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A Case Study on e-Learners Perception and Kansei Experience towards Pedagogical Virtual Agents

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Abstract

The emergence of Web 5.0 technologies has made educators to think of pedagogical virtual agents as an effective e-learning tool. Since the success of an e-learning tool relies mainly on the acceptable level of the tool by the e-Learners and their state of emotion while using the tool, it is important to address the e-Learner's emotional competencies. The present study examined the impact of pedagogical virtual agents, as operationalized by agent's demographic features, e-Learners' perceptions on virtual agents and their Kansei experience. 95 university freshmen from a private higher learning institution participated in this research. Consistent with similarity-attraction hypothesis, attraction-realism hypothesis, and Kansei Experience- hypothesis, it was found that: (1) e-Learners assigned higher ratings for pedagogical agents who have many similar demographic features as them, (2) e-Learners reported higher positive emotion ratings for attractive virtual agents, (3) there is a positive and significant relationship between the attractiveness of the pedagogical virtual agent and the realistic appearance of the agent. Some implications of this research are discussed in this paper.

Keywords: Attraction, e-Learners, Kansei Engineering, Pedagogical Virtual Agent, Realism

1. Introduction

The growing trend in the diversity of teaching, learning tools clearly suggests that there is an increasing recognition for an effective teaching learning tool. A successful learning requires not only quality learning tools, but also appropriate content that is timely to cater the needs of the e-Learners. Therefore the need arises to understand the behaviour and the emotional pattern of the e-Learners. Instructors, who play the role of facilitators, are assigned to administer the instructional tools by finding, adopting and sharing the gained knowledge using the most appropriate teaching learning tool to a specific learning domain. The successful deployment and integration of the e-learning tool depends entirely on the success of the learning engagement[1]. To add on, e-learning tools should not be viewed as just as an educational product, but also as an identifiable artefact to attain the learning objectives, content delivery and interactions.

E-learning tools were identified as a product with uncertain value until it started being deployed in a learning domain that includes e-Learners, technical team members and other organizational attributes. The tool itself has limited life span and needs to be constant update to ensure the content of delivery is valid. The process of new curriculum adaptation, modifiable demographic features of pedagogical agents or instructors, and favoured learning pedagogies plays an important role in the implementation of the e-learning tool. Furthermore, these implications of the e-learning concept need constant maintenance to keep it at par with the technology advancements. Therefore, this e-learning domain drifts

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away from self-paced instruction, learning and deployment of learning in a better learning approach identified as the blended learning approach. Blended learning integrates both the conventional teaching learning approach with the online learning approach to ease the teaching and learning process. The blended literacy classes are convenient, interactive and engaging to many e-Learners. Web 2.0 technologies mark the beginning of the success of blended learning approach. The advancement of the current Web 5.0 technologies provides a sensory emotive web that has the capacity to address the intra and interpersonal, emotional competencies of e-Learners and supports the objectives of the learning pedagogies.

With the trending technologies, it is important to analyse and identify the most suitable e-learning tool design that enhances e-Learner's positive engagement. This can be attained 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. To add on, the access to education is becoming more crucial as the success solely rely on the success of the information age and the society. Therefore, a lot of potential is seen in distributed virtual learning environments and this would allow students and instructors to meet in the virtual learning space and engage in online learning[1]. As a result, virtual learning approach is gaining wide acceptance amongst the young e-Learners nationwide. Besides that, virtual learning approach does not only promote positive engagement and connectivity between the e-Learners but also evokes the desire to acquire new knowledge and skills from the identified virtual learning space. Hence, virtual learning addresses issues related to classroom boredom faced by the young e-Learners. On another note, a tool that caters the emotional need of e-Learners is important to attain greater heights in classroom teaching and learning.

In the area of psychology and sociology, there is a commonality to measure emotion and it gives very high importance. However, Kansei Engineering technology has adapted this study of emotion that originated from the two identified domains into designing products that has aesthetic value. 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. This research applies the six universal emotions identified by Paul Ekman[2]. The six basic emotions identified by Ekman is used in this research as the emotions are clearly defined to reduce ambiguity between the young e-Learners as this will simplify the designing process of effective pedagogical virtual agents. Furthermore, it is important for the e-Learners to be able to identify and feel the stated emotion to produce valid data for the empirical study. Adding on, a suitable design of an effective pedagogical virtual agent as virtual agents will enable virtual learning space to achieve a higher level of interaction by providing increasing engagement and responsiveness in the virtual learning environment. Besides this, the affective design of pedagogical 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. Therefore, Kansei is incorporated into identifying the ultimate design requirement of the pedagogical virtual agents in this research.

The objective of this research is to investigate the e-Learners perception on pedagogical virtual agents and their Kansei experiences. The Kansei experience of e-Learners' are studied using the six basic emotion structure towards the pedagogical virtual agents. Besides this, this research also aims to validate the attractiveness of the pedagogical virtual agents and the relationship between the attractiveness and the realistic appearance of the virtual agents. This approach uses the e-Learner's impression identified in the new production scheme of Kansei Engineering (KE).

In accordance to the objectives of the research study, three hypotheses were identified.

1.1 Similarity-demographic Hypothesis

H1: e-Learners will assign higher ratings for pedagogical agents from the same ethnic group with similar demographic features.

H0: e-Learners do not assign higher ratings for pedagogical agents from the same ethnic group with similar demographic features.

1.2 Kansei Experience Hypothesis

H2: e-Learners will assign higher ratings for the positive emotions for attractive pedagogical virtual agents.

H0: e-Learners will assign higher ratings for the positive emotions for attractive pedagogical virtual agents.

1.3 Attractiveness-realism Hypothesis

H3: e-Learners will assign higher ratings for the attractiveness of the pedagogical agents who has a more realistic appearance.
H0: e-Learners do not assign higher ratings for the attractiveness of the pedagogical agents who has a more realistic appearance.

2. Virtual Reality-based Learning Space

Most of the educational institutions worldwide have incorporated the virtual learning space to facilitate the teaching learning process. Many e-Learners find Virtual Reality Based Learning Space to be more engaging and triggers positive emotions towards the learning process[1,3]. This learning space enables-Learner to visualize the learning process, manipulates the findings, and interact with the current technology that deploysa 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 Abdul-Kader[3], virtual learning space acts as an interface to the existing e-learning system that is available on the Internet and using virtual reality learning space, the applications seem to appear more promising and interactive. Virtual reality runs 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 virtual world is widely used in various e-learning educational systems. This multi user, cross-platform and collaborative learning is widely used in Medical and scientific courses[4–6]. Adding on, this innovation had enabled many virtual classrooms to be set up to ease virtual learning in many educational institutions and training centres all over the world to facilitate the learning process of such complex courses.

Another important component of the virtual reality-based learning space is the virtual agent that has 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, relational agents, pedagogical agents, and chat-bot agents. To add on, Oliver[9] defined ECA's as synthetic characters that maintains a conversation with a 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].

The findings from 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]. To add on, research scientists Bickmore and Picard[12] asserted that there are many research areas 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[13].

On the contrary, the target audience ranges from nursery children to retirees and therefore these age groups must be considered in the designing process of a virtual learning space[7,8]. This supports the research findings that states there are very minimal number of child agents and older aged virtual agents in the virtual learning environment[7]. 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. Amongst the identified pedagogical roles 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 a virtual learning environment.

3. Kansei Engineering

From the perspective of the psychology, many scientists have defined the term emotions in their own context. Acc

According to the past studies by psychologists Ekman[2,14] and Russell[15], emotion is defined as a mental and physical, psychological state associated with a wide variety of feelings, thoughts and measures. In another study cross-cultural study by Ekman[2], he has highlighted the six basic or universal emotions in the year 1972. The six basic emotions comprise of anger, happiness, surprise, disgust, sadness and fear. Besides that, 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 any particular emotion[2].

The affective study from Japan known as Kansei, a technology is also gaining wide acceptance in Asian and European countries. As the pioneer in the area of Kansei Engineering, Nagamichi, stated that many research scientists have defined Kansei in different ways, but they failed to do so accurately define the term[16–18]. Therefore, the definition of Kansei remains as a form of psychological feeling an individual has with a specific product design, situations or surroundings[17,18]. Alternatively, Harada[19] in his research study 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 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 to the founder of the theory Nagamichi[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 to 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, prominent researchers Saeed and Nagashima[22], are very much concerned about the interaction between the product design or services provided besides focusing on the users themselves. With the advancement and commercialization of technology, the researchers 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].

The findings of Nagashima[24] denotes that 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 co-creation between the product designers and users, where they co-operatively

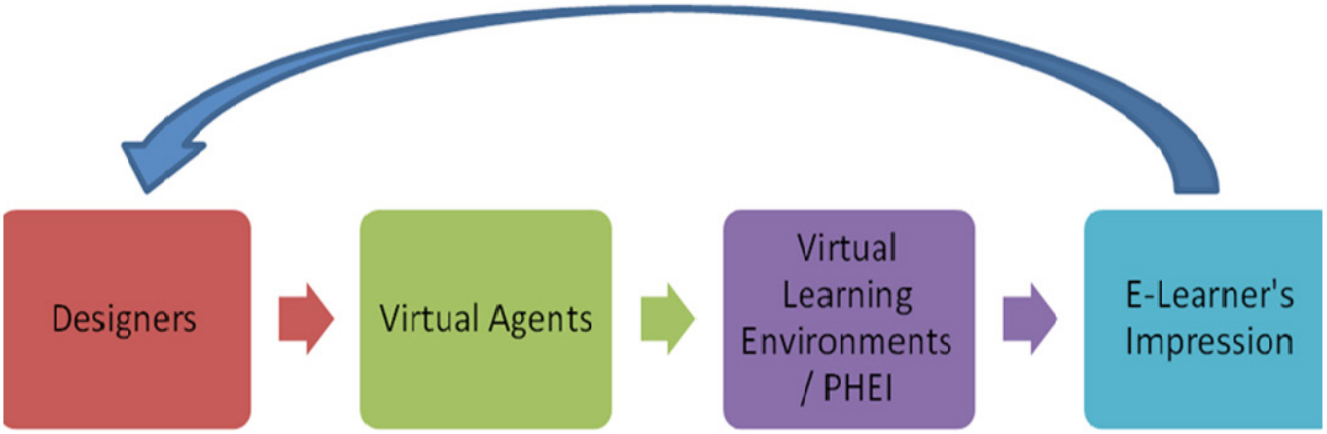

Figure 1. New adopted production scheme of KE.

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]. Figure 1 depicts the new adopted scheme relation to the research study.

The past researchers have highlighted the importance of Human Computer Interaction (HCI) in a learning environment. 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 are known as Virtual Agents that express their emotions without considering the socio-emotional context of interaction[5,6].

4. Research Methods

The e-Learner's Kansei experience and the pedagogical virtual agent's attractiveness were studied using a self-reporting online questionnaire survey. A total of 18 pedagogical virtual agent's attractiveness was rated and 6 universal emotions identified by Paul Ekman[2] were integrated into this study for the Kansei evaluation. The prior reason to select these emotions is due to the fact that they can be easily distinguished from one emotion to the other. The six identified 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 105 undergraduate students. They were selected based on their computer literacy and blogging experience. This research uses random sampling as it reduces the human bias in the selection process. 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 = 67; 64 %); Female (n=38; 36 %)
- Age group of respondents : between 18-22 years
- Computer proficiency : Intermediate
- e-Learner's Nationality: Malaysian (n = 80; 76%); International (n = 25; 24%)

The specimens used in this study are the pedagogical virtual agents. A total of 18 pedagogical 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 pedagogical virtual agent. Next, the e-Learners rated the attractiveness of the 18 pedagogical 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 low-

Figure 2. Classification of 18 pedagogical virtual agents.

est or negative rating and 5 denotes the highest or positive rating.

Figure 2 depicts the 18 selected specimens comprising of pedagogical 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 pedagogical 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 pedagogical virtual agents.

5. Analyses and Results

A total of 105 e-Learners participated actively in this affective design study. It is noted that an affective design of pedagogical agents is an important criterion for an effective user interface design in the virtual learning space. 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 1 depicts the e-Learner's emotional experience or the Kansei value which was obtained using the Semantic Differential scale. Besides that, it also shows the rating of attractiveness and realism for the 18 pedagogical virtual agent specimens. From the tabulated data, the top four virtual agents captured positive Kansei value in terms of positive emotion traits are Agent ID 2, 5, 12 and 7. From the findings the Agent ID 2 and 7 are female and Agent ID 5 and 12 are male. Besides that, Agent ID 2 and 5 are from Chinese ethnicity, Agent ID 12 is Indian ethnicity and Agent ID 7 is of Malay ethnicity. 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 63 (79%) e-Learners who have participated in this study are from the dominant Chinese ethnic group which is the second largest ethnic group in Malaysia. This findings support the H1 whereby the e-Learners assigned high rating for the pedagogical agents from the dominant ethnic group in this study.

Table 1. Evaluation of attractiveness-realism-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	3.62	3.72	2.12	2.06	2.00	3.66	2.18	3.68
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	2.62	2.71	2.21	2.26	2.45	2.98	2.46	2.34
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

Among the 4 highlighted pedagogical agents, Agent ID 2 as shown in Figure 3 has topped the list for being the most attractive and realistic among the 18 virtual agents and displays the positive emotion structure or Kansei value from the perspective of the e-Learners. To add on, Agent ID 2 topped the list for being the most attractive and realistic. Besides that, it also has a notable positive Kansei value. The findings supports the hypothesis H2 where Agent ID 2 has high rating for attractiveness and therefore the positive kansei value are also rated high by the e-Learners.

Figure 3. Best fit pedagogical virtual agents (Agent ID 2).

The statistical analysis validates the strong positive relationship between the realism and attractiveness of the pedagogical agents used in this case study as shown in Table 2 below. We can conclude that for this Virtual Reality based learning space, there is clear evidence that the realism or the realistic appearance of pedagogical agents is related to the attractiveness of the pedagogical agents. In particular, it seems that the more realistic a virtual agents appearance, the more attractive they seem from the perspective of the e-Learners. ($r = 0.942$, $p < 0.001$). Therefore, the findings support hypotheses H3.

Table 2. Realism-Attractiveness

	REALISM	ATTRACT
REALISM Pearson Correlation Sig. (2-tailed) N	1 . 18	.942** .000 18
ATTRACT Pearson Correlation Sig. (2-tailed) N	.942** .000 18	1 . 18

6. Discussion and Conclusion

It is clear that the aim of this study was to examine the e-Learners perception on pedagogical virtual agents and their Kansei experiences. Three central hypotheses which are the Similarity-demographic hypothesis, Kansei Experience hypothesis and Attractiveness-realism hypothesis were posited as the theoretical groundings of this case study. Table 3 presents the findings for the tested hypotheses.

6.1 Similarity-demographic Hypothesis

The Kansei value for Agent ID 2 is the highest. 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. Agent ID demo-

Table 3. Summary of Results of the tested Hypotheses

Tested Hypotheses	Research Findings
Similarity-demographic hypothesis H1: e-Learners will assign higher ratings for pedagogical agents from the same ethnic group with similar demographic features.	H1 is supported but the female agent has higher ratings
Kansei Experience hypothesis H2: e-Learners will assign higher ratings for the positive emotions for attractive pedagogical virtual agents.	H2 is supported
Attractiveness-realism hypothesis H3: e-Learners will assign higher ratings for the attractiveness of the pedagogical agents who has more realistic appearance.	H3 is supported

graphic features are similar to the dominant ethnic group of e-Learners (79%) who are Chinese ethnic group.

6.2 Kansei Experience Hypothesis

This research support the findings by Khan[7,8], where the she have pointed out that attractiveness of virtual agents enhance the learning process in the virtual learning space. There is a close link between attractiveness and Kansei as good design creates positive traits of emotions among the e-Learners. Therefore, Agent ID 2 that has been identified as the most attractive pedagogical agent has rich kansei value that comprises of positive emotion traits such as Happiness and Surprise.

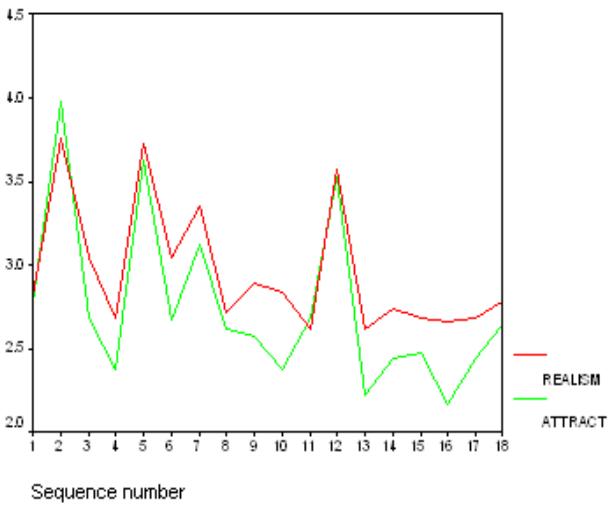

Figure 4. Realism-Attractiveness Chart.

6.3 Attractiveness-realism Hypothesis

Grounded on the attractiveness-realism hypothesis, it was predicted that the more realistic looking pedagogical agents are perceived as more attractive by the e-Learners. Figure 4 below supports the result for the stated hypothesis whereby Agent ID 2 has the highest rating for realism and attractiveness.

From the past review by Russell[15], it is noted that emotion is a complex feeling that is associated with a wide variety of feelings, thoughts and measures. Therefore, the need arises to conduct more research on emotion to determine the success of the product design by the product maker as highlighted by Nagashima[23,24]. According to Kansei Engineering methodology proposed by the founder Nagamichi[16], the affective factors must be taken into consideration by prioritizing the Kansei value while designing an effective pedagogical agent for the virtual learning space. This study has shown that pedagogical virtual agents with an affective interface have provided a positive engagement with the e-Learners. Therefore, using pedagogical agents enhance the learning curve of an e-Learner in the virtual learning space. The research findings that explore the new advancement in pedagogical agent's interface design will produce an optimum and conducive learning environment for e-Learners.

This research also summarizes and supports the significant findings on the impact of attractiveness and the Kansei value of pedagogical virtual agents. The findings by Kansei pioneer researchers have proven that Kansei approach is feasible and reliable to measure the emotion of e-Learners and eventually use this finding to design affective pedagogical virtual agents[16,17,19,20,23].

Though there are many researches being conducted in the area of virtual learning space, there is a demand to design a pedagogical virtual agent that has aesthetic value to ensure the learning becomes a lifelong process[7–9]. Other dimensions of virtual learning space should be highlighted to improvise the effectiveness of the delivery medium. The findings may also vary from one nation to another due to the difference in demographic features of virtual agents. It is a difficult task to understand the psychology of the e-Learners from a multi-ethnic society like the Malaysians. Therefore, more research is required to identify the design guidelines of an attractive and effective pedagogical virtual agent.

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