analyzed to investigate all the possible designs which can be assigned to the products or specimens used. This process is crucial since the findings will be the essence in the success of the Requirement Analysis stage in this KE study.

Alternatively, PII is applicable only for products designed by the designer or researcher to meet specific design objectives. This is applicable for new product development that is yet to exist in the market. At this level, designers and experts have to determine product specification based on their requirements and expectations in relation to the objectives of the product. Then, designers or experts will have to determine specific design elements relevant to product design.

(b) ***L2: Establishment of Checklist***

The second level in KDM known as L2 describes the preparation and development of a Kansei checklist. In this level, the process is divided into 3 different steps as listed:

i) Synthesizing Kansei Words (KW),

ii) Selection of domain specific KW

iii) Development of checklist.

This L2 level synthesizes Kansei words (KW) from the larger set of possible KW to a more domain specific KW that is related to the product specimen. KW can be adjectives or nouns in English such as 'naturalistic', 'sophisticated', 'dynamic' and 'pleasant'. These KW can be synthesized from past reviews, magazines, books, newspapers or even by consulting experts (Nagamachi & Lokman, 2015). The end product from this L2 stage is a domain specific checklist in a Semantic Differential scale form.

(c) ***L3: Determination of Concept and Design Requirement***

In the KDM, the L3 describes identification of the Kansei process and the design requirement. This L3 level is divided into 2 major steps as listed:

i) Kansei Measurement

ii) Requirement Analysis for the research study

The Kansei Measurement procedure is done by incorporating the opinions from the expert or the users as test subjects. They are to rate their impressions towards the product specimen using the Kansei checklist. Then, the results from the checklist evaluation is analysed to identify the association between the experts or users' Kansei and the product design elements identified in level L1. This outcome determines the specific design requirement for the development of a Kansei product that has rich Kansei value (Nagashima, 2013).

(d) ***L4: Prototyping***

L4 is an important level in KDM whereby it describes prototyping and testing stage of the Kansei product. According to Lokman and Nagamachi (2009), in this final level, the results from level L3 will be used as the basis to design a prototype of domain specific Kansei product. This process involves the integration of the concept of Kansei and the design requirements identified in L3. In order to design a successful Kansei product that

gives maximum satisfaction to the user, experts' opinions must also be included in the design process and the porotype testing must be performed to validate the design requirements identified using the KE method.

3.6 Virtual Agent Design Research Method

The Virtual Agent Design Method is the label given to the adapted and enhanced Lokman and Nagamachi's (2009) Kansei Design Model (KDM). The Kansei Virtual Agent Research Method is derived from KDM after outlining the theoretical background on KE and virtual agent design specifications had been identified. This present method enabled the researcher to engineer the learners' emotional responses and identify the design elements of a virtual agent for Higher Education Institutions (HEI). The design identifies the learners' emotional experiences in the effort to promote learning in HEIs and simultaneously enhance the learners' satisfaction. Figure 3.4 depicts the research method developed for this case study.

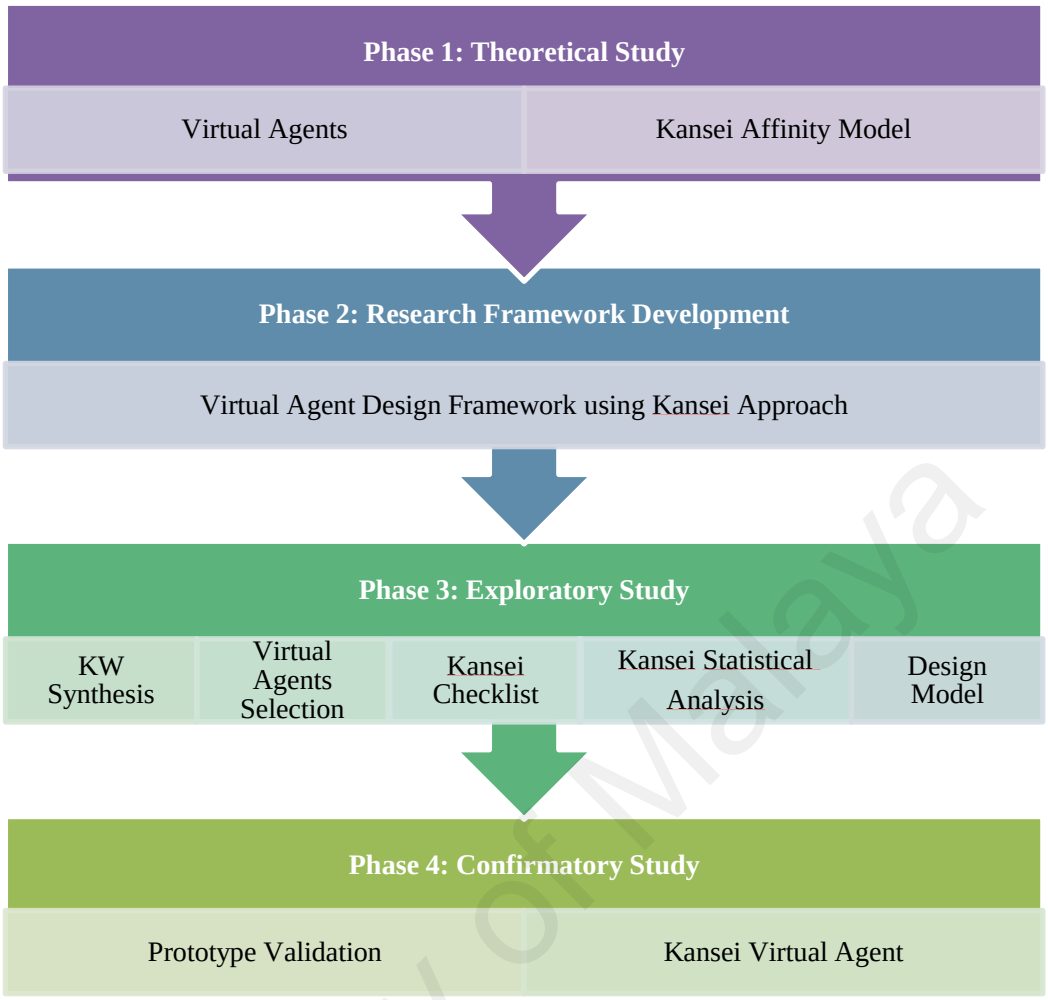


Figure 3.4: Virtual Agent Design Research Method

Kansei Virtual Agent Research Method as shown in Figure 3.4 enabled the KE measurement of learners' emotional or affective responses towards virtual agents, identified the various design specifications from the learners' perspectives, investigated the associations between the affective responses and the virtual agent prototype design elements and the development and validation of the model designed for Kansei virtual agent design.

There are four vital phases in this research study as listed:

- Phase I : Theoretical Study

- Phase II : Research Framework Development
- Phase III : Exploratory Study
- Phase IV : Confirmatory Study

These four stages in the Kansei Virtual Agent Research Method facilitated the KE procedure adapted in this research study to design a Kansei Virtual Agent that has rich Kansei value to promote learners' satisfaction and enhance their learning curves.

3.7 Phase I: Theoretical Study

Phase I as defined in Figure 3.5 is the initial stage of the research study where it commenced with the review of previous literature on the general concepts of and challenges in relation to virtual agent design process and Kansei Engineering. The review focused mainly on the learners' experience, virtual agent design specifications, Kansei Engineering Affinity Cluster and the importance of the emotional aspect of virtual agent design. Furthermore, this phase enabled the researcher to identify the issues and facets in the virtual agent design process that requires further enhancement or investigations The details of the review has been discussed in Chapter 2.

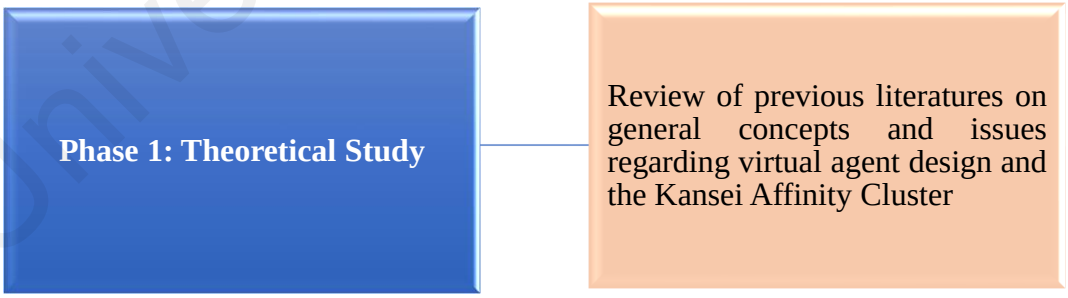


Figure 3.5: Theoretical Study (Phase I)

In addition, this phase of study also enables the researcher to identify the advancement and transition in the design paradigm of a product design. The prioritization of a design

criterion mainly focuses on usability and functionality of the VLE that deploys virtual agents (Marcus & Gould, 2000; Marcus et al., 2013; Nielsen, 2013). It must be noted that the trend of a product design is now changing towards the emotional consideration in a product design as highlighted by Nagamachi and Lokman (2015). The gap in terms of emotional design requirement for the virtual agent design is evident. Hence, this study enabled evaluation of the learners' emotional experiences towards virtual agents.

3.7.1 Kansei Affinity Cluster

Kansei Affinity Cluster framework was designed by Lokman and Kamaruddin (2010) to outline a total of 820 Kansei Keywords (KW) and their affinity cluster using the Kawakita Jiro (KJ) method. This KJ method developed by Kawakita Jiro in 1960's allows grouping of collected data to reach consensus on priorities and qualitative data (Lokman, 2010; Spool, 2004). Similarly, the Affinity Consultancy (2000) has proven that KJ method can be used as a tool to gather large amounts of data such as ideas, issues and opinions as well as organize them into several groupings based on the coherency or natural relationships.

The objective of Kansei Affinity Cluster is to synthesize KW words that involve emotional values during the Kansei Engineering procedure. This affinity cluster enables the researcher to identify the missing keywords when they face issues related to the semantic. According to Lokman and Kamaruddin (2010), this is a common problem as the notion of emotion is implicit by nature and new researchers will face difficulties to map the verbal descriptors to different states of emotions. Nevertheless, the use of the cluster must be customized to suit the research domain due to the uniqueness of the emotional experience of the users towards different types of products. Figure 3.6 depicts the Kansei Affinity Cluster by Lokman and Kamaruddin (2010).

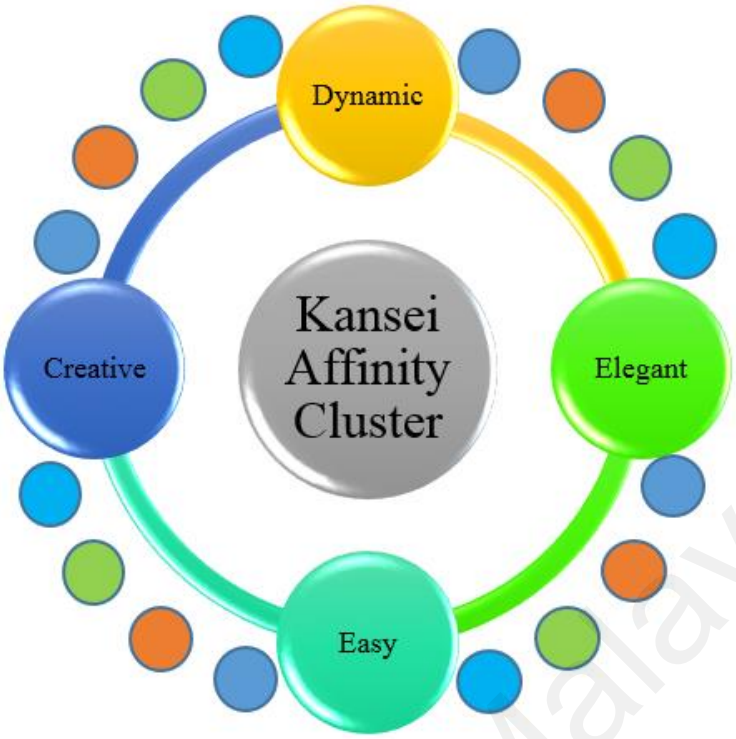


Figure 3.6: Kansei Affinity Cluster View (Lokman & Kamaruddin, 2010)

Figure 3.6 depicts the various clusters that has been identified. A total of 820 KW are grouped into 43 clusters. To name a few, creative, dynamic elegant and easy are examples of clusters in the figure above. The full set of Kansei Affinity Cluster as shown in Table 3.1 captures all the 820 KW identified using the KJ method by the language experts (is defined in the next section) to ensure the validity of the terms. However, in this research only 24 clusters were chosen by the experts. This is due to the suitability of the terms in relation to virtual agents.

Table 3.1: Full set of Kansei Affinity Cluster (Lokman & Kamaruddin, 2010)

Cluster Name	Kansei Words
Adventurous	Capable, Drastic, Energetic, Exposed, Extreme, Valiant, Vigorous, Modern, Outdoor, Radical, Revolutionary
Basic	Common, Familiar, General, Normal, Plain, Regular, Simple, Standard, Typical, Usual
Coarse	Adequate, Ambiguous, Approximate, Boorish, Brief, Heterogeneous, Impure, Informal, Loose, Ordinary, Rough, Slanted, Vague
Compromising	Acceptable, Adaptable, Affordable, Appropriate, Balanced, Cheap, Considerate, Cost-effective, Direct, Encouraging, Frank, Halfway, Hopeful, Make-sense, Mild, Moderate, Motivating, Partial, Reasonable, Satisfactory, Satisfying, Straightforward, Suitable, Tolerating
Creative	Innovative, Inspiring, Persuasive, Puzzling, Skillful, Witty
Decent	Adorable, Appealing, Approaching, Attractive, Awakening, Blooming, Casual, Captivating, Chic, Desirable, Flourishing, Lovely, Presentable, Pretty, Shining, Stimulating, Vibrant, Well-dressed
Degree	Average, Classified, Economical, Effective, Few, Grand, Great, High Level, High Quality, Incomplete, Lasting, Major, Minor, Notable, Noticeable, Overwhelming, Recognizable, Seeming, Tasty, Temporary, Top, Visible, Vast, Vital
Density	Accomplish, Complete, Concentrated, Concise, Congested, Crowded, Deep, Developed, Excellent, Fine, Focus, Heavy, Important, Inadequate, Intermediate, Linked, Messy, Packed, Sufficient, Thick, Total
Difficult	Complicated, Different, Hard, Hard To Adapt, Hard To Use, Hectic, Inconvenient, Particular, Rigid, Risky, Troubling, Turbulence
Dynamic	Beneficial, Brand-new, Changeable, Contemporary, Elastic, Flexible, Functional, High Potential, Influential, Late, Latest, New, Periodical, Practical, Precocious, Recent, Renewing, Talented, Useful, Variegated
Easy	Easy-to-adapt, Easy-to-see, Easy-to-use, Effortless, Gentle, Just Nice, Kind, Lenient, Manageable, Ordered, Organized, Painless, Safe, Tender, Understandable,
Emotional	Big-hearted, Expressive, Generous, Honest, Kind hearted, Lively, Moving, Sincere, Thoughtful, Warm
Elegant	Advance, Arousing, Artistic, Charming, Clear, Delicate, Deluxe, Dignified, Distinguished, Erotic, Exotic, Exclusive, Enchanting, Exceptional, Extraordinary, Famous, Fantastic, Fascinating, Fashionable, Flamboyant, Gallant, Genuine, Gorgeous, Gracious, Graceful, Impressive, Intellectual, Intelligent, Intentional, Magnificent, Mature, Novel, Outstanding, Passionate, Precious, Romantic, Sexy, Smart, Sophisticated, Splendid, Sporty, Stylish, Sweet, Symbolic, Tasteful, Thin, Trendy, Ultimate, Valuable, Versatile, Well-known
Feminine	Aromatic, Beloved, Caring, Comforting, Delicate, Glitter, Glossy, Lady-like, Modest, Nostalgic, Sensitive, Smooth, Soft, Soft-hearted, Womanly
Fruitless	Bitter, Cheerless, Garish, Less, Passive, Restless, Senseless, Separated, Shameless, Tasteless, Terrible, Unreasonable, Useless, Wasting
Global	In-house, Local, International, National, Public, Unisex, Universal
Happy	Amusing, Bright, Brilliant, Calm, Cheerful, Compliment, Delightful, Enjoyable, Fragrant, Funny, Harmonious, Humorous, Joyful, Leisurely, Light, Light-hearted, Nice, Pleasant, Pleasant-looking, Pleasing, Pleasuring, Positive, Prosperous, Relieving, Shiny, Smiling, Spirited, Striking, Unstressed, Welcoming, Wonderful
Indecisive	Blur, Confusing, Dark, Hazy, Inconsistent, Irregular, Sluggish, Unrefined, Unreliable, Unstable
Inferior	Dependent, Failing, Incapable, Poor, Protective, Unimpressive
Innocent	Beautiful, Boyish, Childish, Clean, Cute, Down-to-earth, Fresh, Humble, Immature, Naïve, Pure, Refreshing, Toy-like, Understated, Young, Young looking, Youthful

Masculine	Male, Male-targeted, Manly, Mannish, Noble, Physical, Powerful, Real, Rich, Robust, Severe, Spartan, Steady, Strong, Superior, Tough, Wise
Negative Attitude	Annoying, Anxious, Bad, Cold-hearted, Clumsy, Cowardly, Defensive, Foolish, Hard-hearted, Harsh, Impatient, Impossible, Inconsiderable, Inflexible, Irrational, Narrow, Nasty, Nervous, Pessimistic, Prejudice, Pretentious, Prohibitive, Rude, Sighing, Show-off, Spoiled, Stubborn, Suspicious, Tarnished, Tedious, Thoughtless, Unaffected, Unconsidered, Undignified, Unemotional, Unfavourable, Unfriendly, Ungrateful, Unpleasant, Unsatisfactory, Untidy, Untrustworthy
Negative Feeling	Awful, Bad Feeling, Dirty, Disgusting, Disregarding, Frightening, Frustrating, Horrible, Irritating, Monotonous, Tense, Terrifying, Unhealthy
Negative Perception	Bad Atmosphere, Bad Colour Combination, Bad Colour Tone, Bad Condition, Bad Design, Bad Looking, Bad Quality, Bad Style, Bad Visibility, Conservative, Conventional, Disappointing, Disengaging, Doubtful, Long-Winded, Low Class, Low Cost, Low Level, Low Potential, Obnoxious, Overstressed, Primitive, Unimaginative, Unusual
Negative Physical	Disordered, Flat, Forceful, Fragile, Gutless, Low Performance, Low Quality, Poor Condition, Poor Design, Poor Finishing, Poor Quality, Poor Shape, Rushed, Smelly, Unattractive, Unsightly, Violent
Occupied	Busy, Engaged, Existing, Filled, Fully-used, Handful, Utilized
Old	Adult-like, Affective, Aged, Antique, Aware, Classy, Emotional, Exhausting, Existent, Grown-up, Historical, Homely, Lingering, Old-fashioned, Old-look, Old-style, Original, Orthodox, Out-of-date, Outdated, Past, Peaceful, Ponderous, Preserved, Private, Quiet, Relaxing, Reserved, Rural-like, Sensible, Slow, Tiring, Traditional, Ugly, Unappealing, Unclear, Uncomfortable, Undesirable, Unique, Unstylish
Personality	Characteristic, Charismatic, Independent, Individual, Interesting, Loud, Personal, Responsive, Serious, Uninteresting
Positive Behaviour	Certain, Clever, Concerned, Confident, Consistent, Expert, Favourable, Friendly, Good Hobby, Grateful, High Sense, Highly Efficient, Insistent, Obedient, Orderly, Persistent, Reliable, Realistic, Resolute, Understanding
Positive Physical	Active, Brave, Courageous, Figurative, Firm, Fit, Formative, Good Atmosphere, Good Balance, Good Colour Combination, Good Colour Tone, Good Condition, Good Design, Good Environment, Good Feeling, Good Finishing, Good Looking, Good Pattern, Good Presentation, Good Quality, Good Shape, Good Style, Good Touch, Good Visibility, Healthy, Neat, Sharp, Tidy, Well, Well-Decorated, Well-Designed, Well-Organized, Well-Prepared
Quantity	Comprehensive, Empty, Full, High, Huge, Intensive, Large, Low, Numerous, Obvious, Representative, Small, Substantial
Rebellious	Aggressive, Arrogant, Boast, Booming, Chaotic, Confronting, Dangerous, Daring, Exaggerating, Fanatic, Flashy, Free, Hot, Intolerant, Militant, Moody, Mysterious, Noisy, Offensive, Open, Quick, Rapid, Remaining, Repelling, Speedy, Suppressing , Tight, Wide, Wild, Zany
Refined	Compact, Complex, Connected, Detail, Emphasized, Even, Extensive, Grown, Improved, Inclusive, Itemized, Perfect, Polished, Precise, Refining, Replicating, Specific, Streamline, Symmetric, Unified, Upgraded, Vivid
Trendy	Amazing, American-style, Awesome, British-look, British-style, City-style, Colourful, Cool, Country-style, Dandy, Dazzling, Decorative, Dressy, Eastern-contemporary, Eastern-style, Ethnic, European-style, Exciting, Fabulous, Fancy, Gaudy, Highlighted, Incredible, Japanese-contemporary, Japanese-style, Modern-east, Modern-west, Multicoloured, Oriental, Pop, Popular, Rhythmic, Sensual, Showy, Sparkling, Thrilling, Town-like, Up-to-date, Urban-style, Western Contemporary, Western Feeling, Western Style
Trustworthy	Appreciative, Associated, Assuring, Attached, Careful, Cautious, Compliant, Contenting, Convincing, Confidential, Determining, Efficient, Faithful, Family-like, Good, Ideal, Idyllic, Liberal, Liberty, Logical, Meaningful, Memorable, Optimistic, Polite, Rational, Respectable, Successful, Tolerant, True, Truthful, Unpretentious

Sad	Cloudy, Cold, Depressing, Displeasing, Disturbing, Dull, Fatigue, Gloomy, Homesick, Ignored, Inactive, Lazy, Lonely, Negative, Painful, Pastel-toned, Shy, Solemn, Stressful, Stupid, Touching, Unexpected, Weak, Worry
Seasonal	All-season, Autumn-like, Cultural, Dry, Forrest-like, Futuristic, Marine-like, Natural, Oceanic, Spring-like, Summer-like, Tropical, Wet, Windy, Winter-like
Sophisticated	Abstract, Branded, Distinctive, High Class, High Cost, High Impression, Elite, Expensive, Formal, High Style, Intellect, Limited, Luxury, Official, Premier, Professional, Special, Significant, Stunning, Top-class, Vogue
Spatial	Interior, Comfortable, Spacious
Static	Actual, Changeless, Concrete, Homogeneous, Linear, Solid, Stable, Stiff, Strict, Uniform
Technological	Artificial, Automatic, Convenient, Custom, Enhanced, Fast, Geometric, Handy, High Performance, High Power, High-tech, Manual, Mechanical, Multi-dimensional, Multi-function, Multi-purpose, Scientific, Secure, Specialized, Systematic, Technical, User Friendly
Surreal	Conceptual, Dream-like, Fake, Fantasy, Ghostly, Imaginative, Magical, Mystic, Science-fiction, Supernatural, Unrealistic
Weird	Abnormal, Awkward, Boring, Contrasting, Funky, Isolated, Maniacal, Odd, Panic, Peculiar, Silly, Strange, Uncommon, Uneven, Unfamiliar, Unnatural, Unorthodox, Vulgar

The identified 24 clusters from Kansei Affinity Cluster by the experts as highlighted in Table 3.1 is based on the perceptions and design requirements by experts who are lecturers and senior lecturers at the Higher Education Institution where this study was carried out.

3.7.2 Virtual Agent Design

Past researchers have highlighted that interactive virtual world that deploys virtual agents offer an exciting learning experience (Rickel, 2001; Moreno & Flowerday, 2006; Bickmore & Cassell, 2005; Ricketts, 2011). According to Ricketts (2011), tools that function as a teaching simulator provides a variety of new capabilities to promote classroom learning. To add on, the deployment of virtual agents is believed to lead to more sophisticated applications with enhanced capabilities (Rickel, 2001). Hence, research on virtual agents in the field of education is not a new phenomenon. Various design elements have been identified by researchers from various countries (Liew et al., 2013; Wheeler, 2012). Design stereotypes such as attractiveness and realism plays a vital role in the virtual agent design paradigm (Khan, 2011). Past literature has also suggested

that the respondents appreciated and preferred to interact with the most attractive and realistic virtual agents (Khan, 2011; Khan, & Sutcliffe, 2014). This is supported by the positive ratings given for the virtual agents that have positive personality traits in comparison to the less attractive agents. Adding on, a research by Khan and Sutcliffe (2014) has proven that female virtual agents were perceived as being more attractive and realistic than the male virtual agents. On another note, Khan (2011) has identified other influencing variables for effective virtual agent design. The design elements listed by researcher Khan and Angeli (2007) are tabulated in Table 3.2.

Table 3.2: Design Elements (Khan & Angeli, 2007)

Design Elements	No of categories / groups	Categories/ groups
Age	4	Child Young Adult Adult Older Adult
Ethnicity	4	White Black Asian Oriental
Dressing Style	4	Casual Formal Uniform Missing
Level of anthropomorphism	4	Cartoon Drawing Mannequin Photo realistic
Profession	5	Pedagogical Agent Actor Storyteller Assistant Presenter
Name	2	Name No Name

Based on the past review, this research adapted selected design variables as design considerations for virtual agent design for the Kansei Engineering product. The design elements are shown in Figure 3.7.

Figure 3.7: Virtual Agent Design Facets

As depicted in Figure 3.7, there are five facets that influence the design of virtual agents. They are attractiveness, realism, gender, ethnicity and age. These facets are selected based on the nature of this study and the suitability of the facets to design an effective Kansei product.

3.8 Phase II: Research Framework Development

Phase II as shown in Figure 3.8 is the Research Framework development phase. In this phase, the researcher incorporated the existing KE methodology (Nagamachi & Lokman, 2015) to create the research platform or framework. The review from past literature from Phase I was applied in this phase. The framework for the research was derived based on the original ideology of KE and the evolution of virtual agent design. Kansei Design Model which is the backbone of this research defines the core phase of this KE research on virtual agent design. The research framework developed to design a Kansei product is elaborated in the next section.

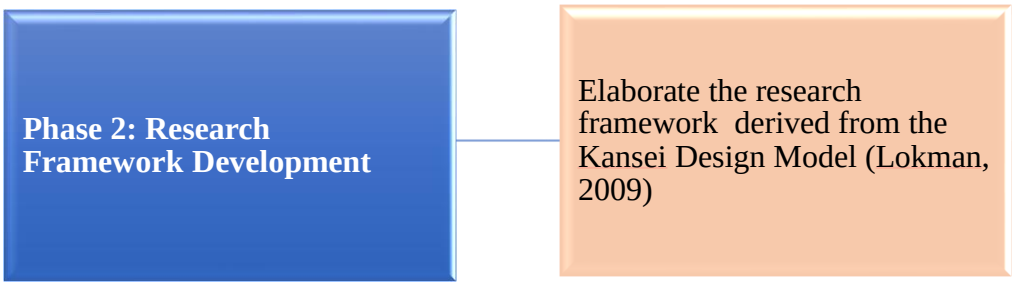


Figure 3.8: Research Framework Development (Phase II)

The research framework designed in this phase also defines the various stages of the Kansei Engineering procedure (Nagamachi, 2003). It adapts the KDM and refines each process as shown in Figure 3.9.

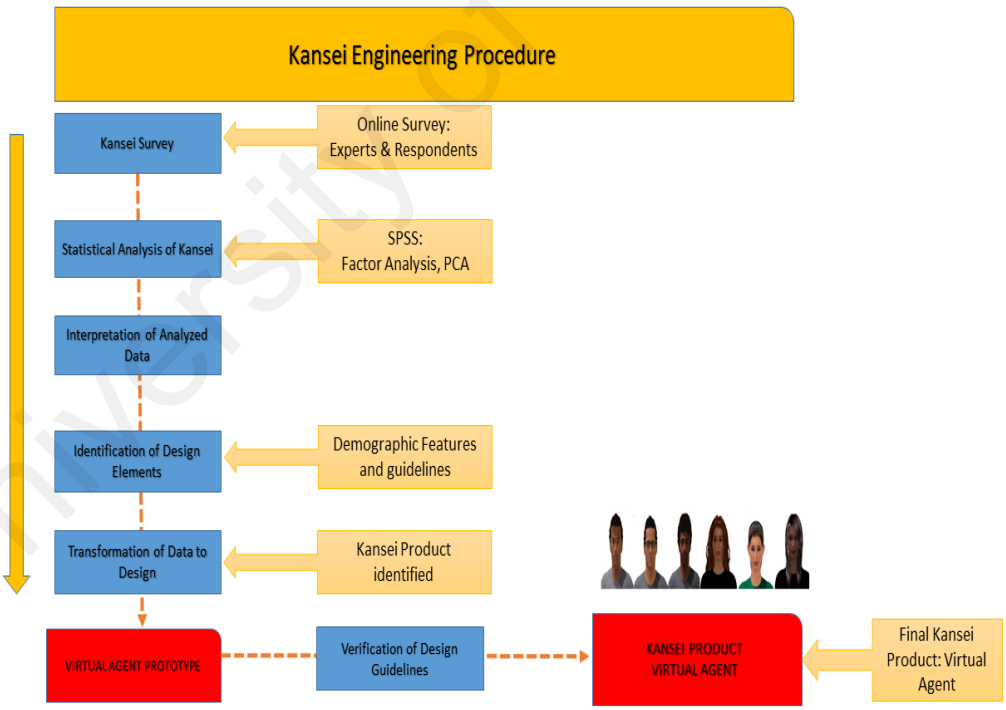


Figure 3.9: Kansei Engineering Procedure

3.9 Phase III: Exploratory Study

Phase III includes the essential stages of KE research as depicted in Figure 3.10. This phase adapted the Kansei Design Model and structured the process accordingly. The exploratory study commenced with the preparation of instruments such as the virtual agents and the measurement tool, the identification of experts as well as the selection of other respondents.

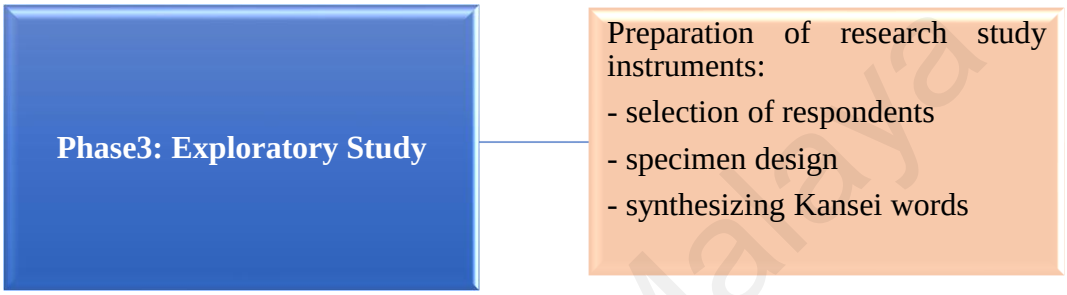


Figure 3.10: Exploratory Study (Phase III)

In accordance to the rules of KE, designing the right instruments was vital to ensure the success of the study on learners' experiences. Failing to do so would lead to inaccuracy of findings. Table 3.2 summarizes the different instruments incorporated in this research.

Table 3.2: Exploratory Research Instrument

Instrument	Quantity	Source
Specimen: Virtual Agents / Pedagogical Agents	18	Designed using 3D Poser software (age group, gender, ethnicity)
Measurement Tool (final)	25	Kansei Keywords KW

3.9.1 Preparation of Specimen

In this research that adapts the KE method, the specimen development phase involves four stages. They are as listed:

i. Identification of Design Elements and Specimens

ii. Designing of the Virtual Agents

iii. Classification of Virtual Agent Design Elements (demographic)

iv. Finalizing Valid Virtual Agents

This phase enabled the researcher to finalize the design elements for virtual agents to be deployed in a Virtual Learning Environment. The identified design elements enabled the categorization of the elements based on the demographic features. It must be noted that past review also played an important role in designing valid design specifications for the research study to identify the association between the learners' emotions and the virtual agents designed.

3.9.1.1 Identification of Design Elements and Specimens

The specimen in this study refers to the virtual agents designed using the multimedia authoring tool known as Poser. The design of virtual agents captured the main features of diversified ethnicity in Malaysia making the visual design diverse. The design elements applied in this research are from the theoretical study of past literature and the identified facets of the virtual agent design. A total of 18 specimens were designed and was improved based on the literature review. The controls were also defined in order to ensure consistency of the specimens' design criterion and the reliability of the virtual agent selection. Table 3.3 defines the control condition in the virtual agent specimen identification process.

Table 3.3: Control Condition in Identification of Virtual Agents

No	Item	Control Condition
1	Dressing Style	Casual (informal and not dressy)
2	Voice	No voice evaluation done
3	Profession	Pedagogical Agent (agents that facilitate learning)
4	Name	No Name (Agents without human like names)

3.9.1.2 Design Process of the Virtual Agents

Realistic three-dimensional human face modeling is a vital part of virtual human design. In order to design virtual agents that are realistic and attractive, Poser was used as a designing tool. Poser is a tool that gives designers full creative control to work with various three dimensional figures that requires rendering and video animation. Figure 3.11 depicts the outcome of a 3D virtual agent model designed using 3D Poser.

Figure 3.11: Virtual Agent Image from 3D Poser (Posing Camera View)

3D Poser has a comprehensive library that has a collection of 3D human figures, hair, clothing, props, scenery, lighting and cameras that is needed to develop a realistic and attractive design. On another note, Poser also delivers the power of interactive 3D figure

design as shown in Figure 3.11 that can portray human diversity and facial expression. Hence, Poser was deployed in this research to design specimens that are realistic looking aligned with the aims of the research.

3.9.1.3 Classification of Virtual Agent Design Elements

Based on past literature, several influencing design elements have been identified (Khan, 2011; Khan & Angeli, 2007). According to Khan (2011), demographic elements such as gender, age and ethnicity play a vital role in a virtual agent design. Therefore, the designed virtual agents are classified based on age and gender. To ensure the consistency of the design phase, the designed specimens were classified into the categories shown in Table 3.4 to ensure there is no redundancy.

Table 3.4: Research Specimen Matric

Specimen ID	Gender		Age		
	Male	Female	Young Adult	Adult	Older Adult
1		√	√		
2		√	√		
3		√	√		
4	√		√		
5	√		√		
6	√		√		
7		√		√	
8		√		√	
9		√		√	
10	√			√	
11	√			√	
12	√			√	
13		√			√
14		√			√
15		√			√
16	√				√
17	√				√
18	√				√

3.9.1.4 Finalizing Valid Virtual Agents

From the matrix of specimen identified by the researcher, the specimen for the research was finalized. The validity rules for specimen design were ruled out to ease the statistical analysis. Figure 3.12 identifies the rules followed to design the valid specimens for the research in accordance to KE.

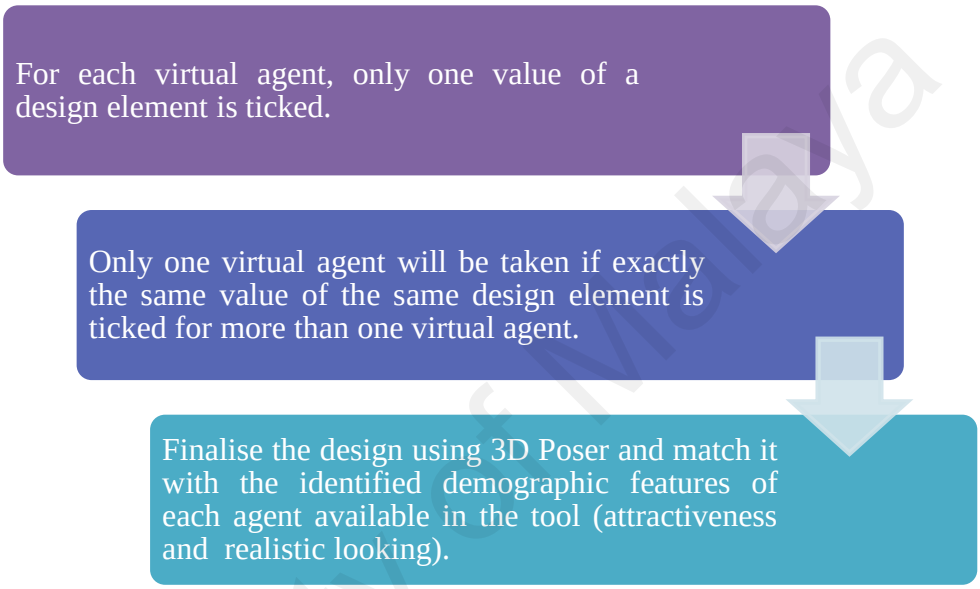


Figure 3.12: Rules of Thumb for Specimen Design

These Rules of Thumb enabled the researcher to identify the various design elements and to produce effective and valid specimen for the study. Although the rules are simple, it was essential to design reliable and valid 18 virtual agents. The snapshots of the specimens that comprised of diversified virtual agents are shown in Figure 3.13.

Figure 3.13: Valid 18 Virtual Agents

3.9.2 Recruitment of Evaluation Subjects (Sampling)

According to Cohen and Manion (2013), the sampling method can be classified as stage sampling, convenience sampling, simple random sampling, systematic sampling, stratified sampling, cluster sampling, purposive sampling, quota sampling, dimensional sampling and snowball sampling. However, to address the aim of this research, a purposive sampling was used whereby the respondents were selected based on their computer literacy and their background of study to ensure that they are able to participate in the research actively.

Researchers Malhotra and Krosnick (2007) affirm that non-probability sampling is a method whereby the selection of sampling units is primarily based on the decision of the researcher. The purposive sampling technique is a type of non-probability sampling, which is most effective for studies on specific cultural domain that includes subject experts. In this research, a non-probability sampling method was adapted for the generalization of the findings. This approach of respondents' selection is a non-random technique that does not need any underlying theories or a specific number of informants. In other words, the researcher can decide on the required knowledge and set out to find

people who can and are willing to provide the information through virtue of knowledge or experience (Lewis & Sheppard, 2006; Tongco, 2007).

The respondents comprised of subject experts and also learners from an American Degree Program in a private HEI in Malaysia. A total of 107 respondents and 15 subject experts participated in this research study. The majority of the 107 respondents were below 25 years old. They are technology savvy and have been using virtual reality tools for gaming and learning. The suitability of these young learners is supported by past literature that suggests form the average age group of the virtual community are below 25 years old (Chou & Liu, 2005; Liu et al., 2008). Besides that, the sampling adopted for this research was according to Creswell's (2013) non-probability sampling. The research adopted a combination of purposive and convenient sampling. This is due to the fact that the research was carried out among students in the technical lab where the last 30 minutes was allocated for the survey. The recruited volunteers stayed on for the survey if they are interested and this survey was conducted over a period of three lab sessions for three technical modules. Prior to the task, volunteers were briefed on the objectives of the study.

Alternatively, the 15 experts are educators with more than five years of teaching experience who have been using a minimum of 30 % of blended learning approach in their courses. The respondents were of diversified specializations such as computer science, engineering, and actuarial science. These experts are knowledgeable and highly rated by students as outstanding educators in the American Degree Program. These ratings were obtained from the Teaching Engagement Scale (TES) ratings conducted by the University at the end of every semester to gauge the effectiveness of the courses and the teaching styles.

Although the population of respondents and experts ranges from five to over a thousand in KE research study, the suggested number for this type of research study is

between 30 to 50 respondents (Nagamachi, 2003). However, in the effort to explore differences in the affective responses of the learners from different education background and to ensure reliability of the results, a total of 107 students from a private HEI were selected as participants in this research study.

It is generally recognized that the success of any research depends on the sampling procedure. According to Cohen and Manion (2013), the sampling method can be classified as stage sampling, convenience sampling, simple random sampling, systematic sampling, stratified sampling, cluster sampling, purposive sampling, quota sampling, dimensional sampling and snowball sampling. However, to address the aim of this research, a purposive sampling was used whereby the respondents were selected based on their computer literacy and their background of study to ensure that they are able to participate in the research actively. As discussed in the preceding paragraph, there are two different samples used in the study: 107 students and 15 subject experts. The first group of sampling is to address Research Question 1 (RQ1) and is labeled as Set 1while the second group of sampling is used to address Research Question 2 (RQ2) and is labeled as Set 2.

(a) Set 1: RQ1

The respondents for this research consisted of 95 undergraduate students who were selected in the initial stage to identify the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment. They were selected based on their computer literacy. The selection criteria required the respondents to be computer literate and IT savvy. The characteristics of the selected respondents are:

- gender: male (n = 61; 64 %); female (n=34; 36 %)
- age group: between 18-22 years

- learner's nationality: Malaysian (n=70; 74%); International (n= 25; 26%)

(b) Set 2: RQ2

As for the recruitment of the evaluation subjects, the respondents comprised of subject experts and also learners from a private HEI in Malaysia. A total of 107 undergraduate students from a private HEI were selected to evaluate the virtual agent prototypes. However, to identify the Kansei Keywords and to facilitate the synthesis of Kansei Keyword (KW), 15 subject experts were recruited. The subject experts comprised of Senior Lecturers from a private Higher Education Institution (HEI) who have a minimum of 5 years of teaching experience and are very IT savvy as they deployed various technology related teaching methods and maintained an online course module.

The demographic of the heterogeneous learners from the HEI is depicted in Figure 3.14.

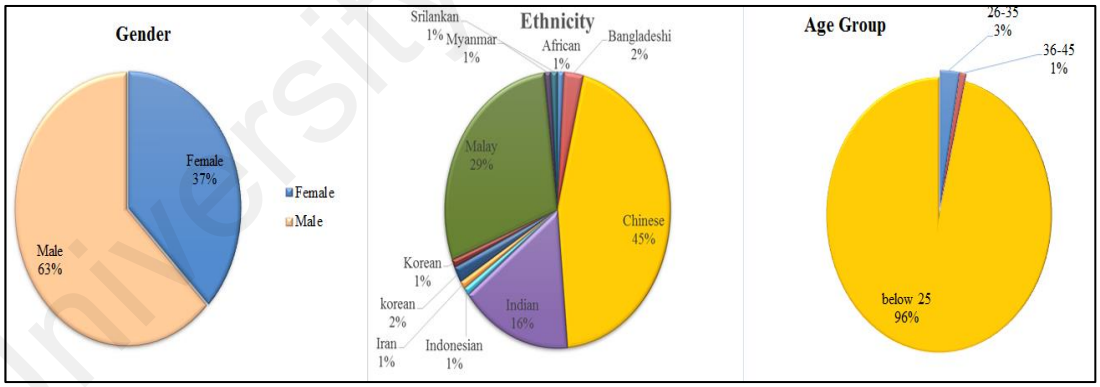


Figure 3.14: Demographic of Respondents

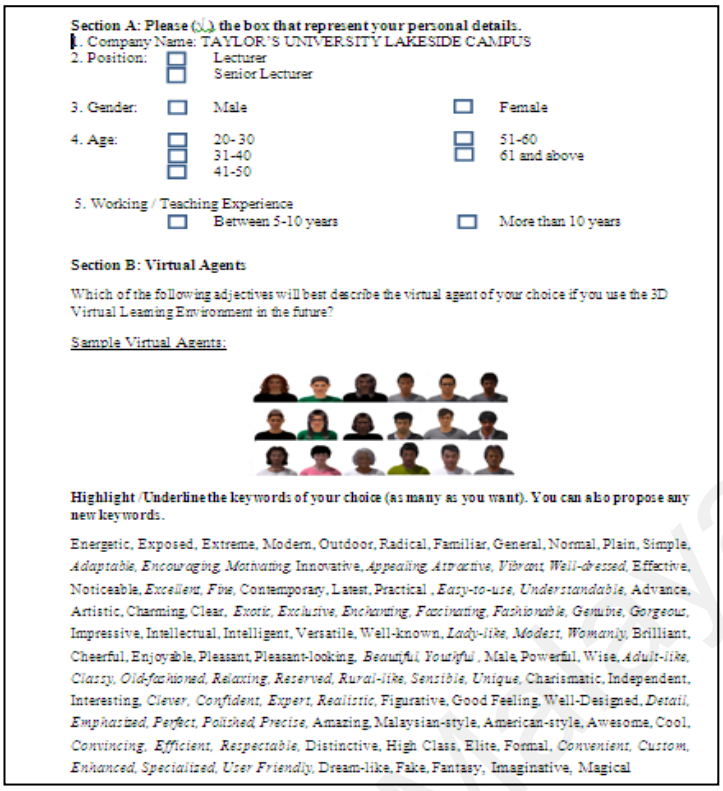
3.9.3 Instrument for Data Collection

The instrument for data collection in this study is the measurement tool designed in the form of a checklist identified as the Kansei checklist. This was developed using the Kawakita Jiro's (KJ) method where the selection of keywords by the selected subject

experts were used as a base. The subject experts selected the appropriate keywords from a list derived from the Kansei Affinity Cluster (Lokman & Kamaruddin, 2010). The final Kansei checklist comprised of emotional keywords also known as the Kansei Keywords (KW) that were identified and verified by the 15 experts during the initial stage of the research. These identified KW were used to measure the learners' experiences towards the virtual agents.

3.9.3.1 Synthesis of Kansei Keywords

Synthesizing the Kansei Keywords (KW) was the most crucial and tedious process of this research. This phase of synthesizing Kansei Keywords permitted the subject experts to reach consensus on the priorities of the design specification (Spool, 2004). The words were cross checked with the Kansei Affinity Cluster form provided by the researcher to ease this process. This process did not require any validation from English Language experts, who were the brains behind the Kansei Affinity Cluster because the keywords in the clusters have already been tested and verified by Lokman and Kamaruddin (2010). From the 820 KWs classified in the cluster, only 102 keywords were appropriate for this study. The form as shown in Figure 3.15 denotes the keywords that were adapted from the 24 clusters.



Section A: Please (√) the box that represent your personal details.

1. Company Name: TAYLOR'S UNIVERSITY LAKESIDE CAMPUS

2. Position: ☐ Lecturer ☐ Senior Lecturer

3. Gender: ☐ Male ☐ Female

4. Age: ☐ 20-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ 61 and above

5. Working / Teaching Experience ☐ Between 5-10 years ☐ More than 10 years

Section B: Virtual Agents

Which of the following adjectives will best describe the virtual agent of your choice if you use the 3D Virtual Learning Environment in the future?

Sample Virtual Agents:

Highlight /Underline the keywords of your choice (as many as you want). You can also propose any new keywords.

Energetic, Exposed, Extreme, Modern, Outdoor, Radical, Familiar, General, Normal, Plain, Simple, *Adaptable, Encouraging, Motivating,* Innovative, *Appealing, Attractive, Vibrant, Well-dressed,* Effective, Noticeable, *Excellent, Fine,* Contemporary, Latest, Practical , *Easy-to-use, Understandable,* Advance, Artistic, Charming, Clear, *Exotic, Exclusive, Enchanting, Fascinating, Fashionable, Genuine, Gorgeous,* Impressive, Intellectual, Intelligent, Versatile, Well-known, *Lady-like, Modest, Womanly,* Brilliant, Cheerful, Enjoyable, Pleasant, Pleasant-looking, *Beautiful, Youthful ,* Male, Powerful, Wise, *Adult-like, Classy, Old-fashioned, Relaxing, Reserved, Rural-like, Sensible, Unique,* Charismatic, Independent, Interesting, *Clever, Confident, Expert, Realistic,* Figurative, Good Feeling, Well-Designed, *Detail, Emphasized, Perfect, Polished, Precise,* Amazing, Malaysian-style, American-style, Awesome, Cool, *Convincing, Efficient, Respectable,* Distinctive, High Class, Elite, Formal, *Convenient, Custom, Enhanced, Specialized, User Friendly,* Dream-like, Fake, Fantasy, Imaginative, Magical

Figure 3.15: Keyword Selection Form

The form as shown in Figure 3.15 was distributed to five subject experts for the purpose of keyword reduction. The five experts highlighted the appropriate keywords that work best for this KE research that aimed to design Kansei virtual agents.

3.9.3.2 Selection of Domain Specific Emotional Keywords

From the spooling of the 102 keywords by the experts, only 76 keywords were found suitable for the research study. The selected 76 keywords were then incorporated into an online questionnaire to be distributed to the 15 experts to select the Kansei KW for the research. Figure 3.15 depicts the screen shot of the online form that was sent to the subject experts for keywords reduction via statistical analysis. The complete online form is attached (Appendix A).

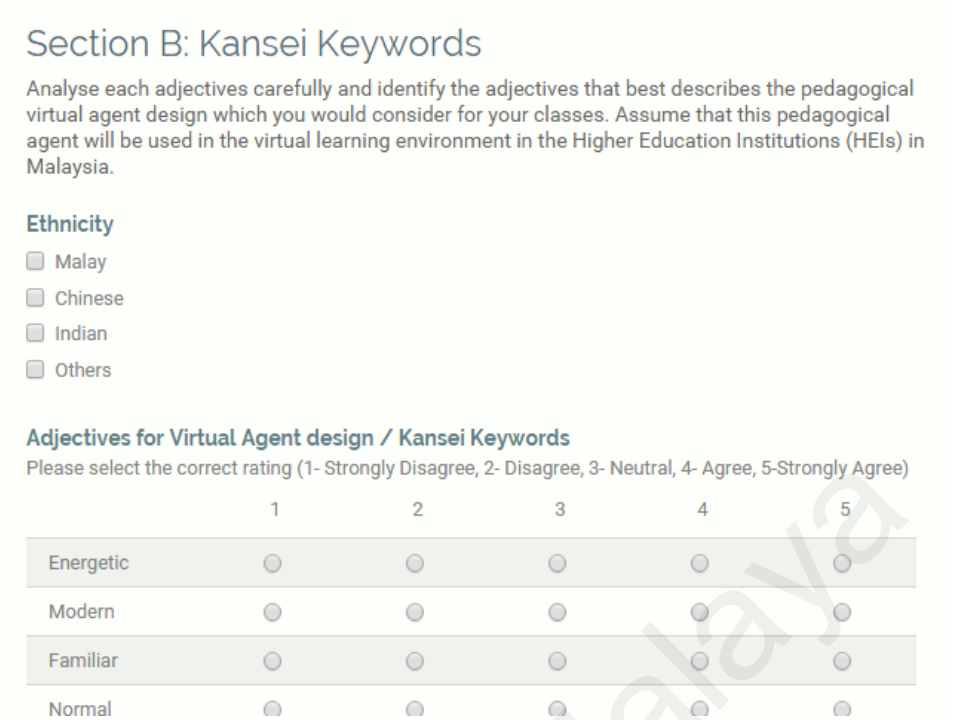


Figure 3.16: Online Keyword Reduction Form

3.9.3.3 Development of Checklist

The 25 set of Kansei keywords selected from the earlier section were then organized into 5-point Likert Scale to form an online form to ease the KE procedure. This online form that adapted the Kansei checklist design was used as a measurement tool to investigate the learners' emotional experiences towards virtual agents. Figure 3.17 illustrates the developed online form used in this research study. The Kansei checklist is attached (Appendix B).

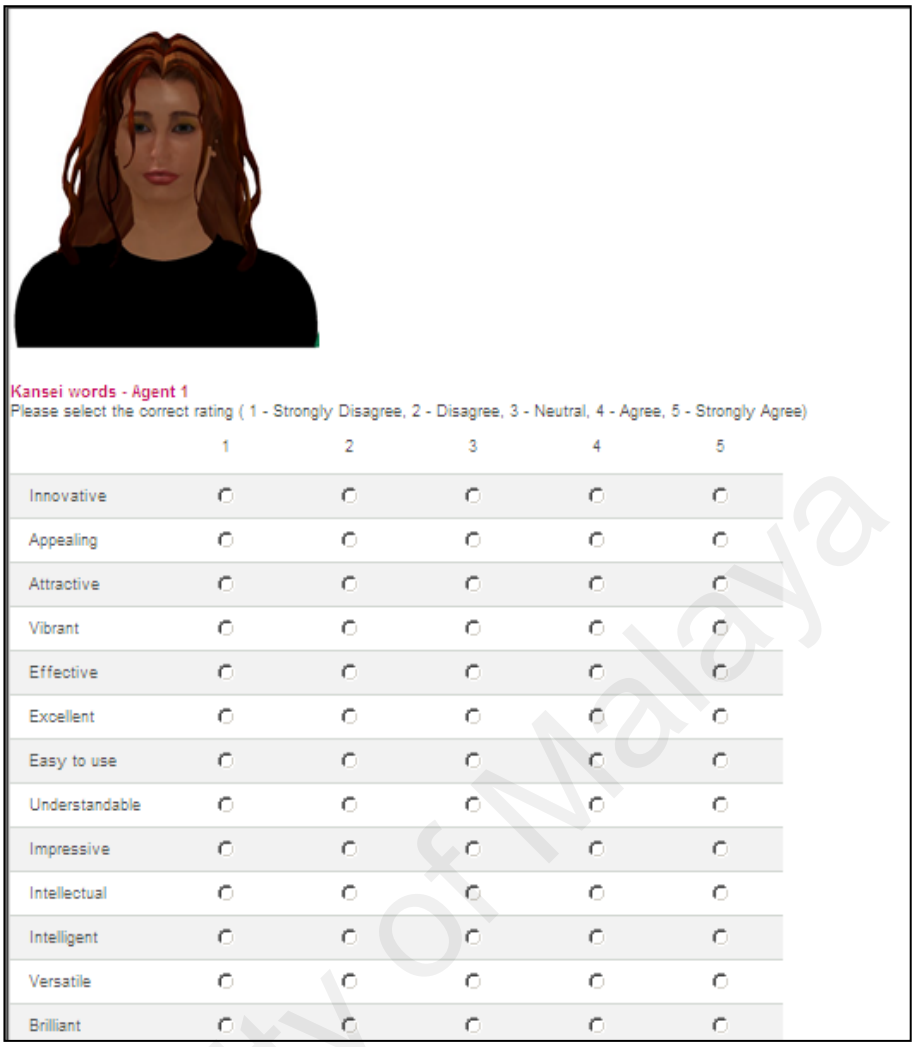


Figure 3.17: Learner's Kansei Experience Evaluation Online Form (screen shot)

Figure 3.18 depicts the guided evaluation process by the respondents from the private education institution based in Malaysia. The URL link that embeds the online form was integrated into the teaching and learning platform of the private HEI where the research was carried out.

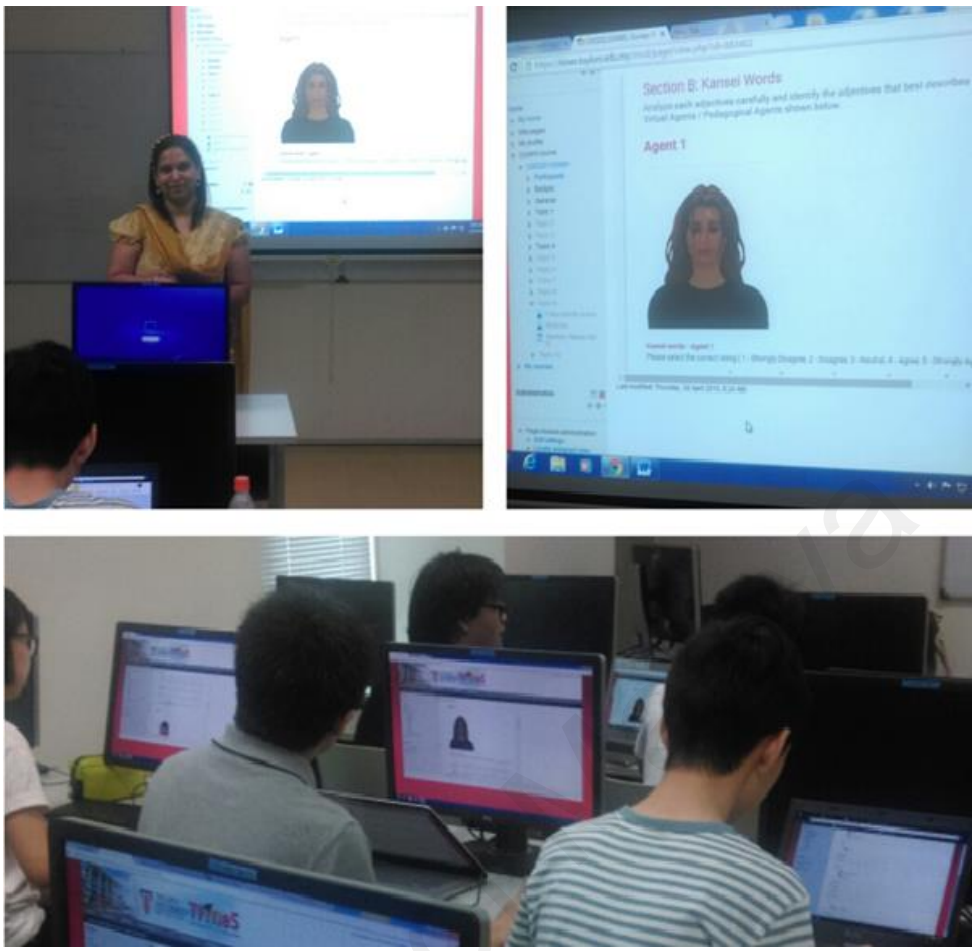


Figure 3.18: Virtual Agent Evaluation Process via Online Form

The concept of KE adaptation to determine the design requirements for the development of Kansei virtual agents which embed the emotional experiences of the learners are clearly defined in this phase of study. The findings from the checklist designed in this phase were ultimately the base for the proposed Virtual Agent Design Model (VADM) for designing Kansei virtual agents.

3.10 Phase IV: Confirmatory / Validation of Proposed VADM

Phase IV was an essential step to validate the proposed model from the Phase III. Figure 3.19 defines the technicality of this phase.

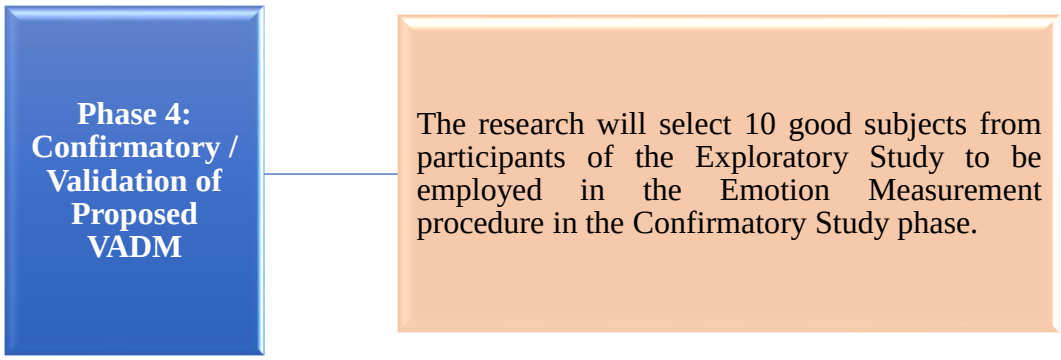


Figure 3.19: Confirmatory / Validation of Proposed VADM (Phase IV)

This confirmatory study deployed the selected virtual agents in a virtual learning environment to be tested for the validity of the design model adapted in the prototype virtual agent design. A total of six prototypes of virtual agents were used in this test that aimed to validate the design requirements of virtual agents.

3.10.1 Preparation of Research Instrument for Confirmatory / Validation of Proposed VADM

This phase of research also required the preparation of the various instruments that comprised of the prototypes, respondents' selection and an effective measurement tool. Table 3.5 summarizes the instruments used by the researcher in this phase of KE research study.

Table 3.5: Identified Instrument for Confirmatory Study

Instrument	Quantity
Specimen: Virtual Agents Prototype	6
Measurement Tool	5 selected Kansei Keywords (KW)

3.10.1.1 The Prototype (Specimen)

The aim of this study was to validate the proposed Virtual Agent Design Model. Thus, the specimens used in this phase were designed in line with the objectives of the research. Five elements of emotion or Kansei words were used to validate the five virtual agent design requirements. The selected prototypes designed using 3D Poser multimedia authoring tool are shown in Figure 3.20.

Figure 3.20: Virtual Agent Prototype

3.10.1.2 Respondents for Confirmatory / Validation of the Proposed VADM

The respondents for this phase of study comprised of selected learners from the exploratory study. They were categorized as good evaluation subjects based on their expertise level and capabilities to participate in emotion based research as this study. According to Nagamachi (2010), good sample defines respondents who are capable in performing consistent emotion measurement and simultaneously provide good structure of emotion ratings. It was vital to identify a good sample for this phase in order to ensure data consistency for the confirmatory data sets. This phase applied a random sampling approach where a total of ten good samples were identified to facilitate this research. Ten

respondents were sufficient for this testing phase as identified by researchers in the past literature review studies (Button et al., 2013; O'Rourke et al., 2013; Marsh et al., 1988). Figure 3.21 illustrates the good samples chosen for the research. The ten respondents are from a private HEI and are in the second year of study majoring in Computer Science and Engineering.

Figure 3.21: Respondents from HEI

3.10.1.3 The Measurement Tool

From the finalized 25 Kansei keywords as listed in the online form, only five elements were used in this phase. The emotional elements that originated from the Kansei Affinity Cluster (2010) were used in this phase as a confirmatory analysis instrument. The five elements or keywords were organized in a 5-point Likert scale to access the learners' emotional responses towards the five virtual agent prototypes. As a result, it produced a

confirmatory data set for the research. Figure 3.22 depicts a sample checklist used in this phase of study. The detailed checklist is attached (Appendix C).

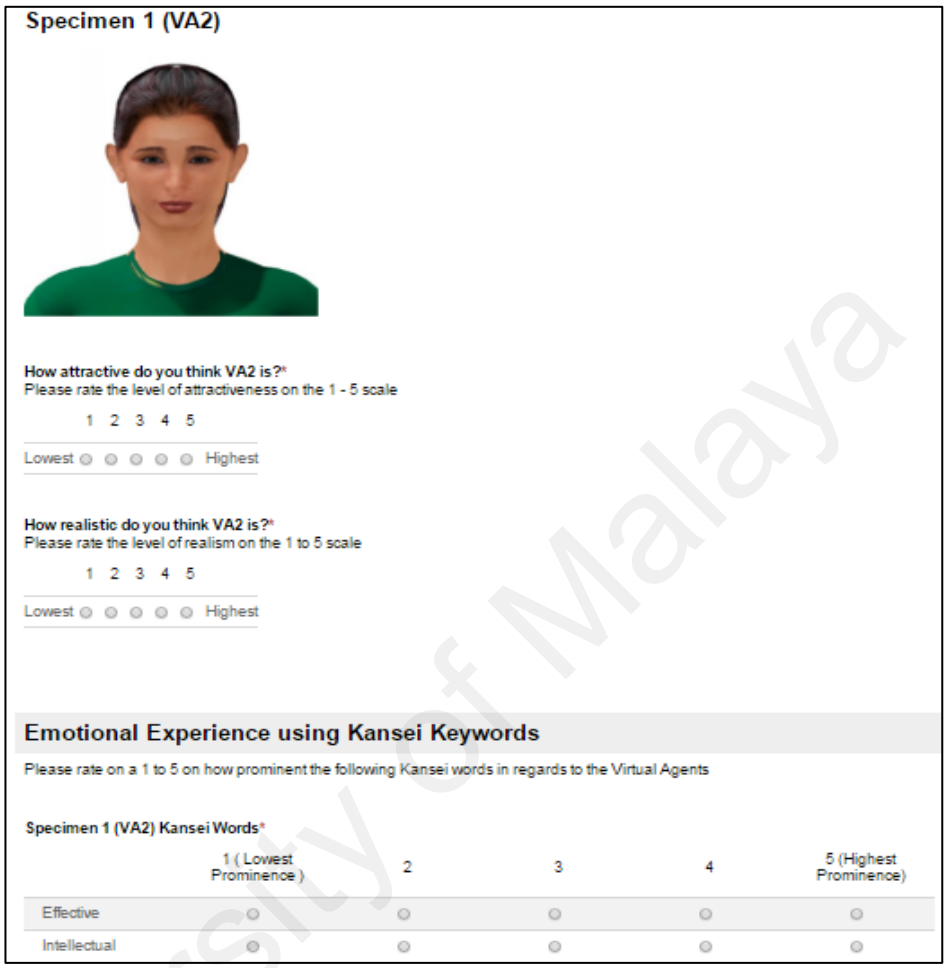


Figure 3.22: Sample of Checklist for the Virtual Agent Design Confirmatory Study

The structure of emotions from both the confirmatory and exploratory phase data set was analyzed to enable the researcher to confirm the validity of the proposed model to design virtual agents. This action also justified the success of the research in capturing learners' emotional experiences towards virtual agents. The validation and identified justification of the findings enabled the researcher to validate the correctness of the proposed model used to design the virtual agents for a virtual learning environment.

3.11 Pilot Test

A pilot study was conducted to identify the feasibility of the research instruments. The pilot study enabled the researcher to assess the research instruments in terms of weaknesses and strengths. A total of 30 students were selected from the private Higher Education Institution (HEI) for this purpose. The Kansei Checklist that comprised of 25 Kansei Keywords (KWs) was used in the pilot study for data collection. Table 3.6 depicts the research instruments tested in the pilot study.

Table 3.6: Pilot Study Research Instrument

Instrument	Quantity	Source
Specimen: Virtual Agents	18	Designed using 3D Poser software
Measurement Tool: Kansei Checklist	25	Kansei Keywords KW

3.12 Research Framework

The research framework is depicted in Figure 3.23. There are three main processes identified in the research to derive the desired outcome. The contribution of this research is the Virtual Agent Design Model (VADM) that can assist designers to plan and design virtual agents that have high aesthetic value or are rich in Kansei (Nagamachi, 2016).

The first section elaborates the process of theoretical study and specimen identification process. In this process, the two team players were the virtual agent prototypes and the Kansei Affinity Cluster (Lokman & Kamaruddin, 2010). A total of 43 clusters were identified by specialists and three demographic variables were adapted in the virtual agent design process. This was followed by the actual Kansei Engineering (KE) approach that was adapted from the Kansei Design Model (Lokman & Nagamachi, 2009). In this procedure, the Kansei words were identified and analyzed. The findings were then transformed into design elements for developing virtual agents.

The final VADM was tested and validated. The positive responses from learners from Higher Education Institution (HEI) denoted the level of satisfaction among the learners. The increased satisfaction level determined the aesthetic value of the designed product as proven by Nagamachi (2003) and Yamamoto et al.'s (2011) research in other domains of study.

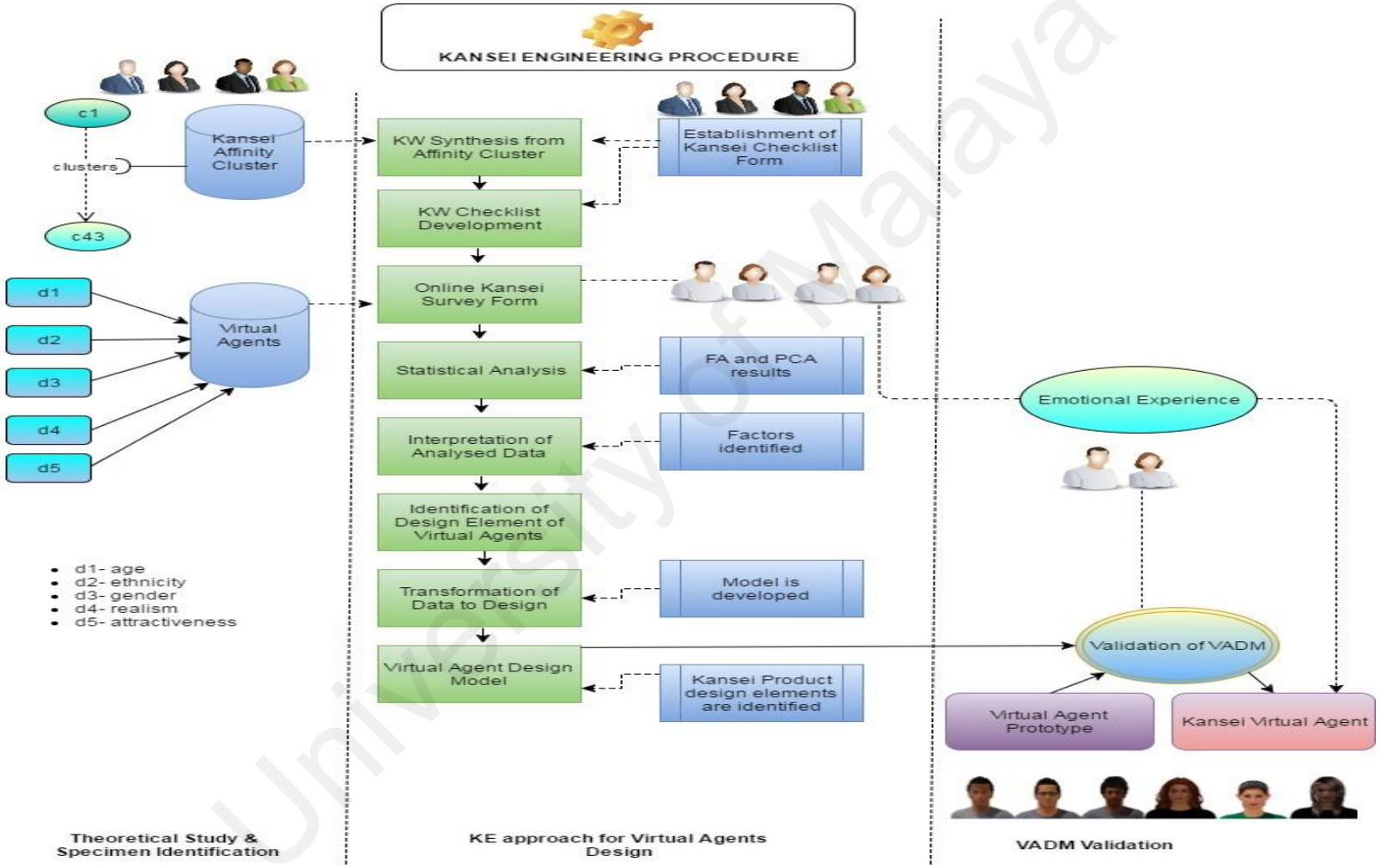


Figure 3.23: Research Framework

3.13 Summary

Among the presented method to evaluate learners' experiences, this research pay interest to Kansei Engineering (KE) method as it enabled the quantification of learners' emotional experiences and the association of emotions with virtual agent design elements or demographics. Hence, for the first time, this research attempts to bring the method of KE into the design of virtual agents deployed in the Virtual Learning Environment (VLE). This chapter has described the identified research framework constructed specifically for a Kansei Engineering research that aimed to study the design of virtual agents deployed in a Higher Education Institution (HEI). The virtual agents designed using this methodology were adapted into a VLE in a private HEI in Malaysia. On another note, this chapter has also highlighted the four vital phases of the KE study and the outcome of each phase. The heart of the KE procedure is mainly associated with the exploratory and confirmatory study. The result of the exploratory study and the validation of the successful implementation of KE for virtual agent design are discussed in-depth in Chapter 4.

CHAPTER 4: FINDINGS AND DISCUSSIONS

This chapter elaborates the phases of the research framework depicted in Chapter 3. The adapted methodology is discussed in detail and the findings are elaborated. The exploratory study was performed to analyze the affective responses from learners in relation to evaluating virtual agents. This chapter also highlights the overall results from the Kansei Engineering procedure as discussed in Chapter 3 and the pilot test conducted verified the reliability of the research instruments used in this study. Chapter 4 also aims to provide answers for the research questions raised in Chapter 1. In brief, this chapter describes the outcome of the Kansei Engineering procedure implemented in this case study conducted in a private Higher Education Institution (HEI). The chapter concludes with the validation of the proposed Virtual Agent Design Model to design Kansei virtual agents that capture the learners' emotional experiences.

4.1 Research Questions

There are four research questions addressed in this research study. The research findings and data analyses are elaborated in accordance to the research questions.

4.1.1 Research Question 1 (RQ1)

What are the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment?

4.1.1.1 Research Method

To answer the research question, the emotional interference and the relationship between the emotional interference with the design factors of pedagogical agents were studied. A total of 18 pedagogical agent's attractiveness and naturalistic was rated along with the six universal emotions identified by Ekman (1980). The prior reason to select these basic emotions is due to the fact that they can be easily distinguished and helps to

reduce ambiguity among the learners. The six identified basic human emotions can be classified into two categories and they are the positive emotions and negative emotions. The positive emotions consisted of happiness and surprise and the negative emotions consisted of anger, disgust, fear and sadness. Adding on, this research also used the purposive sampling and the respondents are from a private HEI. They comprised of 95 undergraduate students from an American Degree Program. Besides that, the specimens used in this study are the 18 pedagogical agents designed using the 3D Poser tool.

In this study, the learners responded to a series of open ended questions whereby they clearly stated their emotions using a five-point Semantic Differential (SD) Scale. This is a scale identified to measure the connotative meaning of an object or specimens in relation to Kansei study. Next, the learners rated the attractiveness and naturalistic of the 18 pedagogical agents using the 5 point SD scale that comprised of two bi-polar adjectives at the end of each question. The scale 1 in the SD scale is evaluated as the lowest and 5 as the highest.

Data analysis was the second phase of the research. This was a process where all collected data from the survey was analyzed using the Statistical Package for Social Science (SPSS). The analysis involved calculation of frequency of various emotions and characteristics of pedagogical agents using descriptive statistics and the Pearson correlation test to identify the relationship between the characteristics of the pedagogical agent and the happiness emotions to determine the significance level of satisfaction. The findings from the data collected are discussed in the following section.

4.1.1.2 Findings

The 95 learners' active participation in this study showed that an affective design is an important criterion for an effective virtual learning tool. The two positive emotion traits; happiness and surprise was rated the highest for the pedagogical agents who were

perceived as attractive and naturalistic by the learners from the HEI. Table 4.1 summarizes the learners' affective responses and the ratings of the design characteristics of the virtual agents. From the tabulated data, it is noted that the top two agents with high ratings for positive emotion traits are Agent ID 2 and Agent ID 8. The virtual agents identified as Agent ID 2 and 8 topped the list for being the most attractive and naturalistic among the 18 pedagogical agents.

Table 4.1: Evaluation of Attractiveness-Naturalistic-Emotions

Agent ID	Attractiveness	Realism	Anger	Disgust	Fear	Happiness	Sadness	Surprise
1	2.77	2.82	2.56	2.66	2.68	2.41	3.14	2.28
2	3.98	3.76	2.26	2.48	2.55	3.78	2.53	3.93
3	2.69	3.05	2.92	2.51	2.38	2.91	3.23	2.46
4	2.38	2.68	2.33	2.36	2.37	2.51	2.36	2.91
5	2.62	2.71	2.21	2.26	2.45	2.98	2.46	2.34
6	2.67	3.05	2.37	2.39	2.53	2.56	2.51	2.48
7	3.12	3.35	2.39	2.46	2.45	2.32	2.49	3.59
8	3.62	3.72	2.12	2.06	2.00	3.66	2.18	3.68
9	2.58	2.89	2.86	2.73	2.35	2.41	2.32	2.41
10	2.38	2.84	2.76	2.67	2.51	2.28	2.53	2.34
11	2.69	2.62	2.14	2.23	2.42	2.85	2.51	2.57
12	3.53	3.57	2.59	2.46	2.31	3.49	2.40	3.71
13	2.22	2.62	2.60	2.69	2.45	2.36	2.73	2.37
14	2.44	2.74	2.37	2.47	2.39	2.38	2.63	2.41
15	2.48	2.68	2.75	2.68	2.42	2.22	2.53	2.43
16	2.17	2.66	2.11	2.26	2.52	2.25	2.71	2.54
17	2.44	2.68	2.84	2.73	2.44	2.35	2.34	2.60
18	2.64	2.78	2.76	2.63	2.48	2.32	2.52	2.37

As depicted in the Table 4.1, Agent ID 2 and 8 had high ratings for the positive emotions which comprised of happiness and surprise as well as for the attractiveness and naturalistic which are the design characteristics of the pedagogical agents. Therefore, the emotional interferences in learners do reflect on the characteristics of the virtual agents. The visual representations of the best-fit virtual agents are depicted in the Figure 4.1.

Figure 4.1: Best-fit Pedagogical Virtual Agents

Figure 4.1 depicts the pedagogical agents that were rated the highest for attractiveness, naturalism and positive emotion traits. Another important finding is that the identified agents (Agent ID 2 and 8) are from the age group classified as adults and young adults. Another prominent demographic feature is that they have similar demographic features.

On another note, the statistical analysis validated the significance of the relationship between attractiveness, realism and happiness. Table 4.2 summarizes the findings from the statistical analysis. To sum up, it is evident that the characteristic of pedagogical agent is associated to the level of satisfaction which was represented by happiness emotion. The characteristic of the virtual agents analyzed in this research study were the attractiveness and naturalistic.

Table 4.2: Attractiveness-Naturalistic-Enjoyment

		Attractiveness	Naturalistic	Happiness
Attractiveness	Pearson Correlation	1	.894**	.593**
	Sig. (2-tailed)	.	.000	.009
	N	18	18	18
Naturalistic	Pearson Correlation	.894**	1	.302
	Sig. (2-tailed)	.000	.	.223
	N	18	18	18
Happiness	Pearson Correlation	.593**	.302	1
	Sig. (2-tailed)	.009	.223	.
	N	18	18	18

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

To elaborate further, the findings depicted in Table 4.2 suggest that the more natural or realistic a virtual agent's appearance, the more attractive they seem from the perspectives of the learners ($r = 0.894$, $p < 0.05$). To add on, learners satisfaction level in relation to happiness emotion is higher for the Virtual Learning Environment (VLE) that deploys a more attractive virtual agent ($r = 0.593$, $p < 0.05$). Conversely, the naturalistic does not exhibit a significant relationship as the attractiveness of virtual agents and has weak correlation with the learners' satisfaction level ($r = 0.302$, $p > 0.05$).

4.1.1.3 Discussion

It is evident that the aim of this study was to identify the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment. Past researches by Lokman et al. (2006; 2010) and Nagamachi (1992; 2003) have proven that the affective factors must be taken into consideration by prioritizing the consumers' satisfaction while designing a product with aesthetic value. As a result, this study has shown that pedagogical agents with an affective interface have triggered the positive emotion trait and increased the level of satisfaction among the learners of this 21st century. This is in line with the notion of design-science research that addresses important unsolved problems in unique or innovative ways using the effective method as advocated by Hevner and Chatterjee (2010).

Figure 4.2 depicts the Kansei emotion structure in the 18 pedagogical agents. The six universal emotions highlighted by Ekman (1972) were evaluated by integrating the new production scheme of KE (Nagashima, 2013). To elaborate further, learners' positive perception determines the success of the virtual learning environment that deploys the pedagogical agents.

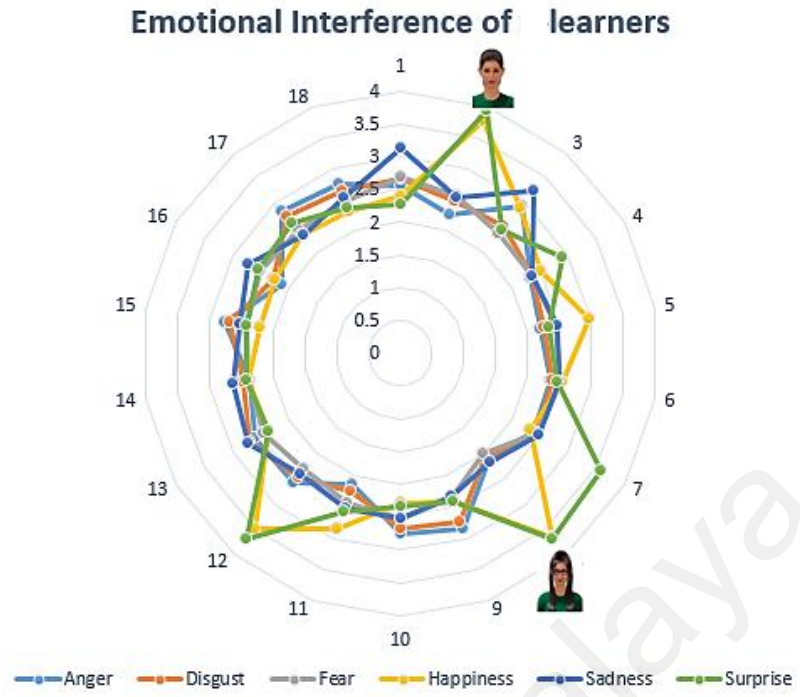


Figure 4.2: Emotional Interference of learners from HEI

The learners learning engagement is important as they will be constantly engaged in the active virtual learning platform that deploys virtual agents that have aesthetic values as depicted by the positive emotion traits in Figure 4.2. Agent ID 2 is the most preferred virtual agent as the positive emotion traits happiness and surprise were rated the highest in comparison to the negative emotion traits such as anger, disgust, fear and sadness. Therefore, it is important to identify the emotional interference amongst the learners from the HEI to produce a successful learning platform.

This research also supports the findings of Khan and Angeli (2007) who have proven that attractiveness of virtual agents enhance the learning process in the virtual learning environment. The statistical analysis clearly supports the findings as there is a strong and positive correlation between the attractiveness and the positive emotion traits. It is also noted that the correlation is weak for the naturalistic looking pedagogical agents with the happiness emotion. Therefore, the design of a virtual agent for a successful learning

environment must deploy an attractive looking virtual agent. The pedagogical agents, Agent ID 2 and 8 have topped the list for being the most attractive agents.

This research summarizes and supports the significant findings on the impact of attractiveness and learners' level of satisfaction in regards to the deployment of the virtual agents. The findings by Kansei pioneer researchers Nagamachi et al. (2016), Nagashima (2013), Lokman and Noor (2006), and Harada (1998) have proven that Kansei is an important factor in product design. The high ratings obtained from this research strongly supports Nagamachi's statements in his article published in the year 1992 that clearly state that the rich Kansei value indicates the richness of emotions in a product design and it has aesthetic value.

4.1.2 Research Question 2 (RQ2)

What are the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment using the Kansei design approach?

4.1.2.1 Research Method

To address this research question, the researcher adopted the research framework designed in the Phase II of the research elaborated in Chapter 3. Kansei Engineering (KE) was deployed to identify the factors that affect learners from a heterogeneous society. This phase is also known as the exploratory study. A pilot study was also conducted in a small scale using 30 respondents to assess the feasibility of this research study. This pilot study enabled the researcher to develop and test the adequacy of the research instruments. Upon identifying the feasibility of the instruments used in this research, the instruments were used on the larger sample size. There are several crucial steps in this phase of study as shown in the Figure 4.3. These steps were discussed in Chapter 3.

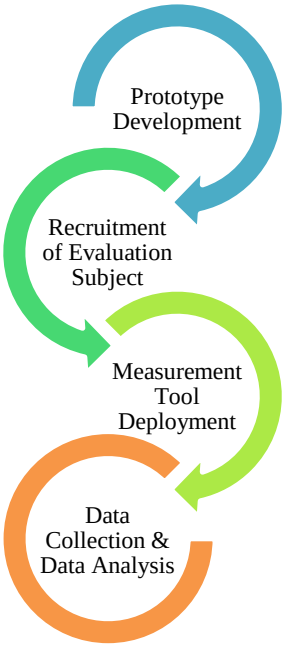


Figure 4.3: Exploratory Study Stages

A total of 107 undergraduate students from a private HEI and 15 subject experts were recruited for this study. The data collected from the respondents was analyzed using the SPSS software. Factor Analysis and Principal Component Analysis were conducted to identify the various factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment. The findings are discussed in the following section.

4.1.2.2 Findings

The findings can be classified into three sections. The sections are Kansei Keywords (KW) checklist, pilot test results and exploratory results.

(a) ***Kansei Word Checklist***

From the Kansei Affinity Cluster Database, the 15 subject experts derived 25 Kansei Keywords (KW). To ease the selection process, a total of 102 keywords were selected by 5 experts at the initial stage and it was further synthesized to 25 KW using the online

survey. The KW for the checklist was used based on the mean value obtained from the KW selection process. The mean of KW was calculated using the following formulation.

$$\text{Sample mean} = x = \Sigma x / n$$

The mean of the sample used is derived from the stated formula where Σx is the sum of all the sample observations, and n is the number of sample observations. The KW Synthesis chart in Figure 4.4 depicts the mean value obtained from this research.

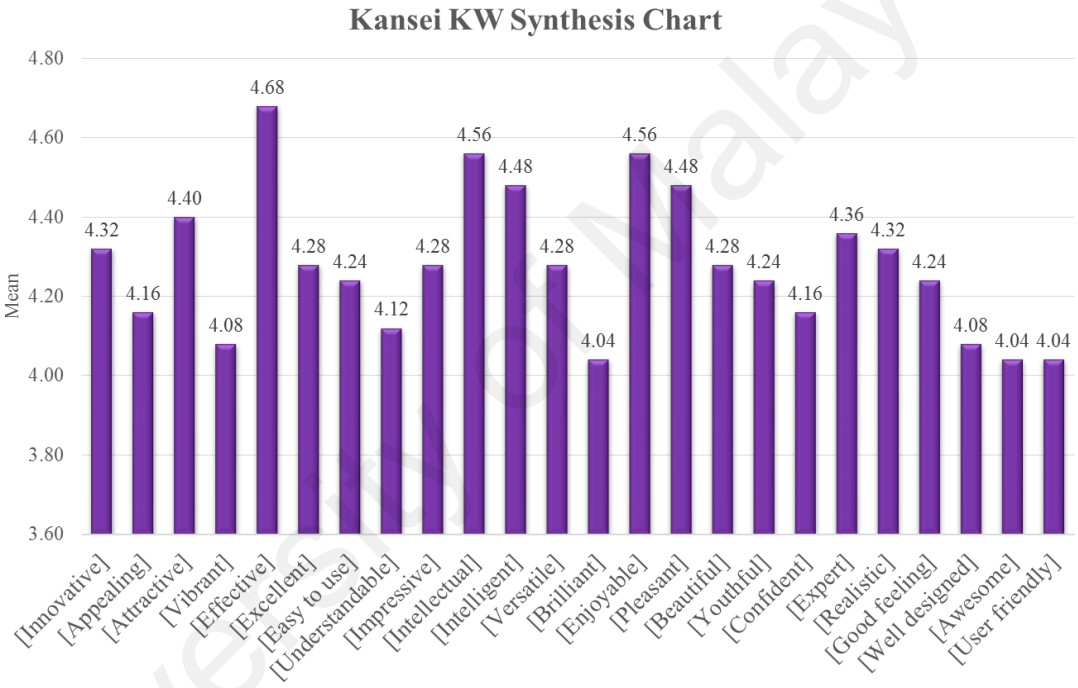


Figure 4.4: Kansei Keywords Synthesis Chart

The 25 KWs were further classified and mapped into the Clusters identified in the Kansei Affinity Diagram. This gives an overview of the favorable and vital clusters for a research design. Table 4.3 depicts the finalized 25 KWs from the Kansei Affinity Cluster.

Table 4.3: Selection of KW

No	KW	Clusters
KW1	Innovative	Creative
KW2	Appealing	Decent
KW3	Attractive	Decent
KW4	Vibrant	Decent
KW5	Effective	Degree
KW6	Excellent	Density
KW7	Easy to use	Easy
KW8	Understandable	Easy
KW9	Impressive	Elegant
KW10	Intellectual	Elegant
KW11	Intelligent	Elegant
KW12	Versatile	Elegant
KW13	Motivating	Compromising
KW14	Brilliant	Happy
KW15	Enjoyable	Happy
KW16	Pleasant	Happy
KW17	Beautiful	Innocent
KW18	Youthful	Innocent
KW19	Confident	Positive Behaviour
KW20	Expert	Positive Behaviour
KW21	Realistic	Positive Behaviour
KW22	Good feeling	Positive Physical
KW23	Well designed	Positive Physical
KW24	Awesome	Trendy
KW25	User friendly	Technological

The mapping of the 25 KWs to the clusters is shown in a pictorial form as Figure 4.5. It is noted that the 25 KWs were selected from the 13 clusters identified in the Kansei Affinity Cluster. The clusters are creative, decent, degree, density, easy, elegant, happy, innocent, positive behavior, positive physical, trendy, technological and compromising.

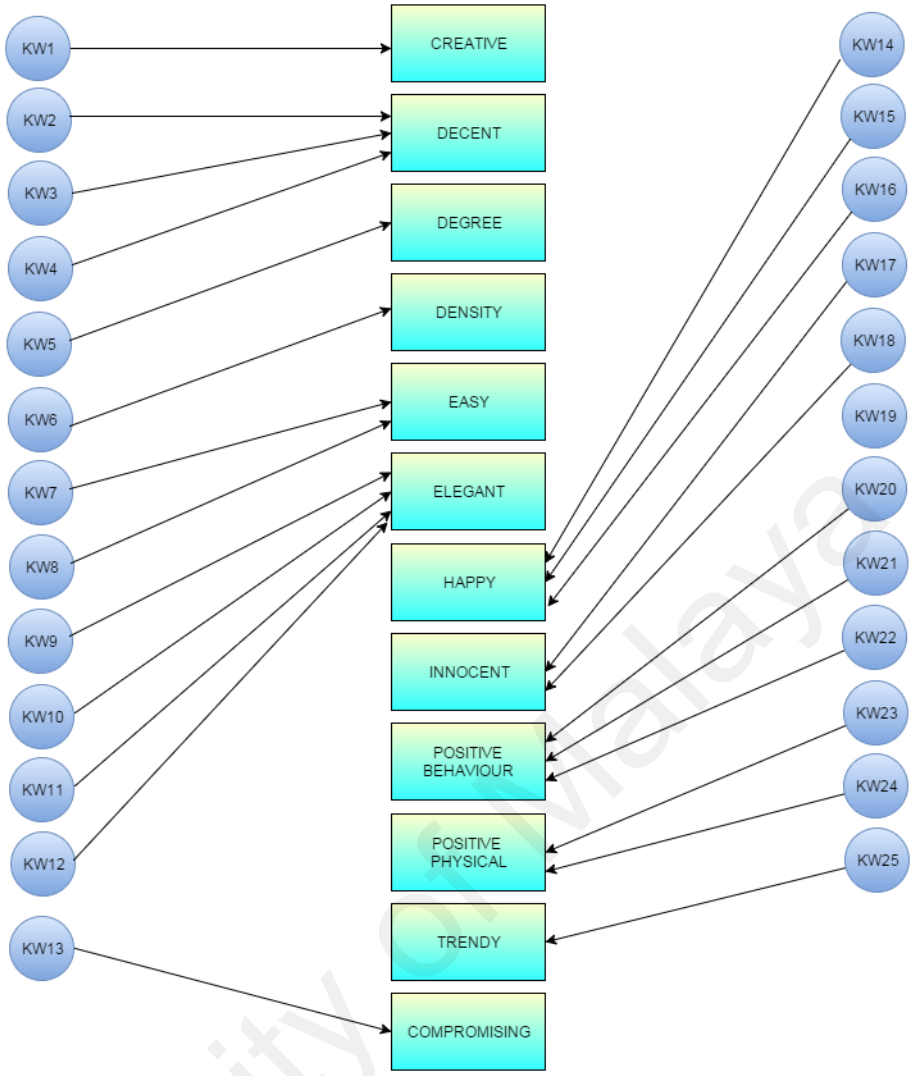


Figure 4.5: Mapping of KW to Clusters

These identified 25 KWs were used in the research study for a sample size of 107. The population of data for this research is calculated as following:

s: number of specimen

k: number of emotional keywords

r: number of respondent

Total population = *s* x *k* x *r* = *18 x 25 x 107 = 48150*

The calculation shows that the total population for this research is 48150. This is to identify the population size for the conducted research.

On the other hand, for an online survey, a minimum of 20% of response rate is considered good while 30% response rate is considered to be really good (Andrews et al., 2003). A total of 107 respondents from the population size of 478 students participated in this study. It shows that 22.38% students participated in this research study and it is classified as a good response rate.

(b) *Pilot Test Findings*

The findings are derived from the data collection process that used 30 respondents. Upon data collection, the statistical analysis was performed on the data collected from these respondents using the derived Kansei Checklist elaborated in the earlier sub section. The data collected which was used in the following analysis is depicted in Appendix D. A number of statistical tests were carried out to analyze the data in the pilot study and the findings are discussed in sub sections (I) and (II).

I. Reliability Analysis

The Cronbach's Alpha reliability test was conducted on the sample size to estimate the reliability of the research study. The Cronbach's alpha reliability coefficient ranges from 0 to 1. It is noted that the closer Cronbach's alpha coefficient value to 1.0, the greater the internal consistency of the items in the scale. The Cronbach's alpha α value for the pilot study was 0.980 which is categorized as excellent. Table 4.4 depicts the reliability of the plot test. Further, this reliability score was matched with the exploratory study score to compare and conclude the final results.

Table 4.4: Reliability of Pilot Test

Cronbach's Alpha	N of Items
.980	25

II. Descriptive Statistics for KW

Table 4.5 depicts the descriptive analysis of the 25 KW used in this research.

Table 4.5: Descriptive Statistics for the KW

KW	N	Minimum	Maximum	Mean	Std. Deviation
Realistic	18	2.9333	3.7333	3.257406	.2222241
Intelligent	18	2.8333	3.8667	3.244456	.2729675
Intellectual	18	2.7667	3.7333	3.212961	.2602523
Brilliant	18	2.8667	3.6667	3.205567	.1957920
Expert	18	2.8333	3.6000	3.200000	.2132806
Innovative	18	2.8667	3.6000	3.198144	.2040319
Easy to use	18	2.8333	3.5667	3.170372	.2207814
Versatile	18	2.8333	3.5000	3.164822	.2001488
Excellent	18	2.7667	3.6667	3.161111	.2630304
Effective	18	2.7667	3.7667	3.155561	.2446831
Understandable	18	2.7667	3.5000	3.155556	.2231603
Good feeling	18	2.7333	3.6000	3.148150	.2534107
Motivating	18	2.9000	3.6000	3.148139	.2020229
Well designed	18	2.7667	3.8000	3.142600	.2804703
Confident	18	2.8000	3.5333	3.138889	.2290212
Awesome	18	2.8667	3.6333	3.129633	.2314736
User friendly	18	2.8000	3.5667	3.107417	.2372422
Enjoyable	18	2.8333	3.4000	3.105544	.1954532
Impressive	18	2.7000	3.6333	3.099989	.2392767
Pleasant	18	2.8333	3.4667	3.081489	.2148836
Vibrant	18	2.8333	3.6333	3.081478	.2290201
Beautiful	18	2.6667	3.5333	3.059267	.2267957
Youthful	18	2.3000	3.4667	3.011106	.3143638
Attractive	18	2.5000	3.6333	2.987039	.2789153
Appealing	18	2.6000	3.4667	2.968506	.2313619

From Table 4.5, realistic, intelligent, realistic, intelligent, intellectual, brilliant and expert topped the list for being the favorable KW among the 30 respondents. To add on, youthful, attractive and appealing had the lowest mean value. The findings were then analyzed using PCA loading analysis as depicted in Figure 4.6. The PC loadings showed that the KW or emotions are distributed in the positive domain.

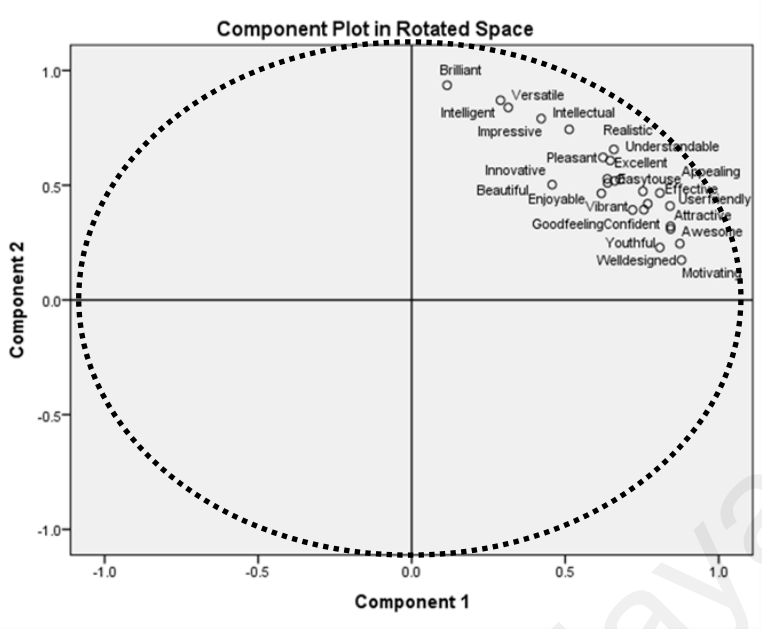


Figure 4.6: PC Loading for Pilot Study

Unlike most of the researches, this study did not display a well distributed emotional keywords as the words have been synthesized and only positive keywords were selected by the 15 experts. To sum up, based on the Cronbach's Alpha and PCA statistical analysis performed in the pilot study, the findings provided hypothetical credence that the instruments and the research process was valid and the emotional signature identified by Lokman (2009) does exist and can be quantified.

(c) *Exploratory Study Findings*

The findings are derived from the data collection process that recruited 107 respondents from the private HEI. The Statistical Analysis was performed on the data collected from these respondents. The findings are reported in the sub sections below. The tabulation of the data collected is depicted in Appendix E. The statistical tests carried out to analyze the data in the exploratory stage are discussed in sub sections (I) to (III).

I. Reliability Analysis

The Cronbach's alpha α value for the pilot study is 0.993 which is categorized as excellent. Table 4.6 depicts the reliability of the research study. This reliability score matched the pilot study reliability score. Therefore, both the findings are valid and consistent.

Table 4.6: Reliability of Exploratory Study

Cronbach's Alpha	N of Items
.993	25

II. Descriptive Statistics for KW

Table 4.7 depicts the descriptive analysis of the 25 KW used in this exploratory research study that deployed 107 respondents from the private HEI.

Table 4.7: Descriptive Statistics for the KW

KW	N	Minimum	Maximum	Mean	Std. Deviation
Intelligent	18	2.9720	3.6262	3.203531	.1846079
Intellectual	18	2.8692	3.5514	3.188993	.1877539
Realistic	18	2.9626	3.5047	3.177570	.1478395
Expert	18	2.9159	3.5047	3.167705	.1484801
Confident	18	2.8411	3.5514	3.160955	.1876992
Brilliant	18	2.8785	3.4393	3.147456	.1607769
Excellent	18	2.7757	3.4860	3.125649	.2224410
Versatile	18	2.8411	3.3645	3.118899	.1453089
Understandable	18	2.7757	3.4393	3.104361	.1976898
Well designed	18	2.8224	3.5701	3.101765	.1944044
Innovative	18	2.8037	3.4299	3.096573	.1785655
User friendly	18	2.7944	3.4206	3.092420	.1897771
Effective	18	2.7570	3.4579	3.088266	.1937249
Easy to use	18	2.7383	3.4112	3.087227	.2007011
Awesome	18	2.7757	3.4486	3.082555	.1892175
Impressive	18	2.7850	3.4579	3.077362	.1884981
Motivating	18	2.7944	3.4019	3.077362	.1676983
Good feeling	18	2.6636	3.5047	3.073209	.2183857
Enjoyable	18	2.6729	3.4206	3.065421	.1993913
Pleasant	18	2.7103	3.4579	3.043094	.2313386
Vibrant	18	2.6916	3.4953	3.031153	.2139830
Beautiful	18	2.6449	3.4112	3.002077	.2095076
Appealing	18	2.5327	3.5140	2.997923	.2468205
Youthful	18	2.3925	3.4579	2.987020	.2925018
Attractive	18	2.5047	3.5794	2.985462	.2540354

Findings from the descriptive analysis suggest that the intelligent, intellectual, realistic, expert and confident are the top five KW in the table. The findings are similar to the findings of the pilot test conducted; however there was a new addition, confident. On the other hand, appealing, youthful and attractive KWs had low mean value and were not identified as an important KW in the Kansei Checklist. This was similar to the findings from the pilot study conducted.

III. PCA Loading for Kansei Keywords

The PCA loading is an important analysis for this research study as identified in the pilot study. Similar to the pilot study, the loadings were on the positive domain as depicted in the Figure 4.7.

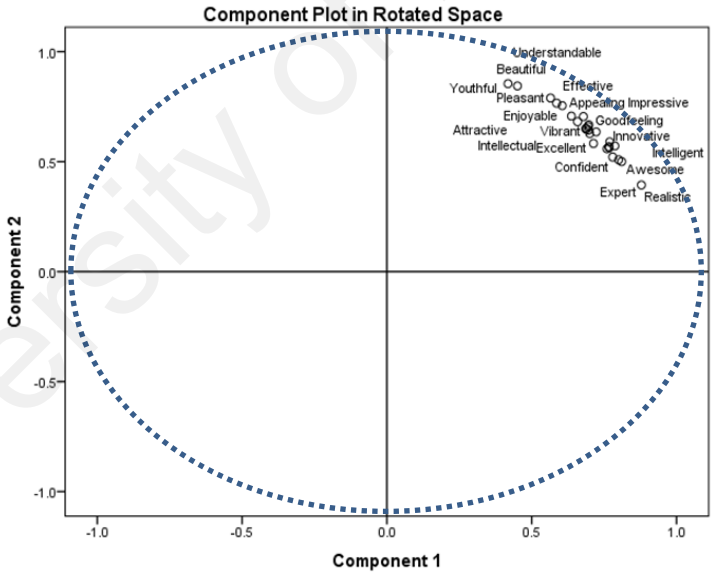


Figure 4.7: PC Loading for Exploratory Study

Based on Figure 4.7, the emotions such as expert, realistic, awesome and intelligent produced the first PC loadings (x- axis). Therefore, this axis is labeled as Expertness. Conversely, emotions such as youthful, attractive and beautiful produced the second PC

loadings (y-axis) labeled as Attractiveness. Hence, virtual agents with high score on x-axis were found to be more expert looking and virtual agents with high score on y-axis were found to be more attractive.

Figure 4.8 maps the virtual agents to the PC1 and PC2 as discussed earlier. Component 1 was identified as Expertness and the Component 2 was identified as the Attractiveness. This figure made visualization of the virtual agents with strong emotion elements possible. Those virtual agents located at the edge of the axis had very strong meanings that correspond to the emotion structure.

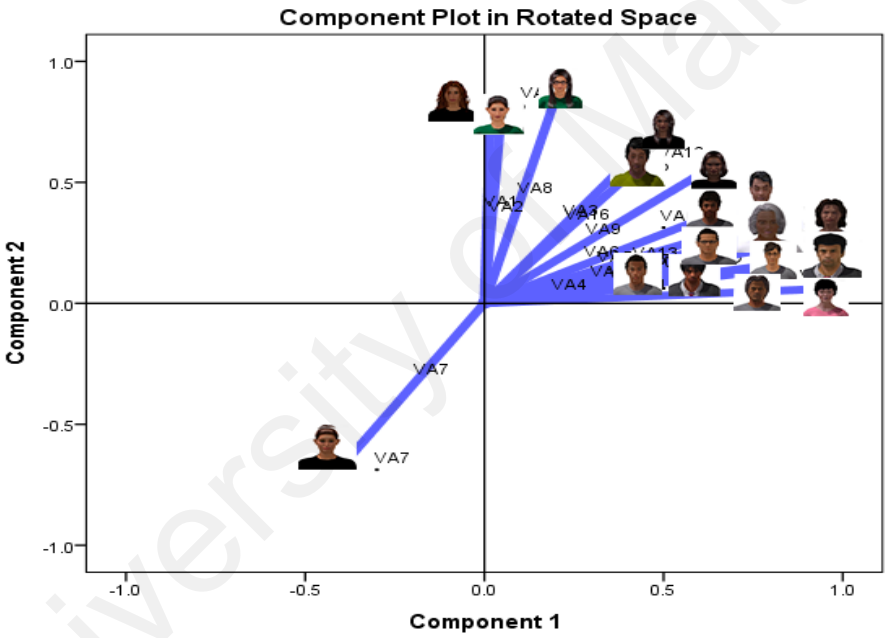


Figure 4.8: PC1 and PC2 for Virtual Agents

Based on the findings depicted in Figure 4.8, virtual agents VA1, VA2 and VA8 were found to be attractive. Conversely, virtual agents VA10, VA14 and VA18 were classified as experts from the perspective of the learners.

However, the best area for Kansei concept is in the highlighted area as shown in Figure 4.9. This is the area where new concepts of design must be considered by designers.

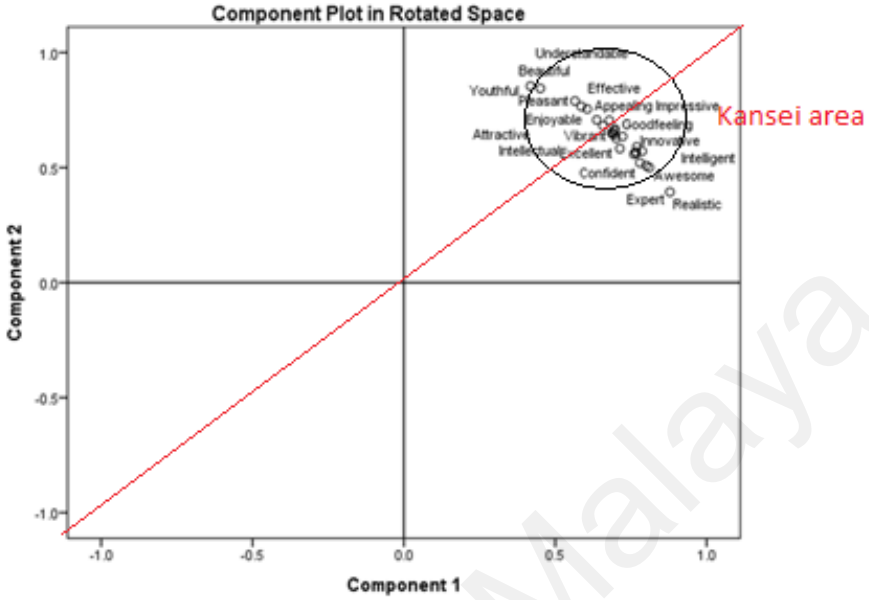


Figure 4.9: PC Vector: Kansei Area

- Factor Analysis (FA)

The research adapted the FA to identify the concept of emotion as practiced by Lokman (2009). The ideology of FA is to determine the concept of emotion in virtual agents design by determining the significant factors. Table 4.8 shows the results from the FA performed using Varimax rotation.

Table 4.8: Factor Analysis Table

Factors	Total	Variance (%)	Cumulative (%)
Factor 1	22.229	88.92	88.92
Factor 2	.554	2.21	91.13
Factor 3	.503	2.01	93.14
Factor 4	.418	1.67	94.81

The FA uses Varimax rotation which is the most prominent rotation method as it simplifies the variable interpretations. Table 4.8 depicts the 3 factors derived using the FA. The first factor explained the majority of the data (88.92%) and the second factor only explained 2.21 % of the data similar to factor 3 (2.01%). However, Factor 4's proportion was very minimal (1.67) and it can be omitted as it is insignificant. To conclude, it is proven that Factor 1 has dominant influence to the emotion or KWs. It is also noted that the four factors explained 94.81% of the data. Table 4.9 depicts the factor loading results after Varimax rotation.

Table 4.9: Factor Analysis Table (Kansei Keywords)

Variables	Factor 1	Factor 2	Factor 3	Factor 4
Well designed	.776	.395	.333	.327
Awesome	.702	.474	.270	.393
Good feeling	.681	.463	.479	.262
Easy to use	.657	.380	.433	.402
Vibrant	.651	.362	.415	.446
User friendly	.629	.445	.492	.324
Effective	.614	.419	.461	.421
Motivating	.603	.561	.411	.329
Enjoyable	.553	.330	.531	.504
Attractive	.541	.366	.482	.510
Appealing	.515	.453	.510	.478
Realistic	.467	.756	.285	.296
Intelligent	.389	.728	.457	.265
Expert	.393	.665	.353	.463
Intellectual	.329	.606	.493	.471
Brilliant	.424	.598	.549	.317
Impressive	.545	.549	.411	.414
Beautiful	.330	.377	.804	.265
Pleasant	.436	.442	.680	.342
Youthful	.352	.248	.625	.623
Versatile	.497	.512	.570	.298
Understandable	.547	.334	.566	.452
Excellent	.492	.417	.307	.643
Confident	.385	.573	.341	.620
Innovative	.459	.523	.327	.605

Table 4.9 shows the factor loading results after the Varimax rotation. The factor results are displayed in the ascending order which enabled easy observation of the variables used in this study. The significant variables or also known as KWs (> 0.5) were factorized into the identified factors as highlighted in Table 4.9.

4.1.2.3 Discussion

The research has enabled the researcher to identify the significance of statistical analysis to determine the emotions of a product. As claimed by Nagamachi and Lokman (2015), emotion can be quantified using the FA and PCA analysis.

The mapping of the PCA loadings obtained in the exploratory study resulted in the identification of the 2 factors and they are Attractiveness and Expertness of virtual agent designed. This also supports Khan and Angeli's (2007) research that identified attractiveness and realism as the design specification for Embodied Conversation Agents (ECAs) deployed in a learning environment. Adding on, the PCA was conducted to identify the strength of the virtual agents' emotion structure based on the KWs. It is proven that the structure of specimen was distinguishable based on the two components derived using the PCA. It can be concluded that integrating these two components can be a new concept in virtual agent design. This design concept using the PCA is supported in various research related to Kansei Engineering elaborated by the founder of Kansei Engineering, Nagamachi (2016). Besides that, the implemented method conceptualizes the active research design process highlighted by Sein et al. (2011) and inherently interwoven activities of building the IT artifact such as the virtual agents.

4.1.3 Research Question 3 (RQ3)

What are the Virtual Agent Design Model (VADM) design specification needed for an effective design of virtual agents to capture learners' satisfaction using the Kansei design approach?

4.1.3.1 Research Method

This section elaborates the initial Virtual Agent Design Model (VADM) development, which defines the structure of the model and the components in the model. The working process of the VADM is described in this section. The mapping between the derived findings from the theoretical study as well as empirical study was conducted to derive the VADM model that provides a design guide for a heterogeneous society to overcome the existing standard stereotype design specification. Adding on, the findings from both research questions were further analyzed using an adaptation of the Kansei design model (Lokman & Nagamachi, 2009) and Product Experience Framework (Desmet & Hekkert, 2007). The findings from the RQ1 and RQ2 enabled the development of this model.

4.1.3.2 Findings

The findings from the mapping of the research questions and the theoretical studies identified several components for the VADM model consideration. The proposed model captured the entire research flow to design Kansei virtual agents simultaneously resulting in a Kansei product. The findings from Research Question 1 and Research Question 2 were used to identify the design components of this model. The proposed model which was the outcome of Research Question 3 (RQ3) is shown in Figure 4.10.

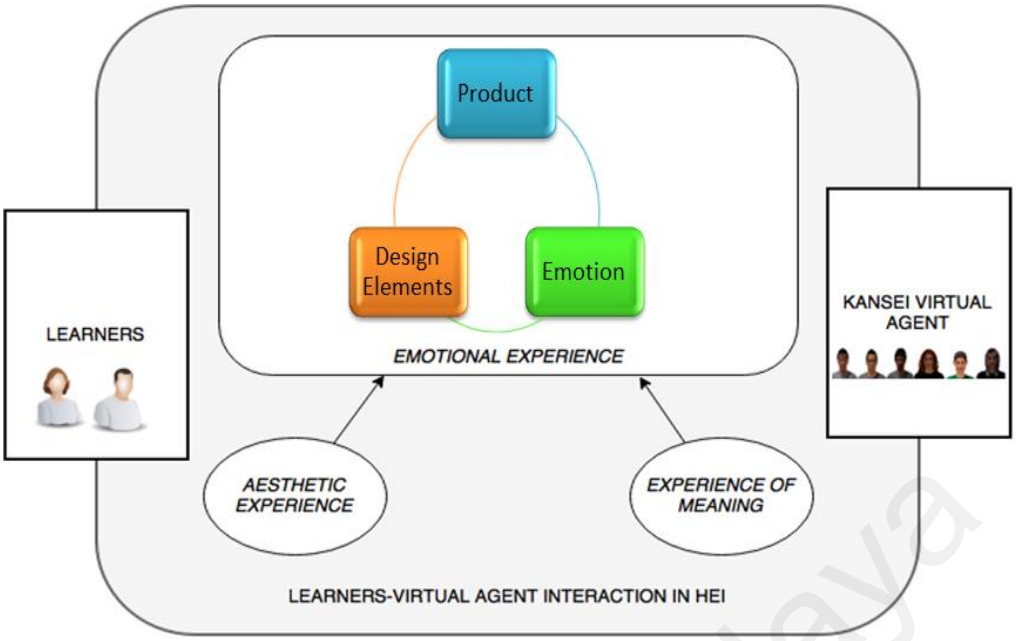


Figure 4.10: Virtual Agent Design Model

Besides that, the VADM designed was tested to identify the validity of the virtual agent prototypes designed using the VADM model which has been elaborated in detail in Chapter 5. The validation of the model is discussed in the next section.

4.1.3.3 Discussion

According to Hevner and Chatterjee (2010), an effective design-science research must provide clear contributions in the areas of the design artifact, design construction knowledge and design evaluation knowledge specifically the methodology. This ideology on design science is similar to Von Alan et al.'s (2004) findings. Accordingly, the current research has contributed to the current literature in the area of design science by integrating and enhancing the Framework on Product Experience by Desmet and Hekkert (2007) and Kansei Design Model by Lokman and Nagamachi (2009). The ideology of RQ3 was to derive a model that specifically caters to needs of the heterogeneous learners. However, the existing virtual agent models do not have emotional consideration. Therefore, the researcher proposed the Virtual Agent design Model to address this issue. This is in line with past literatures that have proven that products with high emotional

appeals can maximize user satisfaction (Nagamachi et al., 2016; Page, 2014; Lokman et al., 2010)

The cycle of Kansei design was also integrated into the Learners-Virtual Agents Interactions in HEI as depicted in the Virtual Agent Design Model (VADM). In the cycle of the Kansei design, the findings from RQ1 and RQ2 were integrated and referred to. Hence, this is a robust and holistic model that caters to the need of designers to produce Kansei virtual agents with rich kansei values.

4.1.4 Research Question 4 (RQ4)

Do virtual agents designed using the Virtual Agent Design Model (VADM) have high emotional appeal and enhance learners' satisfaction?

4.1.4.1 Research Method

This confirmatory study tested the selected virtual agents of the VADM proposed in the earlier section for validity. A total of six prototypes of virtual agents were tested to validate this model using the 5 Kansei Keywords (KWs). The KWs used are effective, intellectual, enjoyable, pleasant and intelligent. Besides this 5 KWs, the attractiveness and realism of the virtual agents were also included in the online questionnaire as elaborated in Chapter 3. As for the specimen used, 6 virtual agents designed using the VADM model were used to determine the validity of the proposed model.

4.1.4.2 Findings

The data collected from 10 good samples were used in this study to validate this model. The online form was used as a validation tool to evaluate the 6 virtual agents. Table 4.10 depicts the descriptive analysis of the 5 KWs used in this confirmatory research study that deployed 10 good samples from private HEI.

Table 4.10: Descriptive Analysis for the 6 Virtual Agents

Kansei Keywords	mean	min	max	std dev
Attractiveness	3.20	2.22	3.67	0.5086
Expertness	3.04	2.33	3.56	0.4136
Effective	3.34	3.00	3.63	0.2488
Intellectual	3.23	2.75	3.78	0.3867
Enjoyable	3.23	2.38	3.50	0.4248
Pleasant	3.20	2.43	3.67	0.4353
Intelligent	3.40	3.11	3.67	0.2413

Table 4.10 depicts the descriptive analysis for the emotional keywords or identified as Kansei Keywords (KWs) in this research. The table indicates 'Attractiveness' and 'Intelligent' as being the KWs with high Kansei value. However, it is also noted that the other keywords from the similar cluster identified by Lokman et al., (2010) also have high mean values. Therefore, the emotion structure identified in this confirmatory study shows a positive structure.

The data tabulated from the Confirmatory or Validation of VADM phase is depicted in Figure 4.11. The figure depicts the association of the six virtual agents with the emotion structure. From the figure, it is proven that Virtual Agent 2 (VA2) has high kansei value for all the Kansei Keywords (KWs) used in this study.

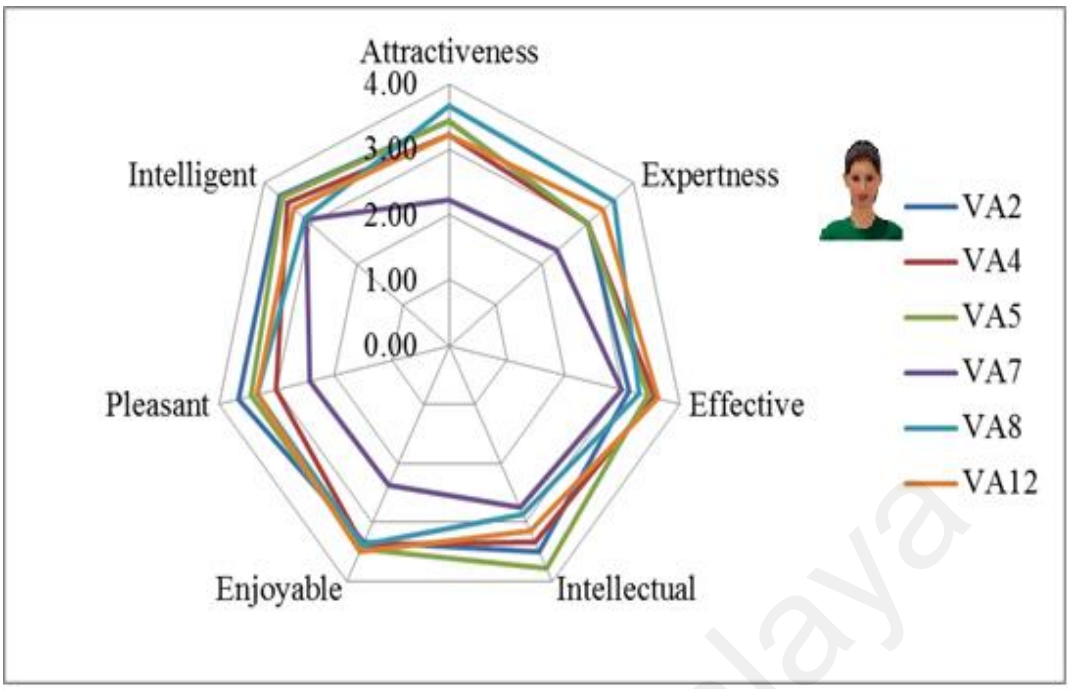


Figure 4.11: Relationship between Emotional Keywords and Virtual Agents

Findings from Figure 4.11 also suggest that there is no gender biasness as the emotion structures for male virtual agents were also similar to the female. Furthermore, the designs of virtual agents were not inclined towards a particular group or ethnicity but were meant for a heterogeneous society. The heterogeneity of the sampling used in this study was further tested to support the findings using the paired sample t-test. The findings are tabulated in Table 4.11.

Table 4.11: Heterogeneity of the Sampling (Virtual Agents- Ethnicity t-test)

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Dev	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
	A1 - Ethnicity	1.35514	1.22284	.11822	1.12077	1.58951	11.463	106	.000
Pair 2	A2 - Ethnicity	1.09813	1.22751	.11867	.86286	1.33340	9.254	106	.000
Pair 3	A3 - Ethnicity	1.21963	1.27045	.12282	.97613	1.46313	9.930	106	.000
Pair 4	A4 - Ethnicity	1.19159	1.17088	.11319	.96717	1.41601	10.527	106	.000
Pair 5	A5 - Ethnicity	1.45794	1.21919	.11786	1.22427	1.69162	12.370	106	.000
Pair 6	A6 - Ethnicity	1.14953	1.27792	.12354	.90460	1.39447	9.305	106	.000
Pair 7	A7 - Ethnicity	1.44393	1.27997	.12374	1.19860	1.68925	11.669	106	.000
Pair 8	A8 - Ethnicity	1.18692	1.30044	.12572	.93767	1.43616	9.441	106	.000
Pair 9	A9 - Ethnicity	1.01402	1.34490	.13002	.75625	1.27179	7.799	106	.000
Pair 10	A10 - Ethnicity	1.17290	1.28140	.12388	.92730	1.41850	9.468	106	.000
Pair 11	A11 - Ethnicity	1.32710	1.29786	.12547	1.07835	1.57586	10.577	106	.000
Pair 12	A12 - Ethnicity	1.19626	1.31529	.12715	.94417	1.44836	9.408	106	.000
Pair 13	A13 - Ethnicity	.86449	1.40008	.13535	.59614	1.13283	6.387	106	.000
Pair 14	A14 - Ethnicity	.99533	1.37102	.13254	.73255	1.25810	7.510	106	.000
Pair 15	A15 - Ethnicity	1.09813	1.31292	.12693	.84649	1.34977	8.652	106	.000
Pair 16	A16 - Ethnicity	.90187	1.42657	.13791	.62845	1.17529	6.539	106	.000
Pair 17	A17 - Ethnicity	.98598	1.41498	.13679	.71478	1.25718	7.208	106	.000
Pair 18	A18 - Ethnicity	1.08411	1.32196	.12780	.83074	1.33749	8.483	106	.000

Table 4.11 depicts the paired sample t-test conducted to support the heterogeneity of the sampling used in this research study. The null hypothesis (H0) in this research assumes that the true mean difference between the paired samples (Virtual Agents prototype- Ethnicity) is zero. This confirms the sampling has homogeneous behavior. Conversely, the alternative hypothesis (H1) assumes that the true mean difference between the paired samples is not equal to zero. In this study, the Sig. (2-Tailed) value is 0.000 which is less than 0.05. This value indicates that there is statistically significant difference between the mean of affective responses towards the 18 virtual agents and the various categorized ethnicities. This findings supports the heterogeneity of the sampling as depicted in the demographic figure as shown in Chapter 3. Therefore, it is a heterogeneous sampling.

4.1.4.3 Discussion

The research has successfully deployed the Kansei Engineering (KE) approach and it is proven that there is an association between the emotions and the design of the virtual agents. As a result, the research has validated the proposed Virtual Agent Design Model (VADM) developed using the adapted and enhanced KE approach. According to Lokman (2010) and Yanagisawa et al. (2017), a model is valid when there is evidence of positive improvement in the structure of emotion which is known as Kansei Keywords (KWs).

In this research the two identified factors, Attractiveness and Expertness, which were identified in the earlier study have shown a positive emotion structure as discussed in the findings section. Besides that, VA2 has been listed as the most favorable Virtual Agent as it had high Kansei value. This conclusion is in line with Nagamachi and Lokman's (2016) ideology that explains the importance of high Kansei value for a Kansei product.

Thus, the findings from the confirmatory study and the paired t-test can be taken be taken as evidence to conclude that the design of the virtual agents are globalized and

caters for heterogeneous group of learners. The design managed to overcome the standard stereotype designs discussed in previous researches (Liew et al., 2013; Khan and Sutcliffe, 2014).

4.2 Summary

This chapter reported the findings from the research studies conducted to answer the four research questions. The chapter has systematically elaborated the flow of the exploratory study and the application of statistical analysis such as Factor Analysis (FA) and Principal Component Analyses (PCA) to derive the emotion structure of the studied virtual agents. Furthermore, in this phase, the conceptualization of emotion for virtual agent design was successfully executed. The stages of Confirmatory or Validation of VADM has also been discussed in this chapter. It is evident that virtual agents designed using the VADM have rich or high Kansei value. The validation of VADM has resulted in the identification of the design elements for virtual agents to be deployed in the Virtual Learning Environment. To conclude, the VADM designed by the researcher has been found to be a solution to the identified research problems. Chapter 5 gives an in-depth description of the VADM model that was designed and validated in this chapter.

CHAPTER 5: VIRTUAL AGENT DESIGN MODEL

This chapter elaborates the findings from the Research Question 4 (RQ4). It presents the Virtual Agent Design Model (VADM) evaluation and revised model development. The summary of the VADM model development and components are also discussed.

5.1 Initial Virtual Agent Design Model Development

The initial model development of VADM began with the understanding of the importance of emotional experience based on Framework on Product Experience (Desmet & Hekkert, 2007) and Kansei Design Model (Lokman & Nagamachi, 2009). This provided an understanding on the entities that were crucial for VADM development. Figure 5.1 provides an overview on the VADM development process.

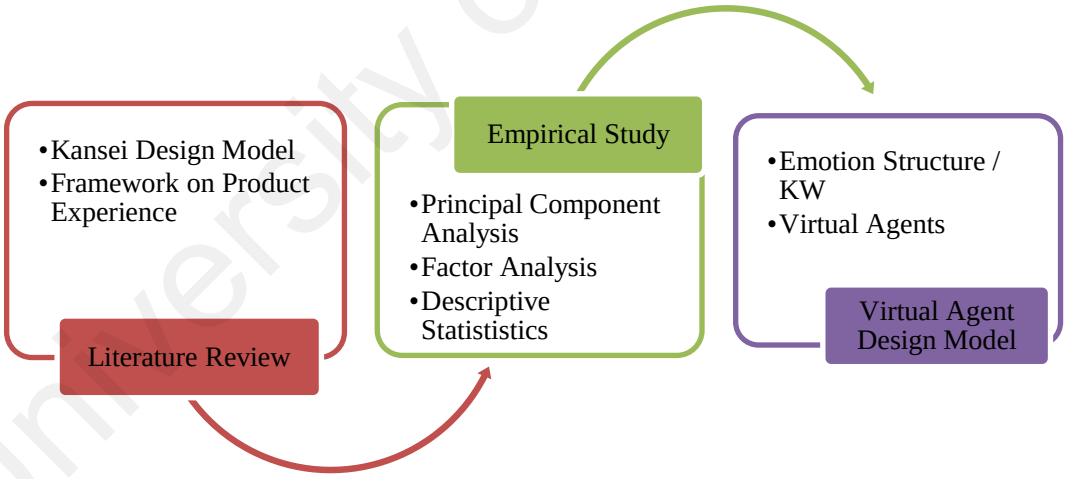


Figure 5.1: VADM Model Development

Figure 5.1 defines the flow of Virtual Agent Design Model development phases. The first phase encompasses the study of past literature which identified the frameworks and

models that were crucial for the development of VADM. The next phase highlighted the types of statistical analysis involved in the empirical study. Last but not least, the final phase identified the analyzed items that contributed to the Virtual Agent Design Model (VADM).

5.2 Structure of Virtual Agent Design Model

The structure of VADM can be divided into several layers. The layers are as depicted in Figure 5.2.

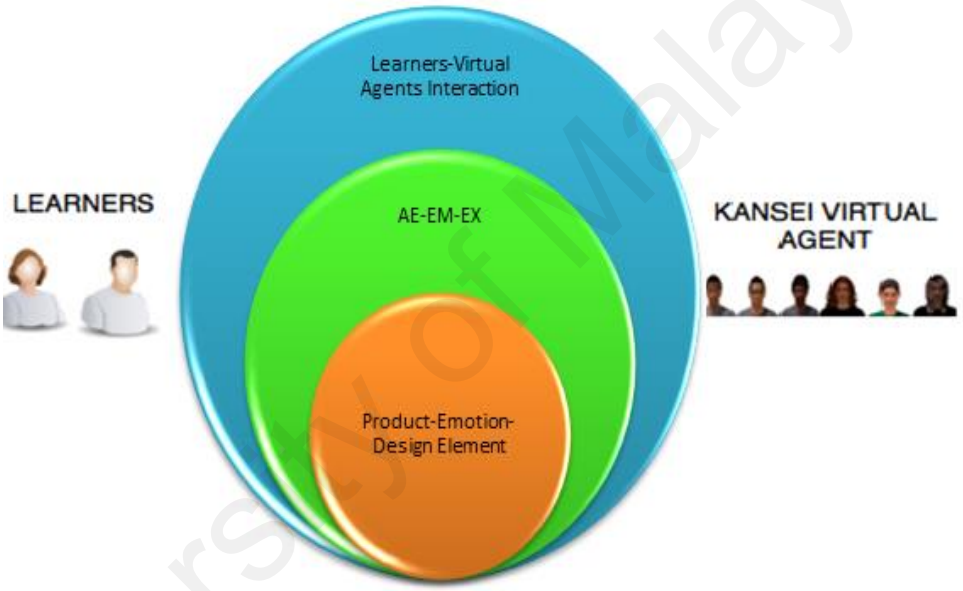


Figure 5.2: Layers of VADM

The outer layers denote the Learners and the Virtual Interaction environment. The second layer comprises of the framework designed by Desmet and Hekkert (2007). The three major components that determine emotional experience are aesthetic experience, experience of meaning and emotional experience. This framework was elaborated in Chapter 1 in detail. The inner most layer is the Product-Emotion-Design Element Cycle. These identified structures will be elaborated in the following sub sections.

5.2.1 Learners – Virtual Agents Interaction

The Learners–Virtual Agents Interaction refers to the environment where the learners and virtual agents interact such as the learning platform deployed in Higher Education Institutions (HEIs). The learning platform that promotes interaction between the learners and virtual agents is conducive for this research study. The learners identified in this VADM model are the heterogeneous learners from a private Higher Education Institution (HEI) that had the right composition of Malaysian and International students. On the other hand, the Kansei virtual Agents refer to the virtual agents designed using the Kansei approach and have high emotional appeal or rich Kansei value. Richness of Kansei value was defined by Nagamachi (2010) as a quantified value that represents the aesthetic value of a Kansei product. Since this study aimed to design Kansei virtual agents using the VADM model, the interaction is identified as the interaction between the learners and the Kansei product designed.

5.2.2 Aesthetic Experience

According to Desmet and Hekkert (2007), Aesthetic Experience (AE) is the product's capacity to delight one or more sensory or stimulus modalities. The sensory modality is an aspect of a stimulus identified as light, sound, temperature, taste and pressure. In this level, a product may look attractive, make pleasant and calm sound, smell good or feel good to embrace the product (Gaver & Mandler, 1987; Hekkert et al., 2003; Reason et al., 2016).

The concept of AE also refers to the beauty of use, meaning the beauty one experiences during the interaction process between the user and designed product (Overbeeke & Wensveen, 2003). Along similar lines, Stienstra (2016) asserted that the design goal of a product focuses on perceptual motor skills of users that aim for richness in aesthetic experiences.

Though the research identifies AE as a visual domain since the Kansei approach enables learners to evaluate a product based on the visual representation of the virtual agents, other modalities are also explored indirectly.

5.2.3 Experience of Meaning

According to Desmet (2003), this Experience of Meaning (EM) coincides with Crilly et al.'s (2004) cognitive response identified as semantic interpretation and symbolic association. This is also the level where the cognitive processes such as interpretation, associations and identification of significance of a certain product design are recognized. Research by Gibbs (2003) has proven that human body can understand linguistics expression as well as figurative expressions. As a result, these findings were adapted by O'Connors (2016) in his research related to neuroscience.

EM is identified as a luxury and attachment towards a product. The EM is represented by products that have some profound and sustained meaning to the user (Desmet & Hekkert, 2007). Therefore, EM ensures the learner's attachment towards the virtual agent. Thus, it ensures the sustainability of the product as the learners will feel attached towards the deployed Kansei virtual agents. As a result, this will enhance the learner's satisfaction and attain the goal of Kansei Engineering.

5.2.4 Emotional Experience

Emotional Experience (EX) refers to the phenomena identified in psychology as the everyday language about emotions such as love, happiness, desire and so on (Desmet & Hekkert, 2007). Psychologists have proven that emotions are coherent, organized and they are a functional system as they establish the humans position towards a product (Smith & Kirby, 2001). They also elaborated that human's feelings are very subjective as it either pulls towards a specific product or pushes one away from a product. On another note, Desmet (2003) affirms that pleasant emotions pull us to products whereas

unpleasant emotions will push us from those products which are classified as unbeneficial.

In the VADM model, the EX refers to learners' positive experiences toward the virtual agents. This emotional experience was determined using the Kansei approach which was represented in the Product-Emotion-Design Element cycle. This is a cycle as Kansei believes in improvisation of product that gives maximum satisfaction to the users. Therefore, the product is evaluated using the emotion measurement methodology identified as KE to identify the design elements and the product is then further enhanced to cater to the needs of the users. In this research, the design elements in the VADM were very specific to design elements of Kansei virtual agents which are discussed in the following section.

5.2.5 Product - Emotion- Design Element Cycle

The Product-Emotion-Design Element Cycle is the core for VADM. This cycle represents the KE approach used in this study. It adapts the Kansei Design Model (Lokman & Nagamachi, 2009). Figure 5.3 depicts the cycle that summarizes the ideology of Kansei by Nagamachi and Lokman (2016) as well as Nagashima (2013).

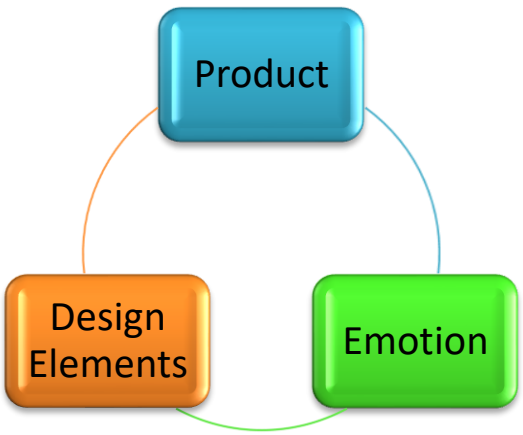


Figure 5.3: Product-Emotion-Design Element Cycle

This cycle clearly elaborates the Kansei approach as discussed in Chapter 2. The design elements for the VADM can be classified as the factors or emotion structure as well as demographics features of the Kansei virtual agents.

The product refers to the virtual agents, emotions is Kansei that are being analyzed using the KE approach and design elements refer to the characteristics of Kansei Virtual Agents. This process is an on-going process and it can also work vice versa.

5.2.6 Final Design of Virtual Agent Design Model

From the findings, the structure of VADM was identified and was designed to address Research Question 3 (RQ3). Figure 5.4 depicts the developed and validated model for this research study.

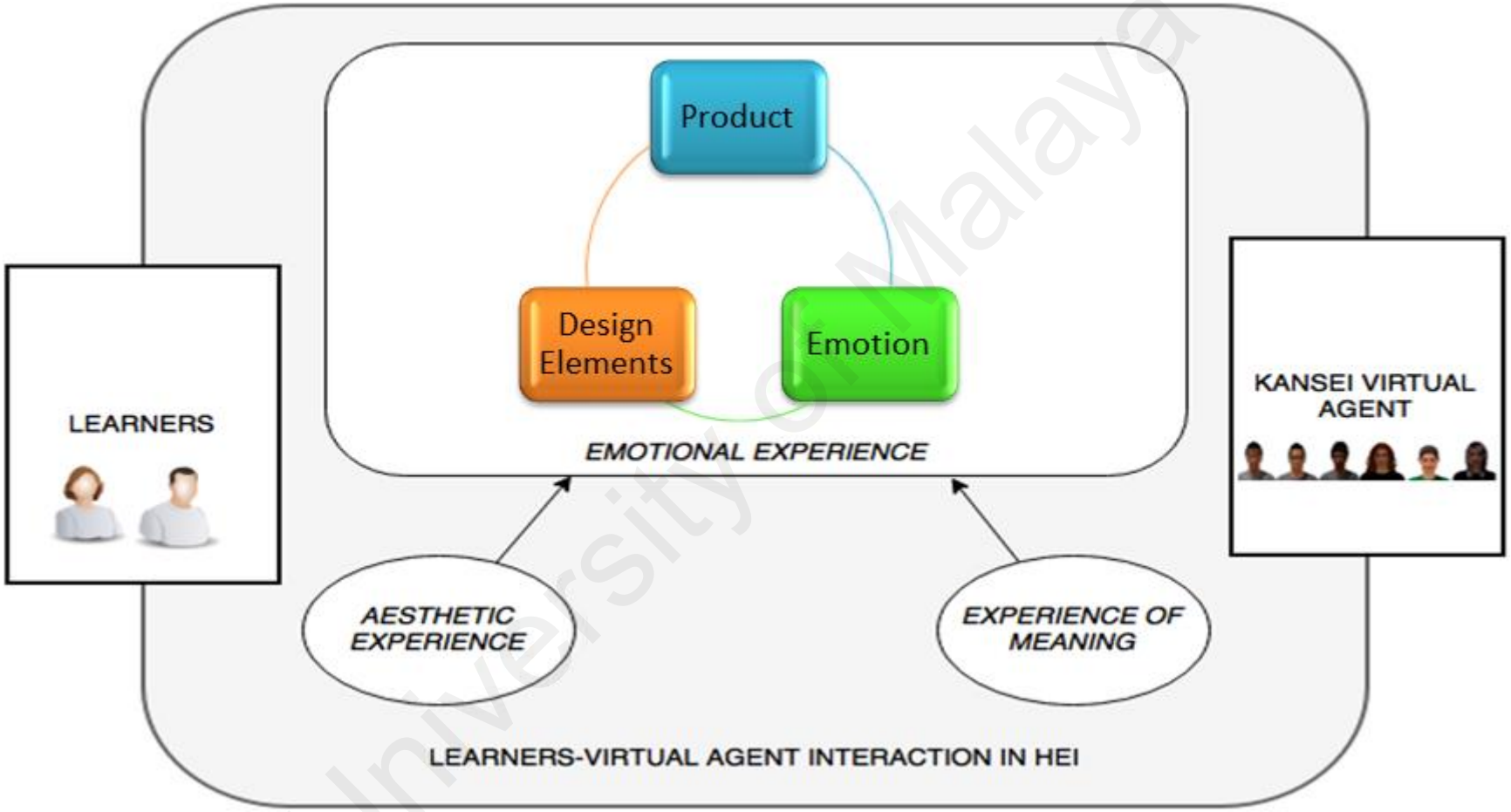


Figure 5.4: Virtual Agent Design Model

5.3 Summary

This chapter provided insights on the Virtual Agent Design Model (VADM) that has several design considerations which was adopted based on the findings of the research questions discussed in Chapter 4. This is the tangible output from this research study that deploys the Kansei approach that can parametrically link learners' emotional responses and simultaneously analyze learners' emotional experiences. This chapter had also provided the justification for the design consideration of the VADM and the method involved in the designing process. The three layers involved in the VADM were elaborated in detail and the finalized VADM is depicted in this chapter. Chapter 6 will summarize the discussions and conclude with recommendations for future research.

CHAPTER 6: SUMMARY OF DISCUSSION AND CONCLUSION

The study was carried out with three objectives in mind. Firstly, it was to identify the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment. Secondly, it aimed to develop a Virtual Agent Design Model (VADM) that caters to a heterogeneous community using the Kansei design approach. Lastly, it aimed to validate whether VADM developed using the case study has high emotional appeal and enhances learners' satisfaction. This research adopted a purely quantitative research method comprising of a theoretical, exploratory and confirmatory study. This chapter will discuss the ideology of this research and is followed by a conclusion and recommendations for further studies.

6.1 Summary of Discussion

The theoretical study has indicated that emotional power plays a crucial role in ensuring product satisfaction among users. Research in this area is extensive and evidence has been presented by numerous researchers that designers of product must focus on the powerful appeal of emotions and design products with aesthetic value to ensure the sustainability of the product in the market (Norman, 2005; Desmet, 2003; Hekkert et al., 2003). Designing virtual agents for Virtual Learning Environment (VLE) was also developed alongside this need to cater to emotional appeal to ensure learning becomes more effective. In line with this, the Kansei Engineering approach which was used to measure Kansei, the psychological feelings and images held in the mind towards artifacts, situations and surroundings (Nagamachi & Lokman, 2016) emerged as an important tool for designing products with high emotional appeal. Past researchers support the aim of the Kansei Engineering (KE) that unites Kansei into engineering and allows the assimilation of human Kansei into an affective product design that has high emotional appeal to the consumers (Nagamachi, 2016; Nagamachi & Lokman, 2015; Lokman et al.,

2014; Ishihara et al., 2005). Hence, it enhances consumers' satisfaction. The theoretical study also identified the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment. Among the factors identified are the Attractiveness, Realism and Emotional Interference.

The findings from the theoretical study paved the way for the Exploratory Study that aimed to identify the factors that affect the learners in a Higher Education Institution (HEI) in relation to virtual agent deployment using the Kansei design approach. These factors were explored further using the Kansei checklist determined by the experts and derived from Kansei Affinity Cluster (Lokman et al., 2010). Using the findings from the Kansei checklist, the Virtual Agent Design Model (VADM) was developed. This model was adapted from the Framework of Product Experience (Desmet & Hekkert, 2007) and Kansei Design Model (Lokman & Nagamachi, 2009) and further enhanced. The structure of VADM can be divided into several layers; Learner-Virtual Agents Interaction, Aesthetic Experience (AE)-Experience of Meaning (EM)-Emotional Experience (EX) and Product-Emotion-Design Element Cycle. AE is the product's capacity to delight one or more sensory or stimulus modalities (Desmet and Hekkert, 2007). According to Overbeeke and Wensveen (2003), AE can also be said to refer to the beauty of use, meaning the beauty one experiences during the interaction process between the user and the product designed. EM can be simplified as a luxury and attachment towards a product which ensures learners' attachment towards the virtual agent and in the long run establishes sustainability of the product. This is due to the attachment learners have towards the deployed Kansei virtual agents which enhance the learner's satisfaction. EX on the other hand, refers to the phenomena identified in psychology as the everyday language about emotions such as love, happiness, desire and so on (Desmet & Hekkert, 2007) which either pulls one towards a specific product or pushes one away from the product.

In the VADM model, the Product-Emotion-Design Element Cycle is the core. This cycle represents the KE approach used in this study which adapts the Kansei Design Model (Lokman & Nagamachi, 2009). The final output, the VADM deploys the Kasei approach which parametrically links learners' emotional responses and simultaneously analyzes learners' emotional experiences.

In the confirmatory study, the VADM was validated using 6 virtual agents with high emotional appeal and 10 good samples using descriptive analysis. The findings indicate that Attractiveness and Intelligent are the Kansei Keywords (KWs) with highest kansei value. The other keywords from the similar cluster identified by Lokman et al., (2010) also showed high mean values. The findings from the confirmatory study concluded that the design of virtual agents using Kansei approach meant for the heterogeneous group of learners proved successful in overcoming the standard stereotype designs discussed in previous researches (Liew et al., 2013; Khan and Sutcliffe, 2014).

6.2 Conclusion

This study represents an attempt to design and validate a Virtual Agent Design Model (VADM) using the Kansei approach with the ultimate objective of approving this approach as more effective in product design specifically in the design of virtual agents deployed in the Virtual Learning Environment for the Higher Education Institution that comprises of heterogeneous group of learners. Based on the findings of the Confirmatory / Validation stage, there is no doubt that the VADM designed by the researcher is a possible solution to the identified research problems from past researches such as lack of sustainability of product designed, failure to embed the emotional elements into virtual agent designs and inadequacy of virtual agents designed in VLE for HEIs to cater to the needs and preferences of the heterogeneous nature of the learners as discussed in Chapter 4. Thus, this research which is related to emotional user experience provides a new

perspective on the user-oriented design that can maximize user satisfaction where KE which addresses this issue elucidates an effective approach for the designers to ensure the sustainability of virtual agents designed for HEIs to ensure effective learning. To sum up, this research provides various benefits to the four identified stakeholders: students, lecturers, designers and the society. This was elaborated in depth in Chapter 1.

6.3 Recommendation for Future Research

The finding from this study has brought to surface a number of challenges for future research in the area of designing virtual agents for VLE using Kansei Engineering. Existing studies related to the deployment of KE related to product design in this area are limited to specific industries such as automotive, engineering and web design but the use in the Human Computer Interaction (HCI) domain is still at the inception level. The successful use of KE in these domains proven through researchers (Lokman et al., 2016; Harada, 1998; Nagasawa, 2004; Levy et al., 2013; Nagamachi, 1999; Bidin et al., 2017) and the positive findings of the current research clearly advocate the need for incorporating KE in the field of Human Computer Interaction specifically virtual learning. The research has brought to surface the requirements that the process of designing virtual agents needs to address the emotional aspects of a product design which provides maximum satisfaction to the learners. However, this can only be achieved if all the relevant parties inclusive of the Ministry of Higher Education and the HEIs themselves provide opportunities for the designers/educators to be exposed to the significance of incorporating KE in virtual learning to enable them to reap the benefits from this approach to enhance the learning that takes place.

Based on the findings at the validation stage, the research can be further strengthened by having a more extensive and varied sample. For instance, the size of the sample can be increased and further diversified to incorporate more than one university (comprising

of both public and private institutions) as well as to ensure the sample is more balanced with equal percentage of international and local learners because universities are becoming more globalized. Furthermore, the Asians and Westerners may not come to the same conclusion. Though the design is holistic, it can be enhanced by testing it in any Western setting.

In terms of the virtual agent design concept, the research has highlighted the demographic features of virtual agents but did not address other influencing factors such as virtual communication, virtual space and clothing as advocated in similar researches (Rutkowski et al., 2002; Saunders et al., (2011), Unlike the findings from this study, Rutkowski et al. (2002) had focused on the importance of communicative dimensions of a global virtual team. It is also noted that Second Life was widely used in most of the research studies as it known to be the largest virtual world (Boellstorff, 2015). A combination of the three factors should be incorporated in future research to obtain more comprehensive findings which will benefit the academicians.

Another recommendation will be to design a Virtual Learning Environment for the lecturers or educators to deploy virtual agents to facilitate teaching and learning process. Figure 6.1 depicts the deployment of a Kansei virtual agent in a VLE that is integrated into the Moodle platform in Higher Education Institutions (HEIs).

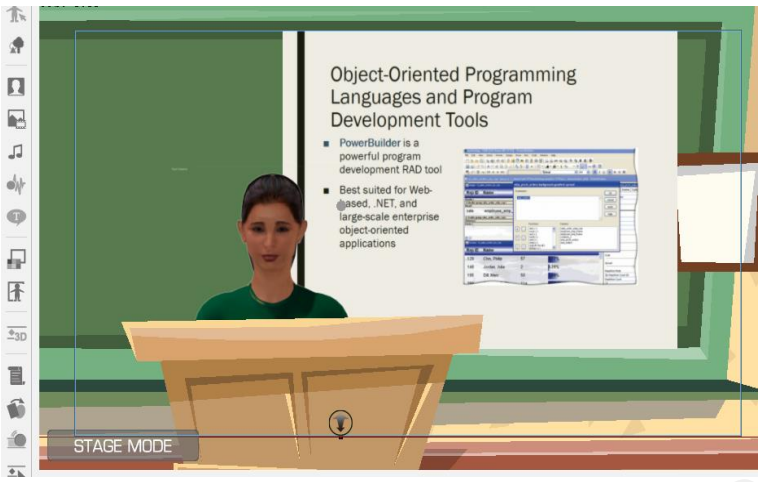


Figure 6.1: Virtual Agent as a Tutor in VLE

The deployment of virtual agents in a VLE inculcates and enhances the learning process. Besides that, the feasibility of converting such VLE into M-learning and Augmented Reality learning is also possible. This enables learning beyond the classrooms which is the niche area for 21st Century learning.

The design of the kansei virtual agent that emerged from this study can be deployed in the Holographic tele-presence systems that can project realistic, full-motion, real-time 3D images of distant people and objects into a room, along with real-time audio communication, with a level of realism rivaling physical presence. The image of the kansei virtual agent image is captured, compressed, transmitted over a broadband network, decompressed, and finally projected using laser beams in much the same way as how a conventional hologram is produced. Hence, it paves ways to a new dimension of learning technology. One can conjecture that 21st century learners' engage better with a video character compared to a 3D animated character. These recommendations will expand the existing research to a larger scale. It will also enable educators and policy makers to face the challenges in cultivating VLE deployment in HEIs.

REFERENCES

Abbattista, F., Degemmis, M., Licchelli, O., Lops, P., Semeraro, G., & *Zambetta*, F. (2002). Improving the usability of an e-commerce web site through personalization. *Recommendation and Personalization in eCommerce*, *2*, 20-29.

Adnan, H., & Redzuan, F. (2016, August). Evaluating students' emotional response in video-based learning using Kansei Engineering. In *User Science and Engineering (i-USEr), 2016 4th International Conference on* (pp. 237-242). IEEE.

Affinity Consulting (2000). The Seven Management & Planning Tools. Leadership and Team Development. Retrieved from http://www.affinitymc.com/affinity-diagram.pdf.

Ahmad, J. (2016). Technology Assisted Language Learning is a silver bullet for enhancing Language competence and performance: A Case Study. *International Journal of Applied Linguistics and English Literature*, *5*(7), 118-131.

Ahmady, A. (2010). *Rough set Kansei engineering: multiple users, multiple Kanseis* (Doctoral dissertation, Wichita State University).

Ahmed, A. A., Zakaria, N. H., & Elmi, A. H. (2014). An Evaluation of Virtual Learning Environment Readiness in Higher Education Institutions (HEIs).*Journal of Information Systewms Research and Innovation*.

Albert, W., & Tullis, T. (2013). *Measuring the user experience: collecting, analyzing, and presenting usability metrics*. Newnes.

American Library Association. (2000). Information literacy competency standards for higher education. Retrieved from http://hdl.handle.net/10150/105645.

Andrews, D., Nonnecke, B., & Preece, J. (2003). Electronic survey methodology: A case study in reaching hard-to-involve Internet users. *International journal of human-computer interaction*, *16*(2), 185-210.

Artacho-Ramirez, M. A., Diego-Mas, J. A., & Alcaide-Marzal, J. (2008). Influence of the mode of graphical representation on the perception of product aesthetic and emotional features: An exploratory study. *International Journal of Industrial Ergonomics*, *38*(11), 942-952.

Barak, M. (2016). Science teacher education in the twenty-first century: a pedagogical framework for technology-integrated social constructivism. *Research in Science Education*, 1-21.

Barrett, L. F. (2006). Are emotions natural kinds?. *Perspectives on psychological science*, *1*(1), 28-58.

Bates, J. (1994). The role of emotion in believable agents. *Communications of the ACM*, *37*(7), 122-125.

Baylor, A. L. (2009). Promoting motivation with virtual agents and avatars: role of visual presence and appearance. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1535), 3559-3565.

Becker-Asano, C. (2008). *WASABI: Affect simulation for agents with believable interactivity* (Vol. 319). IOS Press

Bello, O. W., Ehira, D. N., & Ayeni, J. K. (2014, October). Design of a Synchronous Virtual Learning System. In *Adaptive Science & Technology (ICAST), 2014 IEEE 6th International Conference on* (pp. 1-5). IEEE.

Bentivegna, D. C., & Atkeson, C. G. (2001). Learning from observation using primitives. In *Robotics and Automation, 2001. Proceedings 2001 ICRA. IEEE International Conference on* (Vol. 2, pp. 1988-1993). IEEE.

Bickmore, T. W., & Picard, R. W. (2005). Establishing and maintaining long-term human-computer relationships. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *12*(2), 293-327.

Bidin, S. A. H., Lokman, A. M., Mohd, W. A. R. W., & Tsuchiya, T. (2017). Initial Intervention Study of Kansei Robotic Implementation for Elderly. *Procedia Computer Science*, *105*, 87-92.

Boellstorff, T. (2015). *Coming of age in Second Life: An anthropologist explores the virtually human*. Princeton University Press.

Bosse, T., & De Lange, F. P. (2008, December). Development of virtual agents with a theory of emotion regulation. In *Proceedings of the 2008 IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology-Volume 02* (pp. 461-468). IEEE Computer Society.

Bosse, T., Pontier, M., Siddiqui, G. F., & Treur, J. (2007, January). Incorporating emotion regulation into virtual stories. In *Intelligent Virtual Agents* (pp. 339-347). Springer Berlin Heidelberg.

Broadie, S. (1991). Ethics with Aristotle. Oxford University Press, UK.

Button, K. S., Ioannidis, J. P., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S., & Munafò, M. R. (2013). Power failure: why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*, *14*(5), 365-376.

Charoenpit, S., Chevakidagarn, S., & Ohkura, M. (2014). A New E-Learning System Focusing on Emotional Aspect. 日本感性工学会論文誌, 13(1), 117-125.

Childs, T., Agouridas, V., Barnes, C., & Henson, B. (2006). Controlled appeal product design: a life cycle role for affective (Kansei) engineering. *Proceedings of LCE2006*, 537-542.

Choi, J. I., & Hannafin, M. (1995). Situated cognition and learning environments: Roles, structures, and implications for design. *Educational technology research and development*, *43*(2), 53-69.

Chou, S. W., & Liu, C. H. (2005). Learning effectiveness in a Web-based virtual learning environment: a learner control perspective. *Journal of computer assisted learning*, *21*(1), 65-76.

Chuah, K. M., CHEN, C. J., & TEH, C. S. (2008). Kansei Engineering Concept in Instructional Design. A Novel Perspective in Guiding the Design of Instructional Materials. In *International Cyberspace Conference of Ergonomics* (Vol. 5).

Cobb, P., & Jackson, K. (2011). Towards an Empirically Grounded Theory of Action for Improving the Quality of Mathematics Teaching at Scale. *Mathematics Teacher Education and Development*, *13*(1), 6-33.

Cohen, L., Manion, L., & Morrison, K. (2013). *Research methods in education*. Routledge.

Costello, B., & Edmonds, E. (2009, December). A tool for characterizing the experience of play. In *Proceedings of the Sixth Australasian Conference on Interactive Entertainment* (p. 2). ACM.

Cowell, A. J., & Stanney, K. M. (2003, September). Embodiment and interaction guidelines for designing credible, trustworthy embodied conversational agents. In *International Workshop on Intelligent Virtual Agents* (pp. 301-309). Springer Berlin Heidelberg.

Creswell, John W. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications, 2013.

Crilly, N., Moultrie, J., & Clarkson, P. J. (2004). Seeing things: consumer response to the visual domain in product design. *Design studies*, *25*(6), 547-577.

De Sousa, R. (2004). Emotions: What I know, what I'd like to think I know, and what I'd like to think. *Thinking about feeling: Contemporary philosophers on emotion*, 61-75.

De Sousa, R. (2010). The mind's Bermuda Triangle: Philosophy of emotions and empirical science. *The Oxford Handbook of Philosophy of Emotion. Oxford University Press, Oxford*, 95-117.

Desmet, P. (2003). A multilayered model of product emotions. *The design journal*, *6*(2), 4-13.

Desmet, P., & Hekkert, P. (2007). Framework of product experience. *International journal of design*, *1*(1).

Desmet, P., Overbeeke, K., & Tax, S. (2001). Designing products with added emotional value: Development and appllcation of an approach for research through design. *The design journal*, *4*(1), 32-47.

Dias, J., Mascarenhas, S., & Paiva, A. (2014). Fatima modular: Towards an agent architecture with a generic appraisal framework. In *Emotion Modeling* (pp. 44-56). Springer International Publishing.

Dieterle, E., & Clarke, J. (2007). Multi-user virtual environments for teaching and learning. *Encyclopedia of multimedia technology and networking*, *2*, 1033-44.

Doumanis, I. (2013). *Evaluating humanoid embodied conversational agents in mobile guide applications* (Doctoral dissertation, Middlesex University).

Ekman, P. (1999). Facial expressions. *Handbook of cognition and emotion*, *16*, 301-320.

Ekman, P., & Friesen, W. V. (1972). Hand movements. *Journal of communication*, *22*(4), 353-374.

El-Nasr, M. S., Yen, J., & Ioerger, T. R. (2000). Flame—fuzzy logic adaptive model of emotions. *Autonomous Agents and Multi-agent systems*, *3*(3), 219-257.

Feng, J., Song, H., & Li, Y. (2012). Intelligent Virtual Agents Architecture in Unknown Environment. *International Journal of Computer Science Issues(IJCSI)*, *9*(6).

Fincher, S., & Petre, M. (Eds.). (2004). *Computer science education research*. CRC Press.

Fincher, S., Petre, M., & Clark, M. (Eds.). (2001). *Computer science project work: principles and pragmatics*. Springer Science & Business Media.

Fitzsimons, S. (2012). *An Exploration of Teaching and Learning in a Virtual World in the Context of Higher Education* (Doctoral dissertation, Dublin City University. School of Education Studies).

Frijda, N. H. (2007). *The laws of emotion*. Lawrence Erlbaum Associates Publishers.

Frijda, N. H., Kuipers, P., & Ter Schure, E. (1989). Relations among emotion, appraisal, and emotional action readiness. *Journal of personality and social psychology*, *57*(2), 212

Gabbard, J. L. (1997). *A taxonomy of usability characteristics in virtual environments* (Doctoral dissertation, Virginia Polytechnic Institute and State University).

Gaver, W. W., & Mandler, G. (1987). Play it again Sam: On liking music. *Cognition and Emotion*, *1*, 259-282.

Gebhard, P. (2005, July). ALMA: a layered model of affect. In *Proceedings of the fourth international joint conference on Autonomous agents and multiagent systems* (pp. 29-36). ACM.

Gerhard, M. (2003). A hybrid avatar/agent model for educational CVEs. *PhD diss., PhD Thesis, Leeds Metropolitan University*

Gibbs, R. W. (2003). Embodied experience and linguistic meaning. *Brain and language*, *84*(1), 1-15.

Gil Ortega, M. C., & Falconer, L. (2015). Learning spaces in virtual worlds: bringing our distance students home. *Journal of Applied Research in Higher Education*, *7*(1), 83-98.

Gillioz, Christelle, Johnny RJ Fontaine, Cristina Soriano, and Klaus R. Scherer. "Mapping Emotion Terms into Affective Space." *Swiss journal of psychology* (2016).

Goldman, A. I. (2012). A moderate approach to embodied cognitive science. *Review of Philosophy and Psychology*, *3*(1), 71-88.

Grapragasem, S., Krishnan, A., & Mansor, A. N. (2014). Current trends in Malaysian higher education and the effect on education policy and practice: An overview. *International Journal of Higher Education*, *3*(1), p85.

Gratch, J., & Marsella, S. (2004). A domain-independent framework for modeling emotion. *Cognitive Systems Research*, *5*(4), 269-306

Gratch, J., & Marsella, S. (2004, July). Evaluating the modeling and use of emotion in virtual humans. In *Proceedings of the Third International Joint Conference on Autonomous Agents and Multiagent Systems-Volume 1* (pp. 320-327). IEEE Computer Society.

Gratch, J., Morency, L. P., Scherer, S., Stratou, G., Boberg, J., Koenig, S., ... & Rizzo, A. A. (2013). User-state sensing for virtual health agents and telehealth applications. In *MMVR* (pp. 151-157).

Griffith, J. L., & Griffith, M. E. (2002). *Encountering the sacred in psychotherapy: How to talk with people about their spiritual lives*. New York: Guilford Press.

Haake, M., & Gulz, A. (2008). Visual Stereotypes and Virtual Pedagogical Agents. *Ed*

Harada, A. (1998). On the Definition of Kansei. In Modeling the Evaluation Structure of Kansei Conference. Volume 2, pp. 22.

Harley, J. M., Poitras, E. G., Jarrell, A., Duffy, M. C., & Lajoie, S. P. (2016). Comparing virtual and location-based augmented reality mobile learning: emotions and learning outcomes. *Educational Technology Research and Development*, *64*(3), 359-388.

Heidig, S., & Clarebout, G. (2011). Do pedagogical agents make a difference to student motivation and learning?. *Educational Research Review*, *6*(1), 27-54.

Hekkert, P. (2006). Design aesthetics: principles of pleasure in design. *Psychology science*, *48*(2), 157.

Hekkert, P., Snelders, D., & Wieringen, P. C. (2003). 'Most advanced, yet acceptable': Typicality and novelty as joint predictors of aesthetic preference in industrial design. *British journal of psychology*, *94*(1), 111-124.

Heller, B., & Procter, M. (2014). Conversational Agents in Virtual Worlds: Immersion and the Conversational Record. *Inter-Disciplinary. Net. Retrieved from 2014*.

Hertzum, M., Andersen, H. H., Andersen, V., & Hansen, C. B. (2002). Trust in information sources: seeking information from people, documents, and virtual agents. *Interacting with Computers*, *14*(5), 575-599.

Hevner, A., & Chatterjee, S. (2010). Design science research in information systems. In *Design research in information systems* (pp. 9-22). Springer US.

Ijaz, K., Bogdanovych, A., & Trescak, T. (2016). Virtual worlds vs books and video

Ishihara, I., Nishino, T., Matsubara, Y., Tsuchiya, T., Kanda, F., & Inoue, K. (2005). Kansei And Product Development (In Japanese), Ed. M.

Ishihara, S., & Nagamachi, M. (1999). Analysis of individual differences in kansei evaluation data based on cluster analysis. *Kansei Engineering International*, *1*(1), 49-58.

Ivan, I., & Ciurea, C. (2009, February). Quality characteristics of collaborative systems. In *2009 Second International Conferences on Advances in Computer-Human Interactions* (pp. 164-168). IEEE.

Jiang, H., & Vidal, J. M. (2006). From rational to emotional agents. In *Proceedings of the AAAI Workshop on Cognitive Modeling and Agent-based Social Simulation*.

Johnson, J. (2013). *Designing with the mind in mind: simple guide to understanding user interface design guidelines*. Elsevier.

Johnson, W. L., & Lester, J. C. (2016). Face-to-face interaction with pedagogical agents, twenty years later. *International Journal of Artificial Intelligence in Education*, *26*(1), 25-36.

Karsakov, A., Bilyatdinova, A., & Hoekstra, A. G. (2014, October). 3D virtual environment for project-based learning. In *Application of Information and Communication Technologies (AICT), 2014 IEEE 8th International Conference on* (pp. 1-5). IEEE.

Keller, J. M. (1987). Development and use of the ARCS model of instructional design. *Journal of instructional development*, *10*(3), 2-10.

Keller, J., & Suzuki, K. (2004). Learner motivation and e-learning design: A multinationally validated process. *Journal of educational Media*, *29*(3), 229-239.

Khan, R. F. (2011). *The effect of embodied agents within the user interface* (Doctoral dissertation, University of Manchester).

Khan, R. F., & Sutcliffe, A. (2014). Attractive agents are more persuasive. *International Journal of Human-Computer Interaction*, *30*(2), 142-150.

Khan, R., & De Angeli, A. (2007, September). Mapping the demographics of virtual humans. In *Proceedings of the 21st British HCI Group Annual Conference on People and Computers: HCI... but not as we know it-Volume 2* (pp. 149-152). British Computer Society.

Kim, Y., & Baylor, A. L. (2016). Research-based design of pedagogical agent roles: a review, progress, and recommendations. *International Journal of Artificial Intelligence in Education*, *26*(1), 160-169.

Kim, Y., Baylor, A. L., & Shen, E. (2007). Pedagogical agents as learning companions: the impact of agent emotion and gender. *Journal of Computer Assisted Learning*, *23*(3), 220-234.

Knuuttila, S. (2004). *Emotions in ancient and medieval philosophy*. Clarendon Press.

Kopp, S., Gesellensetter, L., Krämer, N. C., & Wachsmuth, I. (2005, January). A conversational agent as museum guide–design and evaluation of a real-world application. In *Intelligent Virtual Agents* (pp. 329-343). Springer Berlin Heidelberg.

Korhonen, H., Montola, M., & Arrasvuori, J. (2009, October). Understanding playful user experience through digital games. In *International Conference on Designing Pleasurable Products and Interfaces* (Vol. 2009).

Kramer, M., Yaghoubzadeh, R., Kopp, S., & Pitsch, K. (2013). A conversational virtual human as autonomous assistant for elderly and cognitively impaired users? Social acceptability and design considerations. *Lecture Notes in Informatics (LNI)*.

Krämer, N. C., & Bente, G. (2010). Personalizing e-learning. The social effects of pedagogical agents. *Educational Psychology Review*, *22*(1), 71-87.

Krathwohl, D. R. (1993). *Methods of educational and social science research: An integrated approach*. Longman/Addison Wesley Longman.

Kumar, J. A., Muniandy, B., & Yahaya, W. A. J. W. (2016). Emotional Design in Multimedia: Does Gender and Academic Achievement Influence Learning Outcomes?. *Malaysian Online Journal of Educational Technology*, *4*(3), 37-50.

Leighton, S. R. (1982). Aristotle and the Emotions. *Phronesis*, 144-174.

Leonard, D. (2003). Live in your world, play in ours: Race, video games, and consuming the other. *Studies in media & information literacy education*, *3*(4), 1-9.

Levy, P. (2013). Beyond kansei engineering: The emancipation of kansei design. *International Journal of Design*, *7*(2).

Lewis, J. L., & Sheppard, S. R. (2006). Culture and communication: can landscape visualization improve forest management consultation with indigenous communities?. *Landscape and Urban Planning*, *77*(3), 291-313.

Liaw, S. Y., Wong, L. F., Lim, E. Y. P., Ang, S. B. L., Mujumdar, S., Ho, J. T. Y., ... & Ang, E. N. K. (2016). Effectiveness of a web-based simulation in improving nurses' workplace practice with deteriorating ward patients: A pre-and postintervention study. *Journal of medical Internet research*, *18*(2).

Liew, T. W., Tan, S. M., & Jayothisa, C. (2013). The Effects of Peer-Like and Expert-Like Pedagogical Agents on Learners' Agent Perceptions, Task-Related Attitudes, and Learning Achievement. *Educational Technology & Society*, *16*(4), 275-286.

Lim, T., Fadzil, M., & Mansor, N. (2011). Mobile learning via SMS at Open University Malaysia: Equitable, effective, and sustainable. *The International Review of Research in Open and Distributed Learning*, *12*(2), 122-137.

Liu, M., Traphagan, T., Huh, J., Koh, Y. I., Choi, G., & McGregor, A. (2008). Designing websites for ESL learners: A usability testing study. *CALICO Journal*, *25*(2), 207-240.

Lokman, A. M. (2010). Design & emotion: The kansei engineering methodology. *Malaysian Journal of Computing*, *1*(1), 1-11.

Lokman, A. M., & Kamaruddin, K. A. (2010, December). Kansei affinity cluster for affective product design. In *User Science and Engineering (i-USEr), 2010 International Conference on* (pp. 38-43). IEEE.

Lokman, A. M., & Nagamachi, M. (2009). Validation of kansei engineering adoption in e-commerce web design. *Kansei Engineering International Journal*, *9*(1), 21-27.

Lokman, A. M., & Noor, N. L. (2006, August). Kansei Engineering concept in e-commerce website. In *Proceedings of the International Conference on Kansei Engineering and Intelligent Systems* (pp. 117-124).

Lokman, A. M., Awang, A. A., Zaili, R. A. M., & Fathir, M. F. M. (2016). Designing Racial Unity Through Films: The Kansei Engineering Approach. *Advanced Science Letters*, *22*(5-6), 1368-1372.

Lokman, A. M., Mustafa, A. M., Fathir, M. F. M., & Rahman, A. R. A. (2014, September). Avatar warrior: A Kansei analysis. In *User Science and Engineering (i-USEr), 2014 3rd International Conference on* (pp. 24-29). IEEE.

Lokman, A. M., Noor, N. L. M., & Nagamachi, M. (2009, May). ExpertKanseiWeb: A tool to design Kansei website. In *International Conference on Enterprise Information Systems* (pp. 894-905). Springer Berlin Heidelberg.

Looi C.K, Zhang B., Chen W., Seow P., Chia G., Norrist C. and Soloway ‡ E., Mobile Inquiry Learning Experience for Primary Science Students: A Study of Learning Effectiveness, Journal of Computer Assisted Learning, pp. 1-19

Luck, M., & Aylett, R. (2000). Applying artificial intelligence to virtual reality: Intelligent virtual environments. *Applied Artificial Intelligence*, *14*(1), 3-32.

Mahlke, S., & Thüring, M. (2007, April). Studying antecedents of emotional experiences in interactive contexts. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 915-918). ACM.

Malhotra, N., & Krosnick, J. A. (2007). The effect of survey mode and sampling on inferences about political attitudes and behavior: Comparing the 2000 and 2004

ANES to Internet surveys with nonprobability samples.*Political Analysis*, *15*(3), 286-323.

Marcus, A. (2015). Culture Class Versus Culture Clash. In *HCI and User-Experience Design* (pp. 7-12). Springer London.

Marcus, A., & Gould, E. W. (2000). Crosscurrents: cultural dimensions and global Web user-interface design. *interactions*, *7*(4), 32-46.

Marcus, A., Abromowitz, S., & Abulkhair, M. F. (2013). Design, User Experience, and Usability. In *User Experience in Novel Technological Environments: Second Int. Conf., DUXU* (pp. 21-26).

Marsella, S., & Gratch, J. (2014). Computationally modeling human emotion. *Communications of the ACM*, *57*(12), 56-67.

Marsh, H. W., Balla, J. R., & McDonald, R. P. (1988). Goodness-of-fit indexes in confirmatory factor analysis: The effect of sample size.*Psychological bulletin*, *103*(3), 391.

Matsubara, Y., Nagamachi, M., 1997. Kansei virtual reality technology and evaluation on kitchen design. Manuf. Hybrid Automation-I, pp. 81–84.

Matsubara, Y., Wilson, J. R., & Nagamachi, M. (1998, July). Comparative study of Kansei engineering analysis between Japan and BRITAIN. In *Proceedings of the 6th International Conference on Human Aspects of Advanced Manufacturing: Agility and Hybrid Automation, Hong Kong* (pp. 5-8).

May, H., & Keay, J. (2017). Using Communities of Practice to Internationalise Higher Education: Practical and Strategic Considerations. In *Communities of Practice* (pp. 73-97). Springer Singapore.

McArdle, G., Monahan, T., Bertolotto, M., & Mangina, E. (2004). A web-based multimedia virtual reality environment for e-learning. In *Proceedings of Eurographics* (Vol. 4, No. 1, pp. 9-13).

McCarthy, C. J., Lambert, R. G., Crowe, E. W., & McCarthy, C. J. (2010). Coping, stress, and job satisfaction as predictors of advanced placement statistics teachers' intention to leave the field. *Nassp Bulletin*, *94*(4), 306-326.

McIlhagga, M., & George, P. (1999). Communicating meaningful emotional information in a virtual world. In *Proc. of the Workshop on Affect in Interactions-Towards a new Generation of Interfaces, held in conjunction with the 3rd i3 Annual Conference, Siena, Italy* (pp. 150-155).

Mehrabian, A. (1996). Analysis of the Big-five Personality Factors in Terms of the PAD Temperament Model. *Australian Journal of Psychology*, *48*(2), 86-92.

Mehrabian, A. (1997). Comparison of the PAD and PANAS as models for describing emotions and for differentiating anxiety from depression. *Journal of psychopathology and behavioral assessment*, *19*(4), 331-357

Miksatko, J., Kipp, K. H., & Kipp, M. (2010, September). The persona zero-effect: Evaluating virtual character benefits on a learning task with repeated interactions. In *International Conference on Intelligent Virtual Agents* (pp. 475-481). Springer Berlin Heidelberg.

Moreno, R., & Flowerday, T. (2006). Students' choice of animated pedagogical agents in science learning: A test of the similarity-attraction hypothesis on gender and ethnicity. *Contemporary educational psychology*, *31*(2), 186-207.

Morgado, L., & Gaspar, G. (2003, January). Emotion in intelligent virtual agents: The flow model of emotion. In *Intelligent Virtual Agents* (pp. 31-38). Springer Berlin Heidelberg.

Nagamachi, M. (1992). Kansei Engineering And Its Method. Management System, 2 (2), pp.97-105.

Nagamachi, M. (1995). Kansei engineering: a new ergonomic consumer-oriented technology for product development. *International Journal of industrial ergonomics*, *15*(1), 3-11.

Nagamachi, M. (1999). Kansei Engineering: A New Consumer-Oriented Technology For Product Development. In W. Karwowski and W. S. Marras (Eds.), The Occupational Ergonomics Handbook, CRC Press, Chap. 102, pp.1835-1848.

Nagamachi, M. (2002). Kansei engineering as a powerful consumer-oriented technology for product development. *Applied ergonomics*, *33*(3), 289-294.

Nagamachi, M. (2003). The story of Kansei Engineering (in Japanese) (Vol. 6). Tokyo: Japanese Standards Association.

Nagamachi, M. (2010). Methods of Kansei/Affective engineering and specific cases of kansei products. *Kansei/Affective Engineering*, 13-30.

Nagamachi, M. (2016). Home applications of Kansei engineering in Japan: An overview. *Gerontechnology*, *15*(4), 209-215.

Nagamachi, M. (Ed.). (2010). *Kansei/affective engineering*. CRC Press.

Nagamachi, M., & Lokman, A. M. (2015). *Kansei Innovation: Practical Design Applications for Product and Service Development* (Vol. 32). CRC Press.

Nagamachi, M., Okazaki, Y., & Ishikawa, M. (2006). Kansei engineering and application of the rough sets model. *Proceedings of the Institution of Mechanical Engineers, Part I: Journal of Systems and Control Engineering*, *220*(8), 763-768.

Nagaraj, S., Lee, K. H., Goh, K. L., & Tey, N. P. (2016). Malaysian Adolescents Not in School: The Nexus of Education, Work and Gender. *Malaysian Journal of Economic Studies*, *53*(1), 87.

Nagasawa, S. (2004). Present State of Kansei Engineering in Japan. 2004 IEEE International Conference. 1(1), pp.333-338.

Nagashima, T. (2013, July). The fundamentals of Kansei engineering and a methodological problem: Human internal information and empathy. In *Biometrics and Kansei Engineering (ICBAKE), 2013 International Conference on* (pp. 332-335). IEEE.

Nagashima, T., Tanaka, H., & Uozumi, T. (2008). An overview of Kansei engineering: a proposal of Kansei informatics toward realising safety and pleasantness of individuals in information network society. *International Journal of Biometrics*, *1*(1), 3-19.

Ng, A. K., Chan, L. K., & Lau, H. Y. (2016, July). Depth Perception in Virtual Environment: The Effects of Immersive System and Freedom of Movement. In *International Conference on Virtual, Augmented and Mixed Reality* (pp. 173-183). Springer International Publishing.

Nielsen, J. (2013). Usability Heuristics for User Interface Design. 2013.

Nikolaou, A., & Tsolakidis, C. (2013). Three dimensional virtual environments as a tool for development of personal learning networks. *International Journal of Emerging Technologies in Learning (iJET)*, *8*(2013), 79-88.

Norman, D. A. (2004). *Emotional design: Why we love (or hate) everyday things*. Basic books.

Norman, D. A. (2005). *Emotional design: Why we love (or hate) everyday things*. Basic books.

Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion.*Trends in cognitive sciences*, *9*(5), 242-249.

O'Connor, C. (2016). Embodiment and the Construction of Social Knowledge: Towards an Integration of Embodiment and Social Representations Theory. *Journal for the Theory of Social Behaviour*.

Okamoto, R. H., Nishino, T., & Nagamachi, M. (2007). Comparison between statistical and lower/upper approximations rough sets models for beer can design and prototype evaluation. In *The 10th International Conference on Quality Management and Operation Development (QMOD'07), Sweden: Linköping University Electronic Press, ISSN* (pp. 1650-3740).

O'Rourke, N., Psych, R., & Hatcher, L. (2013). *A step-by-step approach to using SAS for factor analysis and structural equation modeling*. Sas Institute.

Ortony, A., Clore, G. L., & Collins, A. (1990). *The cognitive structure of emotions*. Cambridge university press.

Overbeeke, K. C. J., & Wensveen, S. A. G. (2003) From perception to experience, from affordances to irresistibles. In B. Hannington and J. Forlizzi (Eds.), *Proceedings of 2003 International Conference on Designing Pleasurable Products and Interfaces* (pp. 92-97). Pittsburgh: ACM Press.

Page, T. (2014). Product attachment and replacement: implications for sustainable design. *International Journal of Sustainable Design*, *2*(3), 265-282.

Pan, F., Mulkar, R., & Hobbs, J. R. (2006, July). Learning event durations from event descriptions. In *Proceedings of the 21st International Conference on Computational Linguistics and the 44th annual meeting of the Association for Computational Linguistics* (pp. 393-400). Association for Computational Linguistics.

Páramo, M. F., Tinajero, C., & Rodríguez, M. S. (2015). Levels Of Adjustment To College, Gender And Academic Achievement In First-Year Spanish Students. *Education Applications & Developments Advances in Education and Educational Trends Series Edited by: Mafalda Carmo*, 34.

Pena, L., Peña, J. M., & Ossowski, S. (2011, October). Representing emotion and mood states for virtual agents. In *German Conference on Multiagent System Technologies* (pp. 181-188). Springer Berlin Heidelberg.

Piccoli, G., Ahmad, R., & Ives, B. (2001). Web-based virtual learning environments: A research framework and a preliminary assessment of effectiveness in basic IT skills training. *MIS Quarterly*, 401-426.

Plutchik, R. (1980). A general psychoevolutionary theory of emotion. *Theories of emotion*, *1*(3-31), 4.

Plutchik, R., & Kellerman, H. (Eds.). (2013). *The measurement of emotions* (Vol. 4). Academic Press

Poon, W. C., Lock-Teng Low, K., & Gun-Fie Yong, D. (2004). A study of Web-based learning (WBL) environment in Malaysia. *International Journal of Educational Management*, *18*(6), 374-385.

Powell, W. B., Marar, A., Gelfand, J., & Bowers, S. (2002). Implementing real-time optimization models: A case application from the motor carrier industry. *Operations Research, 50*(4), 571-581.

Premack, D. G.; Woodruff, G. (1978). "Does the chimpanzee have a theory of mind?". *Behavioral and Brain Sciences*.

Ramachandiran, C. R. (2011). Efficacy of blog to improve multi-level interactions in a college setting. *IJCA Special Issue on Wireless Information Networks & Business Information System*, *2*, 26-29.

Ramachandran, V. S., & Hirstein, W. (1999). The science of art: A neurological theory of aesthetic experience. *Journal of consciousness Studies*, *6*(6-7), 15-51.

Rasiah, R. R. V. (2015). The Impact of Holistic Education Approaches on First-Year Experience of Business Undergraduates: Promoting Interactive and Creative Learning Environments. In *Taylor's 7th Teaching and Learning Conference 2014 Proceedings* (pp. 311-321). Springer Singapore.

Reason, M., Jola, C., Kay, R., Reynolds, D., Kauppi, J. P., Grobras, M. H., & Pollick, F. E. (2016). Spectators' aesthetic experience of sound and movement in dance performance: A transdisciplinary investigation. *Psychology of Aesthetics, Creativity, and the Arts*, *10*(1), 42.

Redzuan, F., Lokman, A. M., Othman, Z. A., & Abdullah, S. (2011, November). Kansei Design Model for Engagement in Online Learning: A Proposed Model. In *International Conference on Informatics Engineering and Information Science* (pp. 64-78). Springer Berlin Heidelberg.

Reid, D. (2004). A model of playfulness and flow in virtual reality interactions. *Presence: Teleoperators and Virtual Environments*, *13*(4), 451-462.

Reigeluth, C. M. (Ed.). (1999). *Instructional-design theories and models: A new paradigm of instructional theory* (Vol. 2). Routledge.

Reinmoeller, P. (2002). Emergence of pleasure: Communities of interest and new luxury products. *Pleasure with products: Beyond usability*, 125-134.

Rickel, J. (2001, September). Intelligent virtual agents for education and training: Opportunities and challenges. In *Intelligent Virtual Agents* (pp. 15-22). Springer Berlin Heidelberg.

Ricketts, B. (2011). The role of simulation for learning within pre-registration nursing education—a literature review. *Nurse Education Today*, *31*(7), 650-654.

Riff, D., Lacy, S., & Fico, F. (2014). *Analyzing media messages: Using quantitative content analysis in research*. Routledge.

Russell JA.(1980). Circumplex Model of Affect. Journal of Personality and Social Psychology. 1980;39(6):1161-1178.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological review*, *110*(1), 145.

Rutkowski, A. F., Vogel, D. R., Van Genuchten, M., Bemelmans, T. M., & Favier, M. (2002). E-collaboration: The reality of virtuality. *IEEE Transactions on professional communication*, *45*(4), 219-230.

Saeed, K., & Nagashima, T. (Eds.). (2012). *Biometrics and Kansei engineering*. Springer Science & Business Media.

Saunders, C., Rutkowski, A. F., Genuchten van, M., Vogel, D., & Orrego, J. M. (2011). Virtual space and place: Theory and test. *MIS Quarterly*, 1079-1098.

Savin-Baden, M. (2013). Spaces in between us: a qualitative study into the impact of spatial practice when learning in Second Life. *London Review of Education*, *11*(1), 59-75.

Scherer, K. R. (1994). Toward a concept of "modal emotions". *The nature of emotion: Fundamental questions*, 25-31.

Scherer, K. R. (2005). What are emotions? And how can they be measured?. *Social science information*, *44*(4), 695-729.

Schütte*, S. T., Eklund, J., Axelsson, J. R., & Nagamachi, M. (2004). Concepts, methods and tools in Kansei engineering. *Theoretical Issues in Ergonomics Science*, *5*(3), 214-231.

Schütte, S. (2005). *Engineering emotional values in product design: kansei engineering in development* (Doctoral dissertation, Institutionen för konstruktions-och produktionsteknik).

Schütte, S., Schütte, R., & Eklund, J. (2005). Affective Values of Lift Trucks: an Application of Kansei Engineering.

See Yin Lim, J., Agostinho, S., Harper, B., & Chicharo, J. (2014). The engagement of social media technologies by undergraduate informatics students for academic purpose in Malaysia. *Journal of Information, Communication and Ethics in Society*, *12*(3), 177-194.

Sein, M. K., Henfridsson, O., Purao, S., Rossi, M., & Lindgren, R. (2011). Action design research. MIS quarterly, 37-56.

Shen, L., Wang, M., & Shen, R. (2009). Affective e-Learning: Using" Emotional" Data to Improve Learning in Pervasive Learning Environment. *Educational Technology & Society*, *12*(2), 176-189.

Smith, C. A., & Kirby, L. D. (2001). Toward delivering the promise of appraisal theory. In K. R. Scherer, A. Schorr & T. Johnson (Eds.), *Appraisal processes in emotion* (pp. 121-140). Oxford: Oxford University Press.

Smith, C. A., Tong, E. M., & Ellsworth, P. C. (2016). The differentiation of positive emotional experience as viewed through the lens of appraisal theory. *Handbook of positive emotions*, 11-27.

Soda, S., Nakamura, M., Matsumoto, S., Izumi, S., Kawaguchi, H., & Yoshimoto, M. (2012, December). Implementing virtual agent as an interface for smart home voice control. In *Software Engineering Conference (APSEC), 2012 19th Asia-Pacific* (Vol. 1, pp. 342-345). IEEE.

Sodian, B., & Kristen, S. (2010). Theory of mind. In *Towards a theory of thinking* (pp. 189-201). Springer Berlin Heidelberg

Spillers, F. (2004). Emotion as a cognitive artifact and the design implications for products that are perceived as pleasurable. *Experience Dynamics*.

Spool, J. M. (2004). The KJ-technique: A group process for establishing priorities. *User interface engineering*.

Stienstra, J. T. (2016). Designing for Respectful Embodied Interactions.

Strange, C. C., & Banning, J. H. (2015). *Designing for Learning: Creating Campus Environments for Student Success*. John Wiley & Sons.

Taharim, N. F., Lokman, A. M., & Isa, W. A. R. W. M. (2016, August). Emotion and Playful Elements in Mobile Learning. In *Next Generation Mobile Applications, Security and Technologies (NGMAST), 2016 10th International Conference on* (pp. 72-76). IEEE.

Taharim, N. F., Lokman, A. M., Isa, W. A. R. W. M., & Noor, N. L. M. (2014, September). A Theoretical Framework of Playful Interaction in Mobile Learning. In *Next Generation Mobile Apps, Services and Technologies (NGMAST), 2014 Eighth International Conference on* (pp. 19-23). IEEE.

Taharim, N. F., Lokman, A. M., Isa, W. A. R. W. M., & Noor, N. L. M. (2015). Investigating feasibility of mobile learning (M-learning) for history lesson. In *International Colloquium of Art and Design Education Research (i-CADER 2014)* (pp. 541-550). Springer Singapore.

Taharim, N. F., Mohd Lokman, A., Isa, W. M., Rahim, W. A., Noor, M., & Laila, N. (2013, December). A relationship model of playful interaction, interaction design, kansei engineering and mobile usability in mobile learning. In *Open Systems (ICOS), 2013 IEEE Conference on* (pp. 22-26). IEEE.

Tan, W., Xu, W., Yang, F., Xu, L., & Jiang, C. (2013). A framework for service enterprise workflow simulation with multi-agents cooperation. *Enterprise Information Systems*, *7*(4), 523-542.

Tayebinik, M., & Puteh, M. (2013). Blended Learning or E-learning?.*Tayebinik, M., & Puteh, M.(2012). Blended Learning or E-learning*, 103-110.

Thagard, P. (2011). The brain is wider than the sky: Analogy, emotion, and allegory. *Metaphor and Symbol*, *26*(2), 131-142.

Thorsteinsson, G. (2013). Developing an Understanding of the Pedagogy of Using a Virtual Reality Learning Environment (VRLE) to Support Innovation Education. *The Routledge International Handbook of Innovation Education. Edited by LV Shavinina. Oxford: Routledge. ISBN-10*, *415682215*, 456-470.

Thorsteinsson, G. (2013). Examining Teachers' Role In Using Virtual Learning Environment To Support Conventional Education In Icelandic Schools. *i-Manager's Journal of Educational Technology*, *10*(2), 15

Tomlinson, B., & Blumberg, B. (2003). Alphawolf: Social learning, emotion and development in autonomous virtual agents. In *Innovative Concepts for Agent-Based Systems* (pp. 35-45). Springer Berlin Heidelberg.

Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection.-use-video-games-propaganda, Retrieved 7 October, 2011.

Vaishnavi, V. K., & Kuechler, W. (2015). *Design science research methods and patterns: innovating information and communication technology*. Crc Press.

Van Rompay, T., Hekkert, P., Saakes, D., & Russo, B. (2005). Grounding abstract object characteristics in embodied interactions. *Acta psychologica*,*119*(3), 315-351.

Veletsianos, G., & Russell, G. S. (2014). Pedagogical agents. In *Handbook of research on educational communications and technology* (pp. 759-769). Springer New York.

Von Alan, R. H., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS quarterly*, *28*(1), 75-105.

Westbrook, R. A. (1987). Product/consumption-based affective responses and postpurchase processes. *Journal of marketing research*, 258-270.

Wheeler, A. (2012). *Designing brand identity: an essential guide for the whole branding team*. John Wiley & Sons.

Wiersma, W. (Ed.). (2000). *Research methods in education: An introduction* (Vol. 1). Allyn & Bacon.

Wu, Y., Samant, D., Squibbs, K., Chaet, A., Morshedi, B., & Barnes, L. E. (2014, April). Design of interactive cancer education technology for Latina farmworkers. In *Systems and Information Engineering Design Symposium (SIEDS), 2014* (pp. 1-4). IEEE.

Xu, D., Huang, W. W., Wang, H., & Heales, J. (2014). Enhancing e-learning effectiveness using an intelligent agent-supported personalized virtual learning environment: An empirical investigation. *Information & Management*,*51*(4), 430-440.

Yagi, A. (2000). Engineering psychophysiology in Japan. *Engineering psychophysiology: Issues and applications*, 361-368.

Yamamoto, R., Nakashima, S., Ogawa, S., & Fukumoto, M. (2011, September). Proposal for Automated Creation of Drum's Fill-In Pattern Using Interactive Genetic Algorithm. In *Biometrics and Kansei Engineering (ICBAKE), 2011 International Conference on* (pp. 238-241). IEEE.

Yanagisawa, H., Nakano, S., & Murakami, T. (2017). A Kansei Database Framework for the Delight Design Platform. In *Advances in Affective and Pleasurable Design* (pp. 511-518). Springer International Publishing.

Yong, Y. P., Jantan, A. H., Abdullah, R. H., & Kamaruddin, A. (2016). The impact of visual design principles on classical aesthetic design for a web-based educational platform. *International Journal of Technology Enhanced Learning*, *8*(3-4), 318-339.

Zhang, L., Kong, M., & Li, Z. (2017). Emotion regulation difficulties and moral judgment in different domains: The mediation of emotional valence and arousal. *Personality and Individual Differences*, *109*, 56-60.

Zhang, P., & Li, N. (2005). The importance of affective quality. *Communications of the ACM*, *48*(9), 105-108.

LIST OF PUBLICATIONS AND PAPERS PRESENTED

Journals

- Ramachandiran, C. R., & Jomhari, N. (2015). A case study on e-learners perception and kansei experience towards pedagogical virtual agents. *Indian Journal of Science and Technology*, *8*(11).
- Ramachandiran, C. R., & Jomhari, N. (2016). Challenges faced in Pedagogical Virtual Agent Deployment: eLearner's Perspective. *Kasmera* (pp77-82). Venezula (ISSN: 0075-5222)

Conference Publication

- Ramachandiran, C. R., & Jomhari, N. (2014, September). e-Learners Kansei experience towards expert-like virtual agent: A case study. In *User Science and Engineering (i-USEr), 2014 3rd International Conference on* (pp. 36-41). IEEE.
- Ramachandiran, C. R., & Jomhari, N. (2013, July). Kansei Engineering: Emotion Exploration in Blogs. In *Biometrics and Kansei Engineering (ICBAKE), 2013 International Conference on* (pp. 7-12). IEEE.

APPENDIX A

KANSEI KEYWORDS REDUCTION FORM

Virtual Agents: Keywords

Welcome to this survey which is a part of my PhD research related to Pedagogical Virtual Agents which are visual characters used in virtual learning computer applications. Pedagogical Virtual Agents are also known as virtual tutors or online advisors.
This is an evaluation to identify the most suitable keywords to be used in the research related to Virtual Agents using the Kansei approach.

The survey will take approximately 5-10 minutes to complete.

Section A: Personal Details

Age

- ☐ below 25
- ☐ 26-35
- ☐ 36-45
- ☐ 46-55
- ☐ above 56

Gender

- ☐ Male
- ☐ Female

Profession

- ☐ Academic / Student
- ☐ Others

Section B: Kansei Keywords

Analyse each adjectives carefully and identify the adjectives that best describes the pedagogical virtual agent design which you would consider for your classes. Assume that this pedagogical agent will be used in the virtual learning environment in the Higher Education Institutions (HEIs) in Malaysia.

Adjectives for Virtual Agent design / Kansei Keywords

Please select the correct rating (1- Strongly Disagree, 2- Disagree, 3- Neutral, 4- Agree, 5-Strongly Agree)

	1	2	3	4	5
Energetic	○	○	○	○	○
Modern	○	○	○	○	○
Familiar	○	○	○	○	○
Normal	○	○	○	○	○
Plain	○	○	○	○	○
Simple	○	○	○	○	○
Adaptable	○	○	○	○	○
Encouraging	○	○	○	○	○
Motivating	○	○	○	○	○
Innovative	○	○	○	○	○
Appealing	○	○	○	○	○
Attractive	○	○	○	○	○
Vibrant	○	○	○	○	○
Effective	○	○	○	○	○
Noticeable	○	○	○	○	○
Excellent	○	○	○	○	○
Contemporary	○	○	○	○	○
Practical	○	○	○	○	○
Easy to use	○	○	○	○	○
Understandable	○	○	○	○	○
Artistic	○	○	○	○	○
Charming	○	○	○	○	○
Enchanting	○	○	○	○	○
Fascinating	○	○	○	○	○
Fashionable	○	○	○	○	○
Genuine	○	○	○	○	○
Gorgeous	○	○	○	○	○
Impressive	○	○	○	○	○
Intellectual	○	○	○	○	○
Intelligent	○	○	○	○	○
Versatile	○	○	○	○	○
Lady-like	○	○	○	○	○
Modest	○	○	○	○	○
Womanly	○	○	○	○	○
Brilliant	○	○	○	○	○

	1	2	3	4	5
Cheerful					
Enjoyable					
Pleasant					
Pleasant looking					
Beautiful					
Youthful					
Powerful					
Wise					
Adult like					
Classy					
Old fashioned					
Relaxing					
Reserved					
Rural-like					
Sensible					
Unique					
Charismatic					
Independent					
Interesting					
Clever					
Confident					
Expert					
Realistic					
Good feeling					
Well designed					
Emphasized					
Perfect					
Polished					
Precise					
Amazing					
Malaysian style					
Awesome					
Convincing					
Efficient					
Respectable					
Distinctive					
High class					

	1	2	3	4	5
Formal					
Convenient					
User friendly					
Magical					

APPENDIX B

EXPLORATORY STUDY KANSEI CHECKLIST: SINGLE AGENT

Virtual Agent Evaluation

Case Study: Virtual Agent design using Kansei Engineering

Section A: Personal Details

Age

- below 25
- 26-35
- 36-45
- 46-55
- above 56

Gender:

- Male
- Female

Section B: Kansei Words

Analyze each adjectives carefully and identify the adjectives that best describes the Virtual Agents / Pedagogical Agents shown below.

Ethnicity

- Malay
- Chinese
- Indian
- Other:

Agent 1

Kansei words - Agent 1

Please select the correct rating (1 - Strongly Disagree, 2 - Disagree, 3 - Neutral, 4 - Agree, 5 - Strongly Agree)

	1	2	3	4	5
Innovative	○	○	○	○	○
Appealing	○	○	○	○	○
Attractive	○	○	○	○	○
Vibrant	○	○	○	○	○
Effective	○	○	○	○	○
Excellent	○	○	○	○	○
Easy to use	○	○	○	○	○
Understandable	○	○	○	○	○
Impressive	○	○	○	○	○
Intellectual	○	○	○	○	○
Intelligent	○	○	○	○	○
Versatile	○	○	○	○	○
Brilliant	○	○	○	○	○
Enjoyable	○	○	○	○	○
Pleasant	○	○	○	○	○
Beautiful	○	○	○	○	○
Youthful	○	○	○	○	○
Confident	○	○	○	○	○
Expert	○	○	○	○	○
Realistic	○	○	○	○	○
Good feeling	○	○	○	○	○
Well designed	○	○	○	○	○
Awesome	○	○	○	○	○
User friendly	○	○	○	○	○
Motivation	○	○	○	○	○

APPENDIX C

CONFIRMATORY CHECKLIST FORM: SINGLE AGENT

Virtual Agent Evaluation

on E-learnings.

* Required

Nationality: *
For others, please state your nationality

- Malaysian
- Other:

Ethnic (For malaysian only) : o
For others, please state your nationality

- Malay
- Chinese
- Indian
- Other:

Gender: *

- Male
- Female

Age Group: *

- Less than 20
- Less than 30

Specimen 1 (VA2)

How attractive do you think VA2 is? *

Please rate the level of attractiveness on the 1 - 5 scale

	1	2	3	4	5	
Lowest	○	○	○	○	○	Highest

How realistic do you think VA2 is? *

Please rate the level of realism on the 1 to 5 scale

	1	2	3	4	5	
Lowest	○	○	○	○	○	Highest

Emotional Experience using Kansei Keywords

Please rate on a 1 to 5 on how prominent the following Kansei words in regards to the Virtual Agents

Specimen 1 (VA2) Kansei Words *

	1 (Lowest Prominence)	2	3	4	5 (Highest Prominence)
Effective	○	○	○	○	○
Intellectual	○	○	○	○	○
Enjoyable	○	○	○	○	○
Pleasant	○	○	○	○	○
Intelligent	○	○	○	○	○

APPENDIX D

Pilot Study

KW	VA1	VA2	VA3	VA4	VA5	VA6	VA7	VA8	VA9	VA10	VA11	VA12	VA13	VA14	VA15	VA16	VA17	VA18
Innovative	3.20	3.20	3.20	3.30	3.60	3.13	3.40	3.30	3.30	3.10	3.50	3.43	3.10	2.90	3.00	3.00	2.87	3.03
Appealing	3.23	3.03	2.87	3.03	3.33	2.90	3.47	3.07	2.90	2.90	3.20	3.03	2.60	2.83	2.73	2.83	2.83	2.63
Attractive	3.13	3.07	2.70	3.10	3.37	2.90	3.63	2.90	3.03	3.07	3.40	2.97	2.50	2.77	2.77	2.83	2.70	2.93
Vibrant	2.87	3.10	3.00	3.10	3.40	2.97	3.63	3.27	2.93	2.93	3.47	3.10	2.83	3.10	3.10	3.00	2.83	2.83
Effective	3.07	3.13	3.17	3.23	3.47	3.03	3.77	3.20	3.00	3.17	3.53	3.23	2.77	3.07	3.17	3.07	2.93	2.80
Excellent	3.20	3.47	3.13	3.27	3.67	3.10	3.63	3.13	2.77	3.03	3.40	3.37	2.93	3.00	3.00	2.93	3.10	2.77
Easy to use	3.10	3.43	2.83	3.40	3.57	3.07	3.40	3.27	2.87	3.20	3.47	3.33	3.00	2.97	3.03	3.13	3.03	2.97
Understandable	3.23	3.37	3.13	3.43	3.40	3.07	3.50	3.27	2.77	3.17	3.43	3.13	2.87	2.90	3.13	3.20	2.83	2.97
Impressive	3.10	3.37	3.03	3.27	3.63	3.13	3.23	3.23	2.77	3.20	3.23	3.23	2.83	2.70	3.20	2.90	2.83	2.90
Intellectual	3.27	3.30	3.40	3.13	3.73	3.27	3.37	3.47	3.03	3.33	3.60	3.30	2.80	2.93	3.03	3.07	3.03	2.77
Intelligent	3.30	3.33	3.37	3.07	3.87	3.07	3.33	3.67	3.10	3.40	3.57	3.07	2.87	2.97	3.33	3.10	2.83	3.17
Versatile	3.17	3.17	3.13	3.20	3.50	2.90	3.20	3.33	3.07	3.43	3.40	3.27	2.97	2.87	3.37	3.20	2.83	2.97
Brilliant	3.27	3.30	3.27	3.10	3.67	2.87	3.30	3.37	3.03	3.37	3.27	3.17	3.07	3.00	3.43	3.23	3.03	2.97
Enjoyable	3.23	2.87	3.13	3.27	3.33	3.00	3.40	3.33	2.90	3.40	3.23	3.07	2.83	3.13	2.93	3.00	3.00	2.83
Pleasant	3.23	3.03	2.97	3.17	3.43	3.07	3.47	3.37	2.87	3.20	3.27	2.83	2.83	2.83	3.00	3.17	2.87	2.87
Beautiful	3.43	2.97	3.23	2.97	3.17	3.20	3.53	3.33	2.93	3.07	3.10	2.93	2.77	2.87	3.07	2.97	2.67	2.87
Youthful	3.10	2.93	2.83	3.40	3.13	3.20	3.43	3.27	3.07	2.93	3.47	3.33	2.30	2.80	2.70	2.87	2.60	2.83
Confident	3.17	3.17	2.87	3.40	3.53	3.33	3.33	3.23	3.17	3.17	3.37	3.37	2.80	2.80	2.90	3.03	3.03	2.83
Expert	3.17	3.07	3.00	3.27	3.60	3.30	3.40	3.43	3.13	3.13	3.50	3.43	3.07	3.03	3.17	3.20	2.87	2.83
Realistic	3.27	3.13	3.27	3.30	3.63	3.10	3.50	3.33	3.10	3.50	3.73	3.30	3.07	3.03	3.27	3.20	2.97	2.93
Good feeling	2.97	3.13	2.93	3.27	3.50	3.30	3.60	3.17	2.73	3.30	3.57	3.20	3.20	2.90	3.10	3.10	2.73	2.97
Well designed	3.03	2.77	3.10	3.43	3.37	3.13	3.70	3.20	2.87	3.27	3.80	3.03	2.90	3.00	3.07	3.07	2.87	2.97
Awesome	3.13	2.90	3.07	3.27	3.50	2.97	3.57	2.93	3.00	3.17	3.63	3.20	2.93	2.97	3.03	3.20	2.87	3.00
User friendly	3.07	3.07	2.90	3.20	3.47	3.20	3.53	3.17	2.87	3.30	3.57	2.97	2.80	2.97	2.93	3.17	2.93	2.83
Motivating	3.00	2.97	2.93	3.23	3.40	3.13	3.60	3.03	3.03	3.37	3.53	3.13	3.00	3.10	3.07	3.10	2.90	3.13

APPENDIX E

Exploratory Study

KW	VA1	VA2	VA3	VA4	VA5	VA6	VA7	VA8	VA9	VA10	VA11	VA12	VA13	VA14	VA15	VA16	VA17	VA18
Innovative	3.07	3.32	3.20	3.18	3.43	3.07	3.36	3.12	2.97	3.10	3.23	3.21	2.80	2.96	2.97	2.80	2.90	3.04
Appealing	3.07	3.29	3.06	2.98	3.42	2.99	3.51	3.05	2.73	2.98	3.22	2.99	2.53	2.85	2.79	2.76	2.88	2.86
Attractive	3.05	3.27	2.97	3.06	3.38	2.97	3.58	3.01	2.76	2.99	3.14	2.96	2.50	2.86	2.75	2.72	2.78	2.99
Vibrant	2.80	3.36	3.07	3.08	3.31	3.06	3.50	3.08	2.81	2.98	3.28	3.06	2.69	2.89	2.88	2.89	2.92	2.91
Effective	2.97	3.38	3.18	3.19	3.37	3.11	3.46	3.12	2.87	3.14	3.24	3.07	2.76	3.01	2.99	2.91	2.95	2.87
Excellent	3.07	3.44	3.16	3.24	3.49	3.09	3.43	3.20	2.81	3.06	3.29	3.43	2.78	2.96	2.99	2.89	3.01	2.93
Easy to use	2.99	3.36	3.14	3.27	3.31	2.99	3.41	3.23	2.74	3.14	3.34	3.11	2.80	2.97	2.95	2.87	2.93	3.00
Understandable	3.09	3.43	3.17	3.26	3.35	3.05	3.44	3.21	2.84	3.08	3.31	3.05	2.78	3.05	2.93	2.98	2.85	3.01
Impressive	2.98	3.37	3.07	3.18	3.46	3.06	3.33	3.18	2.80	3.12	3.25	3.05	2.79	2.92	2.97	2.91	3.02	2.95
Intellectual	3.22	3.50	3.29	3.12	3.55	3.21	3.36	3.27	3.00	3.14	3.45	3.20	2.87	3.03	3.06	3.03	3.08	3.02
Intelligent	3.21	3.42	3.34	3.18	3.63	3.16	3.39	3.32	3.04	3.26	3.42	3.07	2.98	3.00	3.15	2.97	3.02	3.11
Versatile	3.15	3.27	3.18	3.15	3.29	3.07	3.36	3.20	2.97	3.23	3.29	3.13	2.84	2.92	3.11	3.02	2.97	2.98
Brilliant	3.15	3.44	3.18	3.15	3.43	3.07	3.40	3.21	2.96	3.26	3.21	3.11	2.88	2.95	3.11	3.03	3.06	3.04
Enjoyable	3.15	3.21	3.09	3.25	3.33	3.11	3.42	3.16	2.84	3.05	3.32	3.06	2.67	2.87	2.91	2.87	2.93	2.94
Pleasant	3.17	3.36	3.09	3.14	3.39	3.03	3.46	3.24	2.75	3.00	3.23	2.93	2.71	2.74	2.94	2.91	2.87	2.82
Beautiful	3.17	3.35	3.18	2.91	3.18	2.99	3.41	3.19	2.76	2.99	3.10	2.89	2.64	2.78	2.91	2.91	2.82	2.88
Youthful	3.13	3.35	3.09	3.20	3.29	3.09	3.46	3.20	2.85	2.86	3.25	3.04	2.39	2.67	2.57	2.80	2.68	2.84
Confident	3.20	3.42	3.14	3.21	3.55	3.18	3.41	3.17	3.07	3.15	3.34	3.25	2.84	2.96	3.03	2.88	3.06	3.05
Expert	3.17	3.36	3.11	3.14	3.50	3.13	3.32	3.26	3.04	3.21	3.36	3.21	2.92	3.09	3.10	3.05	2.98	3.07
Realistic	3.13	3.33	3.20	3.11	3.50	3.07	3.38	3.24	3.07	3.29	3.38	3.17	3.03	3.03	3.09	2.96	3.07	3.13
Good feeling	3.00	3.31	3.11	3.12	3.39	3.10	3.50	3.18	2.66	3.12	3.36	3.04	2.82	2.86	3.02	2.91	2.89	2.93
Well designed	2.98	3.21	3.14	3.18	3.36	3.08	3.57	3.13	2.84	3.15	3.37	3.08	2.82	3.00	3.03	2.85	2.97	3.06
Awesome	3.06	3.17	3.09	3.17	3.45	3.12	3.42	3.01	2.78	3.13	3.36	3.13	2.80	2.97	3.04	2.89	2.93	2.98
User friendly	3.08	3.23	3.19	3.14	3.37	3.19	3.42	3.14	2.80	3.21	3.36	3.05	2.79	2.93	2.93	2.94	2.94	2.93
Motivating	2.99	3.26	3.11	3.07	3.36	3.10	3.40	3.12	2.93	3.11	3.29	3.05	2.79	2.90	3.09	2.87	2.94	3.00