e-Learners Kansei Experience Towards Expert-Like Virtual Agent: A Case Study

Chandra Reka Ramachandiran¹ and Nazean Jomhari²
Faculty of Information Science and Information Technology
University of Malaya
¹chandrareka@hotmail.com, ²nazean@gmail.com

Abstract— The rapid growth of Internet users and diverse Web 5.0 technologies has made the research scholars and educators to think of intelligent tools such as; expert-like virtual agents as an effective e-learning tool. The success of an e-learning tool relies primarily on the level of acceptance of the tool by the e-learners and their state of emotion while using the tool. Therefore, addressing e-learner’s emotional competences is important to understand the implicit emotion of the young minds. In this context, virtual agents are expected to play the role of instructors in a virtual learning environment. This paper aims to study the affective design of the Virtual Agent in terms of attractiveness and realism that adopts Kansei Engineering, an emerging technology used to explore and validate the emotion structure defined as a complex state of feelings that can result in the changes of human behaviour and thoughts of e-learners. Adding on, the paper also highlights and validates the six universal emotions such as anger, happiness, surprise, disgust, sadness and fear. The findings suggest that the most attractive and realistic virtual agents have higher Kansei value. Some implications of the findings in relation to expert-like virtual agent design and Kansei are discussed in this paper.

Keywords - expert-like virtual agent, e-learners, emotion, virtual agent, kansei engineering

I. INTRODUCTION

Over the years, there is an increasing recognition that successful learning requires not just quality instructional design tools but also an appropriate context that includes facilitation and an understanding of the e-learner’s behaviour. The instructor, who monitors the successful deployment and integration of the e-learning content into the teaching and learning environment, facilitates this context. The instructor’s role is to find, adopt and share the gained knowledge using a variety of teaching learning techniques appropriate to a specific learning domain that fulfils the need of the e-learner. e-Learners are students who engage in an e-learning environment actively. Hence, e-learning is an important learning tool for e-learners whereby it eases their learning process and enables them to infer self-directed learning. On another note, e-learning should not be viewed as just an educational product but also as an identifiable artefact of learning objectives, content and interactions.

e-Learning tools were known as a product with uncertain value until it started being deployed in a learning domain that includes its e-learners, technical team members and other organisational attributes. The artefact itself is not timely and has limited life span and needs to be modifiable and timely or else it will succumb to the social pressures of the new generation. The adaptation process of the new curriculum, modifiable demographics of virtual instructors, and favoured learning curves plays an important role in the e-learning tool implementation.

The implications for the e-learning concept of a repository of learning objects are that the database will need constant maintenance to keep it at par with the technology advancements. In the area of e-learning, this proposes a drift away from self-paced instruction learning and deployment of learning to a better learning approach termed blended learning approach.

Blended learning is a combination of various teaching learning approach. It integrates both the conventional teaching learning approach with the online learning approach to ease the learning process. Blended literacy classes are convenient, interactive and engaging to many e-learners. The emergence of Web 2.0 technologies is the main contributor to the success of the Blended Learning approach. Not forgetting the current advancement of Web 5.0, a sensory emotive web has the capacity to address the interpersonal and intra personal emotional competences of e-learners. However, the future of e-learning tool design will consider the e-learner’s positive engagement via active simulation tools such as online role plays and micro worlds; a rule based simulation tool for the construction of the e-learning content and to promote collaborative learning. Access to education is becoming more crucial as the success solely relies on the success of the information society and therefore, a lot of potential is seen in distributed virtual learning environments [1]. As a result, virtual learning approach is gaining wide acceptance amongst the young e-learners. This approach does not only promote positive engagement and connectivity between the e-learners but also evokes the desire to acquire knowledge and skills from a virtual learning environment. Furthermore, virtual learning addresses issues related to classroom boredom. It has a
virtual setting and custom designed Virtual Agents in accordance to the fast growing trends of learning technologies.

A. Problem Statement

Emotion measurement is originated from the field of psychology and sociology. However, with the new emerging technology, Kansei Engineering has adapted this study of emotion into designing affective product design. Though, it has been clearly defined in the Kansei engineering methodology that emotion can be measured using the self-report instruments from the respondents, it is not an easy task to accomplish. This is because to be able to measure an emotion, the respondents must be able to characterize the identified emotion and to distinguish the identified emotion from other states of emotion. In this research, the six universal emotions identified by Paul Ekman in [2] is used to reduce ambiguity between the young respondents as this will simplify the designing process of an effective expert-like virtual agent. It is important to design an effective expert-like virtual agent as virtual agents will enable virtual worlds to achieve a higher level of interaction by providing increasing engagement and responsiveness in the virtual learning environment. Beside this, the affective design of virtual agents has to be given higher priority as the virtual interface design can be misleading and once the agent’s novelty is worn off then these animated interfaces reduce their appeal in comparison to the other user interfaces that doesn’t use virtual agents. Hence, Kansei is integrated into the design requirement of the expert-like virtual agents in this research.

B. Objectives

The objectives of this research are as follow:

1. to explore the Kansei experience of e-learners using the six basic emotion structure in e-learners towards the expert-like virtual agents.
2. to validate the attractiveness and the Kansei value of e-learners emotions using the user impression identified in the new production scheme of Kansei Engineering (KE).

II. Virtual Reality Based Learning Environment

Virtual Reality enables e-learners to visualize the learning process, manipulate the findings, and interact with the current technology that deploys complex set of data. The visualization process refers to the visual representation in the computer, auditory components or any other forms of sensual outputs being displayed in the virtual world. According to research scholar Abdul-Kader in his article [3], virtual reality run wide spectrum from entertainment purpose to educational purpose. The most recent application of virtual reality is the graphical user interface of e-learning applications and they are known as virtual reality based e-learning tools. The potentials of virtual reality technology can facilitate learning process avoiding many problems characterizing traditional or conventional teaching learning methods.

There are many e-learning educational systems were developed that uses virtual environments. Medical and scientific subjects are the most prominent e-learning applications that use virtual reality technology [4-6]. This innovation had enabled many virtual classrooms to be set up to ease virtual learning in many education institutions and training centres all over the world.

Adding on, virtual bodies have become increasingly prevalent in researches related to Human Computer Interactions. Amongst them are the Embodied Conversational Agents (ECAs) and Avatars. Referring to studies by Khan and De Angeli [7], [8], perspectives ECAs can be defined as an interface based on the anthropomorphic metaphor, which is a human look alike and able to mimic a face-to-face interaction. Examples of various embodied agents used in HCI research are: embodied conversational agents (ECA’s), relational agents (RA’s), pedagogical agents (PA’s), and chat-bot agents. To add on, Oliver in [9] defined ECA’s as synthetic characters that maintains a conversation with an user. Based on previous studies on ECA’s, the main concern is how to emulate human conversation following the assumption that ECA’s will have the same properties as humans in face to face interaction [10]. Fig. 1 highlights some of the popular ECA’s such as Laura, Cosmo, Rea and Steve.

This domain of this research, has led many researchers to the definition of relational agents, as computational artefacts designed to build long term, social-emotional relationships with their users [11], [12]. Adding on, researchers Bickmore and Picard in [12] asserted that there are many domains that benefited from the deployment of relational agents such as e-commerce, e-learning, counselling and consultation, psychological behavioural therapy and community services. Most of the existing agents are young adults and teenagers, and only a minority of them are classified as children. This is due to the assumptions by the designers that agents are widely used to attract the attention of the young minds that prefer to stay connected with agents of a similar age group as stated by Cowell and Stanney in [13].

Figure1. Embodied conversational agents
On the contrary, current Internet users range from nursery children to retirees and therefore these age groups must be considered as a target audience of a virtual learning system [7], [8]. This supports the research findings in [7] that very minimal number of child agents and older aged virtual agents are being used over the Internet in the virtual learning environment. It is also noted that the most significant role assigned to a virtual agent is of a pedagogical agent category. Perhaps, this is the role identified by the researchers or product designers and been classified as the most widely accepted virtual agents. The pedagogical roles identified are: tutors, instructors, advisors and guides. On the other hand, the fact remains that virtual agents can play diversified roles, rather than being cocooned into the pedagogical role that is only catered for virtual learning environment.

### III. EMOTION AND KANSEI ENGINEERING

Many psychologists have defined the term emotions in their own context. Past studies by psychologists Ekman [2], [14] and Russell [15], defined emotion as a mental and physical psychological state associated with wide variety of feelings, thoughts and measures. Ekman in his cross-cultural study [2], also highlighted the six basic or universal emotions in the year 1972. They comprises of anger, happiness, surprise, disgust, sadness and fear. He also asserted that there are specific characteristics attached to each positive or negative emotions and can be expressed in varying degree. Therefore, each emotion acts as a discrete category and not as an individual state of emotion.

Adding on, the affective study known as Kansei, a technology deeply rooted in the Japanese culture is gaining wide acceptability in Europe countries. The pioneer in the area of Kansei Engineering, Nagamichi, stated that many researchers have defined Kansei in different ways but they failed to do so [16-18]. Thus, the definition of Kansei remains as a form of psychological feeling an individual has with a specific product, situations or surroundings [17], [18]. On the other hand, Harada in his research study [19] captured Kansei as a mental function of the brain that is implicit and he claims that the Kansei process begins with the gathering of information related to sensory functions such as feelings, emotions, and intuition.

Kansei Engineering (KE), a technology to measure Kansei (感性) that refers to the psychological feelings and images held in the mind towards artifact, situation and surrounding [18]. KE unites Kansei into engineering realms in order to assimilate the human Kansei into product design to meet consumers demand and satisfaction [16], [20], [21]. According the findings in [16], KE is a scientific discipline that develops products technologically that gives maximum satisfaction scale to the consumer. This approach is carried out by collecting consumer’s Kansei experience using a list of Kansei words or adjectives related to the product design. Next is to establish a mathematical prediction models to relate Kansei with the product design. KE targets to improve the quality of human life by addressing the emotional aspects of any product that leads to satisfactions.

On the other hand, a prominent researchers from the area of Kansei Engineering, Saeed and Nagashima [22], believes that the god father of Kansei Engineering, Professor Tomomaso Nagashima is very much concerned of the interaction between the product design or services provided besides focusing on the users themselves. With the advancement and commercialization of technology, the researcher argued that biometric measurement such as face recognition for Kansei Engineering is more popular as this opened many opportunities to the existing researchers and organizations to design products with aesthetic values that have a high Kansei value [22-24].

According to the researcher Nagashima [24], the ultimate goal of Kasei Engineering is to enrich the quality of everyday life of human through new production technologies from the perspective of the user. The perspective of the user ensures that the designed product satisfies the requirement or preference of users [22-24]. This new production scheme is also called the cocreation between the product designers and users, where they cooperatively work together sharing a common sense of value that is identified as the Kansei value of a specific product. Nagashima’s fundamental of Kansei Engineering relative to his production scheme highlighted in his article [23], is as shown in the Fig. 2.

The past researchers have highlighted the importance of Human Computer Interaction (HCI) in a learning environment [5], [6], [25]. They prioritize the effectiveness of the learning tool to deliver knowledge to the e-learners by giving high importance to their emotional persuasiveness. The researchers also asserted that most of the research focuses on the emotional impulsive virtual characters or known as Virtual Agents that express their emotions without considering the socio-emotional context of interaction [25]. Therefore, Kansei Engineering that is related to the study of emotions is an important criterion in the design process of Virtual Agents interaction [25]. Therefore, Kansei Engineering that is related to the study of emotions is an important criterion in the design process of Virtual Agents.

![Figure 2. Production scheme of KE](image)
IV. RESEARCH METHODS

The e-learner’s Kansei experience and the expert-like virtual agent’s attractiveness were studied using a self-reporting online questionnaire survey. A total of 18 expert-like virtual agent’s attractiveness was rated and 6 universal emotions identified by Paul Ekman in [2] were integrated into this study for the Kansei evaluation. The six universal or basic human emotions can be classified into two categories and they are the positive emotions and negative emotions. The positive emotions consist of happiness and surprise and the negative emotions consist of anger, disgust, fear and sadness. These are primary emotions and it is easily understood by the e-learners who are the undergraduate students from a private higher learning institution.

The respondents for this research consist of 95 undergraduate students. They were selected based on their computer literacy and blogging experience. The selection criteria for the respondents are that they are required 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
- Computer Literacy: Intermediate level of Computer Proficiency
- E-learner’s Nationality: Malaysian (n=70; 74%); International (n= 25; 26%)

The specimens used in this study are the expert-like virtual agents. A total of 18 expert-like agents were used in this study. The e-learners then had to respond to a series of open ended questions whereby they clearly state their emotions using a five-point Semantic Differential (SD) Scale as highlighted by Lokman [16]. This is a scale identified to measure the connotative meaning of an object or specimens in relation to Kansei study. The e-learners are requested to rate the six universal emotions or their personal impression triggered by the expert-like virtual agent. Next, the e-learners rated the attractiveness of the 18 expert-like virtual agents using the 5 point SD scale that comprises of two bi-polar adjectives at each end of the question. The scale 1 in the SD scale denotes the lowest or negative rating and 5 denotes the highest or positive rating.

Fig. 3 depicts the 18 selected specimens comprising of expert-like virtual agents used in the research study. They are classified into 3 different groups such as: young adults, adults and older adults. Agents 1 to 6 are from the age group known as young adults. Meanwhile, Agents 7 to 12 are from the age group classified as adults and finally Agents 13 to 18 are from the older adult category. Besides that, the expert-like virtual agents are designed to cater to the Malaysian community. There are three prominent ethnic groups in Malaysia and the instructors in the higher learning institution comprises mainly from these highlighted ethnic groups. Hence, the virtual agents are designed to have the similar appearance of the instructors from Malay, Chinese and not forgetting the minority Indian ethnic group. To sum up there are 6 virtual agents in every age group classification of expert-like virtual agents.

IV. ANALYSES AND RESULTS

The 95 e-learners active participation in this Kansei study in relation to expert-like virtual agent showed that an affective design is an important criterion for an effective user interface design in the virtual learning environment. The two positive emotion traits; happiness, and surprise was rated the highest for the virtual agents who are perceived as attractive by the e-learners. Table I summarizes the e-learner’s emotion response or Kansei value using the SD scale and the rating of attractiveness for the 18 expert-like virtual agent specimens. It is clearly tabulated that the top four virtual agents captured positive Kansei value in terms of positive emotion traits. The expert-like virtual agents with an Agent ID 2, 5, 7 and 12 has topped the list for being the most attractive among the 18 virtual agents and displays the positive emotion structure or Kansei value from the perspective of the e-learners.

Fig. 4 depicts the 2 best fit expert-like virtual agents that were rated the highest for attractiveness and positive emotion traits. It is noticed that the top 2 agents (Agent ID 2 and 5) are from the age group classified as young adults and from the same Chinese ethnic group. A plausible explanation for this high rating is a total of 55 (79%) e-learners who have participated in this study are from the Chinese ethnic group which is the second largest ethnic group in Malaysia. To add on, Agent 2 topped the list for being the most attractive and has a notable positive Kansei value. This proves that the majority of e-learners have a positive impression on female virtual agent although the majority group (64%) of the respondents comprises of young male undergraduate students.
TABLE I. EVALUATION OF EXPERT-LIKE VIRTUAL AGENTS

<table>
<thead>
<tr>
<th>Agent ID</th>
<th>Attractiveness</th>
<th>Anger</th>
<th>Disgust</th>
<th>Fear</th>
<th>Happiness</th>
<th>Sadness</th>
<th>Surprise</th>
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Figure 4. Best fit expert-like virtual agents (Agent ID 2 & 5)

V. DISCUSSION AND CONCLUSION

It is noted, that emotion is a complex feeling that is associated with a wide variety of feelings, thoughts and measures as claimed by Russel [15]. Therefore, the study on emotions are essential to determine the success of the product design by the product maker [24]. Taking emotions or affective factors into consideration, the designers managed to determine an appropriate design of a product in any domain of research. Therefore the affective factors must be taken into consideration by prioritizing the Kansei value while designing an effective e-learning tool such as the virtual agents. This study has shown that expert-like virtual agents with an affective interface have provided a positive impression in terms of socialisation. Therefore, using virtual agents enhance the learning curve of e-learner.

Fig. 5 represents the Kansei structure in 18 expert-like virtual agents. The six universal emotions highlighted in [2] were evaluated by integrating the new production scheme of KE [23]. To elaborate further, e-learner’s user impression is the deciding factor of the Kansei value that determines the success of a factor of the Kansei value that determines the success of a product design. This evaluation method identifies the kansei experience among the e-learners and their learning engagement requirements. The e-learners learning engagement is important as they will be constantly engaged in the active virtual learning platform that deploys virtual agents and this enhances the learning process of the information society as mentioned in [1].

Adding on, the Kansei value for Agent 2 is the highest as shown in Fig. 5. The positive emotion traits happiness and surprise were rated the highest in comparative to the negative emotion traits such as: anger, disgust, fear and sadness.

This research supports the finding in [7] and [8] where the researchers have pointed out that attractiveness of virtual agents enhance the learning process in the virtual learning environment. There is a close link between attractiveness and Kansei as good design creates positive traits of emotions among the e-learners. Expert-like virtual agents with Agent ID 2, 5 and 7 has topped the list for being the top three attractive virtual agents and they have the positive Kansei value ratings. Fig. 6 depicts the level of attractiveness of the expert-like virtual agents used in this research. It also identifies the virtual agent with Agent ID 2 as the most attractive virtual agent by the 95 e-learners.

This research summarizes and supports the significant findings on the impact of attractiveness and the Kansei value of expert-like virtual agents. The findings by Kansei pioneer researchers Nagamichi [16], Lokman and Noor [20], Nagashima [23] and Harada in [19] have proven that Kansei approach is feasible and reliable to measure the emotion of e-learners. The Kansei value obtained from this research strongly supports...
Nagamichi’s statements in [17] that clearly state that the rich Kansei value indicates the richness of emotions in a product design. However, it is important to understand the accomplishment of Kansei Engineering in various domain of research to determine implications of the approach. Though, it is noted that most of the KE researches are in engineering and e-commerce, it is important to explore other dimensions of Kansei in the future such as; a new domain like e-learning via Virtual Agents to standardize the design criterion of the virtual characters.

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