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# Different Realism Designs of 2D Virtual Agents and its' Arousal Effect on Students' Emotions in Learning

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***Abstract:*** ***This research was aimed to analyse students' emotions caused by the character's realism design in the dimension of arousal and its' effect on emotions in learning. Thus, 2D female virtual agents with four different realism appearance namely realistic, semi-realistic, stylized and cartoon-like were designed and developed. Thus, quasi experimental design was used to answer the research questions derived from this study. The data obtained from the experiment was analysed using ANOVA, post hoc and bootstrap mediation analysis. A number of 600 Electrical Engineering students were chosen from seven polytechnics in Malaysia as respondents in the experiment. From the research it was found that cartoon-like design obtained the lowest mean score arousal followed by stylized, realistic and semi-realistic designs. However, cartoon-like design scored highest mean score for emotions in learning followed by semi-realistic, realistic and stylized designs. Therefore, cartoon-like agent is the best agent among others in inducing positive emotions in learning. In addition, the mediation analysis shows that arousal has mediating effects on relation between different realism designs and emotions in learning. In conclusion, this study recommends cartoon-like agent as the best suitable design for 2D virtual agent followed by semi-realistic, realistic and stylized designs subsequently. Finally, the findings of this study can be a useful guideline for multimedia designers in determining the ideal 2D virtual agent appearance to elicit maximum impact of it in promoting positive emotions in multimedia learning environment.***

***Keywords: virtual agent, arousal, emotion in learning, realism, multimedia learning environment***

## I. INTRODUCTION

Interactive learning has been increasingly applied since 1990s through the use of animated on-screen character which is known as a virtual agent [1]. Animated virtual agent has the potential to inspire users [2[,[3]. This is due to the high degree of interactivity by the animated virtual agents with human beings [4]. In fact, Clark and Mayer (2016) mentioned that the interaction occurs visually and verbally as virtual agents can represent a human role. These agents can represent real people in the form of human characters by instructing, giving feedback and directing attention [5]. The aim of this study is to investigate the effect of different realism designs of the 2D female virtual agents on students' arousal and emotions in learning.

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## II. LITERATURE REVIEW

### A. Virtual Agent

The technology using virtual agent is being widely utilized in different fields such as entertainment, film industry, education [6],[7] and finance [4]. In each different field, virtual agent appears with different contexts. For example, virtual agent plays role as a character in video games, avatar in immersive worlds and lifelike pedagogical agent in multimedia learning environments [8]. There are various learning platforms created using virtual agent.

The key function of virtual agent has expanded to aid learning process in the field of education [9],[10],[11]. This is through the motivational role of virtual agent to increase motivation among the learners in order to produce meaningful learning [12],[13]. Such roles include tutors, coaches and actors [14], expert, motivator and mentor [15], learning companions [16], change agents [17] and lifelong learning partners [11].

Even though researches on virtual agents have been being studied for nearly two decades, its efficacy is low in a learning environment. Thus, it remains debatable. In actual fact, the presence of a virtual agent in an interactive learning environment can promote learning process and generate positive perception of the learning experience [18],[19]. Although there is a positive impact on learning, the potential of virtual agents in facilitating the learning process is too broad.

The existing researches on virtual agent are often criticized as it is designed without control conditions to achieve unique pedagogical or motivation benefits [5]. Therefore, this research is focused on establishing the right design for a virtual agent in an educational setting in order to foster positive emotions in learning.

In order to foster positive emotions in learning, an appropriate design is crucial for the evolution of the virtual agent owing to this improvement determines how far it has reached to the learners. Past studies showed that learners get influenced to virtual agents until accept the agents as conversational partners throughout the learning process [20]. On the other hand, there are also some researches that indicate some designs of virtual agent could lead to frustration and disappointment among the learners [21]. Undoubtedly, this is due to the characteristics of virtual agent that are not be able to influence the emotions of learners although it can enhance learning [19]. Initially, human attitudes always change during the interaction with artificial beings [22].

This is due to the different human emotional responses caused by uncanny valley phenomenon [23]. According to Mori (2012), a character that is too realistic or almost resembles a human would eventually cause viewers to feel afraid and horrified when viewing these characters. Though, the designed characters for this research have escaped from the uncanny valley phenomenon which has been proven in the earlier research [10].

### B. Arousal

Emotions play an important role in human life. A stimulation on emotions can influence a person's behavior directly [24]. The emotions recognized through its received stimulus is known as affective experience. Affective experience is related to psychophysiological indices that differentiated by valence and arousal [25]. Both arousal and valence of affective experience help to define various emotional states as a notion of the uncanny effect [10],[26].

Arousal is a physiological mechanism that makes theoretical claims based on its potential for physiological mobilization. In other words, arousal is described through emotional experience that enrich with excitation or calm [27]. This arousal is categorized into positive or negative states through approach or avoidance behavior [28]. That is to say, arousal is ranging from being sleepy to energized (energetic arousal) and from being calm to tensed (tense arousal).

Indeed, higher feeling of excitement on the presently focused process can lead to achieve higher arousal without considering its later consequences [29]. Commonly, an individual seeks for frequent interaction with close and highly familiar people [30]. The communication with familiar people motivates an individual's behavior [31] and increases their arousal as well [30]. However, further increases in arousal cause the elimination of information that relevant to task [32]. Usually, high arousal is caused by the increment in one's own heartbeat [33]. Besides that, arousal is a factor that contributes to memory enhancement effect [34]. In addition, arousal is capable in driving attention and visual processing priority [35]. It is viewed that individuals are likely to give more attention on emotional arousal elements compared to neutral elements. This leads to the enhancement on memory performance. Still, high impact of arousal causes a narrowing of attention and motivation to learn [36].

Different realism designs of virtual agents caused different arousal level among students [10]. With regard to this, the question arises is if the students' emotions in learning are affected by the different arousal level caused by the character's design. Similarly, according to Clark (2017) too high arousal may decrease student's attention and motivation to learn. In contrast, literature reviews have indicated that there were no studies to support this statement. Accordingly, the present study attempts to fill the gap by studying on the effect of arousal on the designs of virtual agents and its effect on students' emotions in learning.

### C. Emotions in Learning

Emotions are very important contribution towards learning. Usually, students experience various emotions throughout the learning process [37]. Emotions play a very important role in creating a strong connection between learners and virtual agent during learning process [38]. Generally, emotions in educational setting are related to the contents of learning and teaching. From a pedagogical point of view, it becomes a critical goal for learners not only to learn the content but also to recognize and use their affective experience on the content of learning and the circumstances of learning. Likewise, learners' affective experience is interconnected with motivation and cognitive learning processes [39]. An individual's emotions influence the cognition success in the learning process [40],[41]. Also, recent studies have demonstrated that emotional experiences during learning influence motivation to learn and learning achievement (e.g., test scores) [42].

Commonly, emotions exist comprehensively in the human experience [43]. In particular, specific feelings that experienced by learners in academic settings are known as academic emotions [44]. Furthermore, according to Pekrun and his colleagues [41], academic emotions can be classified into positive activating emotions (enjoyment hope, pride); positive deactivating emotions (relief); negative activating emotions (anger, anxiety, shame) and negative deactivating emotions (hopelessness, boredom) as illustrated in the table 1 below [44].

**Table 1: Academic Emotions [41]**

| Activation | Valence | |
|---|---|---|
| | Positive | Negative |
| Activating | Enjoyment | Anxiety |
| | Pride | Anger |
| | Hope | Shame/fault Relief |
| Deactivating | Relief | Boredom |
| | | Hopelessness |

Moreover, emotional experiences also impact learners' interest, engagement and personality development towards achievement in learning [37],[43],[45]. Adding to this, the increment of self-efficacy beliefs through emotional experiences encourage students to attach to difficult tasks and previous failures [45]. Subsequently, positive emotions facilitate learning and thereby promote effective teaching and learning [37]. Therefore, it is important to see the suitable virtual agent's design in teaching and learning which stimulates students' emotions in learning. Nonetheless, there is no reliable evidence shows that different realism designs of agent affect students' emotions in learning.

## III. METHOD

### A. Research objectives and hypothesis

The purpose of the study is to observe the effect of realism designs of 2D female virtual agent on students' emotions in the dimension of arousal and its effect on students' emotions in learning as a whole.

a) To analyse the effect of different realism designs of the 2D female virtual agents on students' arousal.
b) To analyse the effect of Quiz based Multimedia Learning Environment (Q-MLE) with different realism designs of the 2D female virtual agents on students' emotions in learning.

c) To analyse whether arousal caused by different realism designs of 2D female virtual agents is a significant mediator in determining students' emotions in learning.

Therefore, the hypotheses of this study are:

1) There is a significant effect of different realism designs of the 2D female virtual agents on students' arousal.
2) There will be significant effect of Quiz based Multimedia Learning Environment (Q-MLE) with different realism designs of the 2D female virtual agents on students' emotions in learning.
3) Arousal caused by different realism designs of 2D female virtual agents is a significant mediator in determining students' emotions in learning.

### B. Development of Virtual Agent

It was stated in the past studies that students are benefited from female agents compared to male agents in learning [1]. On the other hand, elements of virtual agents should reflect the cultural value of the country in which they were originated and tested [46]. To add, female virtual agent of Malaysian native-look was selected for the investigation purpose of this research. So, the appearance of the female virtual agent represents a young Malaysian Malay lady as a subjective approach to cultural acceptance.

The clothes for the four virtual agents were kept similar. The four prototypes which are realistic agent, semi-realistic agent, stylized agent and cartoon-like agent were amended based on the past studies [6],[40],[47].

To brief, the four 2D female virtual agents' designs are as follows:

1. Realistic agent
   This strategy uses an animated character that is realistic (designed very detailed and it mimics like human).
2. Semi-Realistic agent
   This strategy uses an animated character that is medium realistic (not as detailed as the realistic).
3. Stylized agent
   This strategy uses an animated character that is stylized (cartoon character with exaggerated features).
4. Cartoon-like agent
   This strategy uses an animated character that is iconic match a typical cartoon model (simplified geometry of the face).

Each designs were sent to five experts, local and internationally for validation. It is to ensure the virtual agents' designs are according to realism levels. Based on their feedbacks, the designs were altered as shown in Figure 1.


**Fig. 1: Different realism designs of virtual agent**

### C. Development of Quiz based Multimedia Learning Environment (Q-MLE)

The developed quiz was fully based on Multimedia Learning Environment (MLE) that encourages learning among students (Mayer, 2008). Indeed, a well-established line of researches demonstrated that students came about to learn better through words and graphics, in comparison to words alone [48]. Hence, the Quiz based Multimedia Learning Environment (Q-MLE) was designed using Gagne's nine events of instruction [49] and integrated with several multimedia elements such as texts, graphics, audio and video clips, as well as animation.

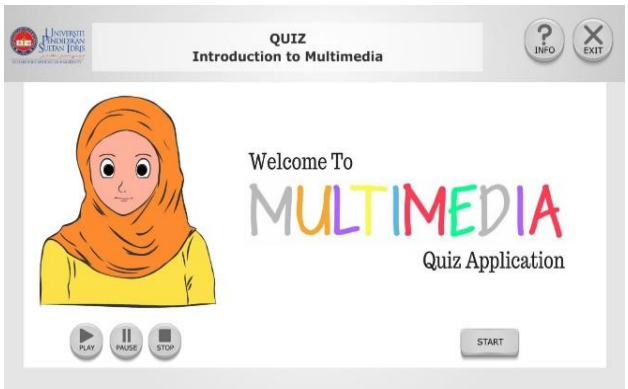


**Fig. 2: Cartoon-like agent Q-MLE**

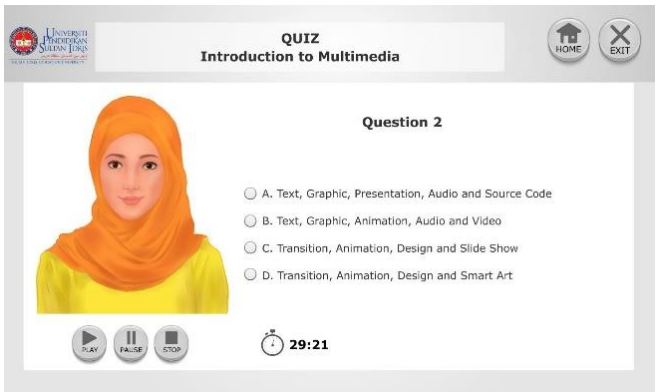


**Fig. 3: Realistic agent Q-MLE**

The virtual agent appears at all times throughout the Q-MLE to guide the students with multiple spoken dialogues; acting as a social affinity between the student and the virtual agent. The Q-MLE is comprised of 20 questions derived from the first chapter of the chosen subject. The students were required to answer 20 multiple-choice questions provided by the virtual agent. Initially, the virtual agent is designed to provide response upon students' choice from the given answer options.

### D. Instruments

In order carry out the survey, the self-assessment manikin (SAM) nonverbal pictographic questionnaire [50] was used to measure students' individual emotions in the dimensions of arousal on the different realism designs of the animated virtual agents. With respect to this, each virtual agents' designs were rated by students using nine-point scale with

pictorial manikins that represent varying value of arousal (ranging from low to high arousal). Whereas, in order to measure students' emotions in learning, a short-form learning-related achievement emotions questionnaire (S-F-L-AEQ) [51] which was derived from original AEQ [52] was used to further answer the research question of this study. Typically, there are eight different categories of emotions in the SF-L-AEQ, which are enjoyment, hope, pride, hopelessness, boredom, anger, anxiety and shame with total of 24 items each. Also, SF-L-A-EQ is a Likert type questionnaire with four degree ranging from one (strongly disagree) to four (strongly agree).

### E. Participants

The target participants for this quiz are students from fourth and fifth semester who have enrolled in DEC5082 term for Interactive Multimedia Applications subject. In particular, the subject is offered in 12 out of 36 polytechnics in Malaysia. Therefore, the study was conducted in seven polytechnics from north, central and south zones. Total 600 students (150 for each group) from electrical engineering department were selected as the sample of study. Students were randomly chosen for four different groups of realistic, semi-realistic, stylized and cartoon-like agents. Subsequently, the experimental study was conducted separately for all the groups in a controlled lab environment. Among the participants, 353 students were male while 247 were female with mean age 20.27 (SD = 0.66) took part in this study. The students were from different ethnics (88.5% Malays, 7.8 % Indians, 1.7 % Chinese and 2.0 % others)

### F. Procedure

Prior to the experiment, the first chapter of the chosen subject has been already taught by their respective lecturers. Alternatively, on the experiment day, students were briefed about the purpose of the experiment being conducted and the role of arousal in investigating the influence of realism designs of 2D virtual agents in Quiz based Multimedia Learning Environment (Q-MLE). Furthermore, students were explained about the rules and regulations in using the Q-MLE. This was to make sure the process run well as planned. Eventually, the experiment has been carried out by allowing students to explore the Q-MLE for 5 minutes. Selected virtual agent was shown to the students. Then, the adapted Self-Assessment Manikin (SAM) nonverbal pictographic questionnaire was given to measure students' arousal level. Taking this a step further, students were allowed to answer the quiz questions in Q-MLE which contained 20 multiple choice questions. Around 30 minutes were allocated for students to answer the quiz. Subsequently, SF-AEQ was distributed to students in order to measure their emotions in learning after they had successfully answered the quiz. Primarily, the experiment was conducted by the same instructor for all the groups.

## IV. FINDINGS

ANOVA test was used to answer first research question and Mediation Analysis (Bootstrapping Method) was carried out for the second research question.

### A. One-Way ANOVA Test Analysis for Arousal

Overall, ANOVA was used to test whether there is any significant difference in arousal between student groups based on different realistic designs of virtual agent which are realistic, semi-realistic, stylized and cartoon-like agents. As a result of the ANOVA test, it is found that there is a significant difference between arousal and different realism designs of virtual agents with $F(3, 596) = 15.79$, $p < 0.05$, partial eta squared = 0.07 of which the effect size is medium according to Cohen (1988). Hence, first hypothesis of this study is acceptable.

Alternatively, in order to find out which virtual agent pairs show significant difference, Tukey's post hoc comparison tests were performed. The descriptive statistics concluded that semi-realistic agent obtained the highest mean score for arousal (M = 6.99, SD = 1.66, n = 150) followed by realistic agent (M = 6.35, SD = 1.74, n = 150), stylized agent (M = 6.13, SD = 1.64, n = 150) and cartoon-like agent (M = 5.64, SD = 1.84, n = 150).

Additionally, the results of the pairwise comparisons test using the Tukey's method showed that the mean difference of arousal for realistic and cartoon-like agents (MD = 0.71, $p < 0.05$), semi-realistic and realistic agents (MD = 0.63, $p < 0.05$), semi-realistic and stylized agents (MD = 0.85, $p < 0.05$) and semi-realistic and cartoon-like agents (MD = 1.35, $p < 0.05$) are significantly different. Besides that, the mean difference between realistic agent and stylized agent (MD = 0.22, $p > 0.05$) and stylized and cartoon-like agents (MD = 0.49, $p > 0.05$) has no significant difference.

### B. One-Way ANOVA Test Analysis for Emotions in learning

ANOVA test was used to test whether there is any significant effect of different realism designs of the virtual agents which are realistic, semi-realistic, stylized and cartoon like on students' emotions in learning. The results of the ANOVA test indicated that there is a significant difference between emotions in learning and different realism designs of virtual agents with $F(3, 596) = 2.89$, $p < 0.05$, partial eta squared = 0.01 of which the effect size is small according to Cohen (1988). Hence, the second hypothesis of this study is acceptable.

Subsequently, to identify which virtual agent pairs show significant differences, Tukey's post hoc comparison tests were performed. The descriptive statistics showed that cartoon-like agent obtained the highest mean score for emotions in learning (M = 76.58, SD = 9.43, n = 150) followed by semi-realistic agent (M = 76.02, SD = 9.74, n = 150), realistic agent (M = 74.87, SD = 9.67, n = 150) and stylized agent (M = 73.67, SD = 8.63, n = 150).

In contrast, the results of the pairwise comparisons test using the Tukey's method showed that the mean difference of emotions for cartoon-like and stylized agents (MD = 2.91, $p < 0.05$) is significantly different whereas realistic and stylized agents (MD = 1.21, $p > 0.05$), semi-realistic and realistic agents (MD = 1.15, $p > 0.05$), semi-realistic and stylized agents (MD = 2.35, $p > 0.05$), cartoon-like and realistic agents

(MD = 1.71, p > 0.05) and cartoon-like and semi-realistic agents (MD = 0.56, p > 0.05) showed no significant difference.

### C. Mediation Analysis (Bootstrapping Method)

Mediation analysis was tested using PROCESS macro (v3.3) for SPSS to test whether there is any significant relation between students' emotions in the dimension of arousal. This is due to the fact that arousal is the mediator to the relationship between different realism designs of virtual agents and emotions in learning. Therefore, the hypothesis was tested using mediation analysis based on Hayes (2018). In addition, mediator (M; arousal) proposed to explain the relationship between an independent variable (X; realistic, semi-realistic, stylized and cartoon like agents) and dependent variable (Y; emotions in learning). This model is a simple mediation model.

Mediation analysis was tested using the bootstrapping method with bias-corrected confidence estimates [54]. In the present study, the 95% confidence interval of the indirect effects was obtained with 5000 bootstrap resamples [54]. The summary of the results is as shown in Table 2. Firstly, it was identified that the direct effect (c') high to low realistic level virtual agents (X) was positively associated with emotions in learning (Y) (ß = 0.597, t = 1.746, p = 0.081). It was indicated that other variables are controlled in the model; high realistic agents score 0.597 units higher on the emotions in learning scale. Hence, the effect is not statistically significant.

**Table 2: Descriptive statistics Regression coefficients, standard errors and model summary predicting score on emotions in learning**

| Path | High realistic agent Versus Low realistic agent | | | | |
|---|---|---|---|---|---|
| | Coeff. | SE | p | 95% CI | |
| | | | | Lower | Upper |
| Total effect (c) | 0.277 | 0.341 | .418 | -0.394 | 0.947 |
| Direct effect (c') | 0.597 | 0.342 | .081 | -0.074 | 1.268 |
| $a_1$ | -0.299 | 0.064 | .000 | -0.425 | -0.174 |
| $b_1$ | 1.039 | 0.331 | .002 | 0.389 | 1.689 |
| Indirect effects | | | | | |
| $a_1b_1$ | -0.311 | 0.117 | - | -0.564 | -0.114 |

In addition, the relationship between virtual agents are negatively related to arousal ($a_1$)(ß = -0.299, t (598) = - 4.67, p= 0.000). In brief, for path a1 it was found that lower realistic agents (as opposed to high realistic level agents) decreases arousal by -0.299; this effect is significant. Secondly, the results also indicated that the mediator, arousal ($b_1$), is also positively associated with emotions in learning (ß = 1.039, t(596) = 3.14, p = 0.002). This concludes that the impact of arousal on emotions in learning is ($b_1$) 1.039; this effect is significant. Consequently, the indirect effect of virtual agents' design on the students' emotions in learning through arousal ($a_1b_1$ = -0.311) is significant because this confidence interval is below zero (- 0.564 to -0.114) (ß = -0.311, CI = -0.564 to -0.114). Hence, arousal has mediating relation between different realism levels of agents' design and emotions in learning. The total effect (c), of high to low realistic level virtual agents was positively associated on emotions in learning through arousal (ß = 0.277, t (598) = 0.810, p=0.418) which means high realistic agents increases emotions in learning (because c is positive). However, this effect is insignificant. Thus, the mediating effect of arousal in the relationship between different realistic level of virtual agents and emotions in learning is illustrated sin Figure 4.

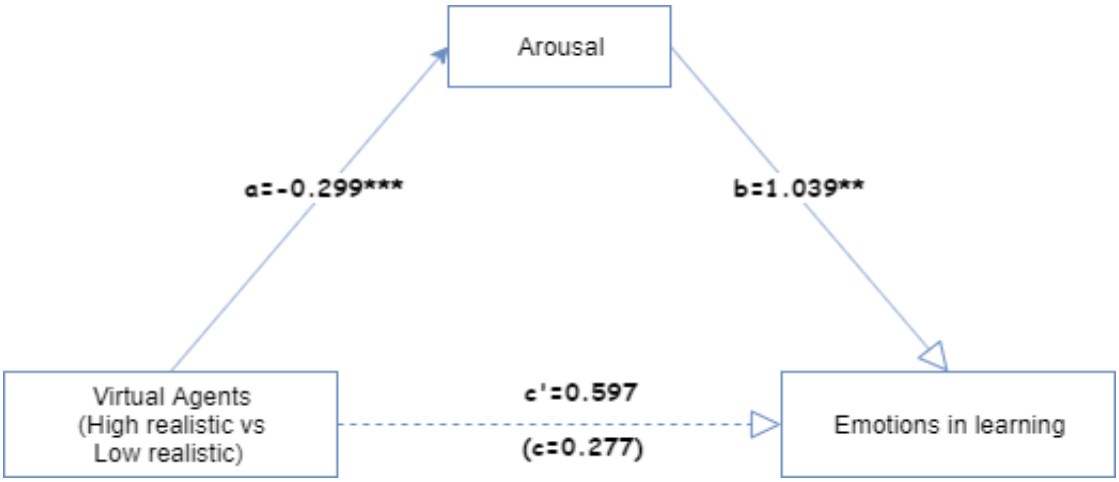

**Fig. 4: The mediating effect arousal in the relationship between different realism designs of virtual agents and emotions in learning.**
**Notes: The figure shows regression coefficients. The dashed line represents non-significant coefficients. *p < .05, **p < .01, ***p < .001**

## V. DISCUSSIONS

### Hypothesis 1

Based on the findings, semi-realistic agent has achieved a higher rate of physiological arousal. The high level of arousal can only be experienced by a very high feeling of excitement. In view of that, students reached the heightened state of energy spontaneously at the first look of the semi-realistic agent on the screen. Since the semi-realistic agent is appeared to be as close as the students' appearance, the excitement level of the students towards the virtual agent has increased immensely. In fact, the human-like features of the semi-realistic agent likely to bring about more effect on the students. This is parallel to the statement made by Perkins et al. (2001) which described that greater level of arousal is raised when individual feel excited and less serious when they are concerned with the process that they presently focused rather than its outcomes or consequences.

The designed semi-realistic agent has one fundamental characteristic which is pinkish beiges skin with a facial look that portrays native Malay people. In actual fact, Malays are the largest ethnic group in Malaysia, mostly Muslims and practice Malay culture. The spoken language of the semi-realistic agent is clear and standard English language dialects. These dialects were recorded in a localized Malaysian's female voice which sounds exactly as how humans articulate. The combination of local people's physical appearance of facial look, attire and voice has prepared an environment where students could feel that they were facing or interacting with a person who can be easily recognizable and close to their own physical features. Hence, the presence of such elements on semi-realistic agent's appearance has offered a high degree of excitement among the students. Their enthusiasm towards the semi-realistic agent was seen from their praiseworthy actions that act as a source of pleasure towards the semi-realistic agent that has a convincing appearance. This is supported in the study by Vogel et al. (2017) which revealed that the contact with familiar people motivates an individual's behavior [31] and consequently increases his or her arousal. Here, the result may differ if a male agent or different ethnic is used.

On the other side of the coin, it was revealed that mean score was the lowest when a virtual agent being portrayed with cartoon-like features. This result showed that students' affective experience with the cartoon-like agent was less emotionally aroused compared to the other virtual agents. This is due to the design of cartoon-like agent that has used an abstract style with less visual details. The visual style and shapes of the cartoon-like agent were expressed through silhouette edges. Thus, it looked simple to the students although the look for the design come from real human's appearance. This is in conjunction with the statement by Schneider et al. (2007) who found that even cartoon-like character clearly display human appearance but still its' abstract features strongly giving the impression that it is not identical to the real human. Thus, the flat looking 2D cartoon-like agent was less attractive to the students compared to other agents. This strengthens the argument by Wang and Rochat (2017) who stated that the unreal faces were significantly less attractive than the real faces. Consequently, students were less intense to the design of the cartoon-like agent and thus caused the lowest arousal rate among them.

When comes to realistic agent, its' concrete and detailed visual were evoked the second highest mean score for the arousal. This result showed that students were more physiologically aroused when they encountered the realistic agent as it imitates like a human. The above finding is consistent with the study by Mitchell et al. (2011) which examined that the sense towards a realistic agent that resembles as a human is being the highest due to the self-identification of the students. Basically, a successful realistic agent is designed with the illusion of reality. It seems to be clear that greater attention has been given to the factor of realism in the design of realistic agent. As a result, all the facial features for the realistic agent fit together perfectly as a human. When the realistic agent is precisely developed, it became a believable agent to the students as they can recognize it well. Consequently, they were attracted to the realistic agent that carried them to the state of high arousal. This is consistent with the statement of James et al. (2015) which showed that when an agent is realistic, it is seen to be credible and attractive to viewers.

Meanwhile, students were less physiologically aroused when the virtual agent design is represented in stylized form compared to realistic agent. This can be seen through the mean score for stylized agent which was lower than realistic agent. The findings from Wang and Rochat (2017) also claimed that unreal appearance of virtual agent is less attractive than the real human-like virtual agent. Generally, stylized agent is a non-realistic agent which is created with a greater appearance with a combination of many styles than an abstract cartoon-like agent. The customized style or look of the stylized agent has been made of some favourable arrangements to the features. These features are very common and they are made to be easily recognized by the students as the look is close to a real human. The stylized agent was designed with a good abstraction of details to initiate exaggerations so that the virtual agent can be easily perceived as an agent with stylized look by the students. This has been supported by Zell et al. (2015) who stated that stylish look can be designed by increasing an agents' appeal or expressivity, exaggerating or softening specific features. Based on the research finding, the degree of stylization of the stylized agent had an effect on the students' interest by falling in high affective state.

This is in line with statement by Adamo-Villani et al. (2016) which stated that the stylized agent is perceived as an appealing design. Nevertheless, with the enhanced style, stylized agent in this research was unable to reach very high arousal effect among the students. This on the other hand is good in terms of producing an appropriate design.

**Hypothesis 2**

The results have revealed several interesting facts. Cartoon-like agent has scored the highest score among the other virtual agents in emotions in learning. This result indicated that the subtle design of cartoon-like virtual agent positivity bias in perceiving emotions in the process of learning. Besides that, there was a substantial increase in the emotions in learning when using a cartoon-like agent compared to the emotions in the dimension of arousal on cartoon-like agent in isolation. This finding showed that there is a connection between both the analysis when the highest score demonstrated in emotions in learning is due to the arousal effect. According to Lu et al. (2017), less arousing emotional states lead to better overall cognitive-motor performance than highly arousing emotional states. The cognitive-motor performance is very much associated with students' performance in learning process. According to Clark (2017), high engagement on the cognitive level is essential for students to perform well in learning process. Thus, arousal must be kept at moderate level to divert learners' full attention on the subject matter. Therefore, students with the lowest arousal score (yet positive) towards the cartoon-like agent before the learning process had high emotional state during the learning process.

Basically, arousal is strongly connected to task performance as it affects an individual's attention. This is in line with the statement by Vesker et al. (2018) that highlighted the capability of arousal in driving attention and visual processing priority. Attention can become either too narrow with too much arousal or too broad with too little arousal. This is supported by the statement by Clark (2017) which revealed that too high arousal decreases student's attention and motivation to learn. According to hypothesis one, cartoon-like agent has the lowest score for arousal. This concludes that students were not too excited about the agent. Besides, the cartoon-like agent with mid-level point of arousal has developed the motivation to learn among the students. Also, it allowed the students to focus attention on the learning process as they develop a sense of being in control in their learning environment. Thus, the students became fully involved and occupied in the learning process. Conversely, further investigation is needed to find out if this moderate arousal may lead to student's better performance.

Despite that, it is very common to use simple abstract style cartoon agents for games. Jin et al. (2016) added that the use of simple abstract style virtual agent in game is capable to create large space for players to easily fill their self-image into it and generates more effects in their experience. Similarly, when cartoon-like agent used in Q-MLE, students are able to identify themselves with the agent, accept it and engage fully in the learning process. In this case, a cartoon-like agent has greater impact on students' affinity towards learning. Also, Habib and Soliman (2015) have proven that cartoon agent has great influence over children where they are habitually attracted to the cartoon content and they prefer to watch cartoons for long hours. This is also applicable to teenagers as proven in the research findings.

In the present research, there were no significant differences between semi-realistic agent and any other agents. Same result has been achieved by the realistic agent as both the virtual agents remained fairly similar with typical features as a human face. Therefore, both virtual agents also produced higher emotional effect on learning. In the dimension of arousal, the increases in arousal will result in the increase of cognitive task performance, up to a point where very high arousal will affect it. It had been predicted that the high level of arousal during the earlier analysis did not go beyond the optimal arousal that allows students to experience pleasant excitement and focus well during the learning process.

In addition, the study by Roxas et al. (2018) examined that emotions are an important element in order to create strong connection between human and virtual agent during learning process. Since the semi-realistic and realistic agents are appeared to be same age group with the students, they could interact easily by accepting the virtual agents as their friend. The finding was consistent with findings of past studies by Vogel et al. (2017) which supported that an individual seek for frequent interaction with close and highly familiar people.

Conversely, stylized agent has reached the mean score that indicating the lowest emotions in learning. This may be caused by a typical features of the stylized agent that decreased students' emotions in learning. Some of the features exaggerated for stylized agent are enlarged eyes, smaller nose and mouth. Similarly, Kätsyri et al. (2015) highlighted that faces with typical or average features are considered more attractive than atypical face in their study. Also, Kätsyri et al. (2015) added that some agents in the 'human' category would be viewed as creepy as they look like human yet contained features such as exaggerated eyes which is not 'entirely right'.

**Hypothesis 3**

In addition, in the third study the result showed arousal has played a mediating role between different realism designs of the virtual agents and students' emotions in learning. The role of arousal as mediator can be seen clearly through the existence of relationship between students' emotions in the dimension of arousal which is caused by different realism designs of the virtual agents and emotions in learning. This result underlined that as the degree of realism level decreases, arousal decreases too and consequently lower arousal was associated with higher emotions in learning. In other words, students who were exposed to lower realism level of virtual agents had experienced lower arousal and thus their emotions in learning process increased significantly. Conversely, students who viewed higher realism level of virtual agents had experienced higher arousal and subsequently they had lower emotions in learning. In short, the rise of arousal through the first look on the virtual agents has influenced the overall affective experience in then learning process. However, highly aroused emotions in this research has not produced a very low emotional state during the learning process. Interestingly, this is due to the achievement of arousal that it did not go beyond the optimal level.

## VI. CONCEPTUAL FRAMEWORK OF VIRTUAL AGENTS BASED MULTIMEDIA LEARNING ENVIRONMENT (VA-MLE)

The main objective of this research is to overview the arousal on different realism designs of virtual agents and its effect on overall emotions in learning. Mayer's multimedia learning cognitive theory, Mori's uncanny valley phenomenon and James Russell's Circumplex Model of Affect are used as the basis to construct conceptual framework in this study. The use of these theories is due to the needs of research that investigated on realism factor on virtual agents' design and its' effect on influencing students' emotions during learning in Quiz based Multimedia Learning Environment (Q-MLE). As a result of the current research findings, a conceptual framework was developed as shown in Figure 5. The conceptual framework serves as a useful tool to represent current research and it acts as a reference for further study by other researchers.

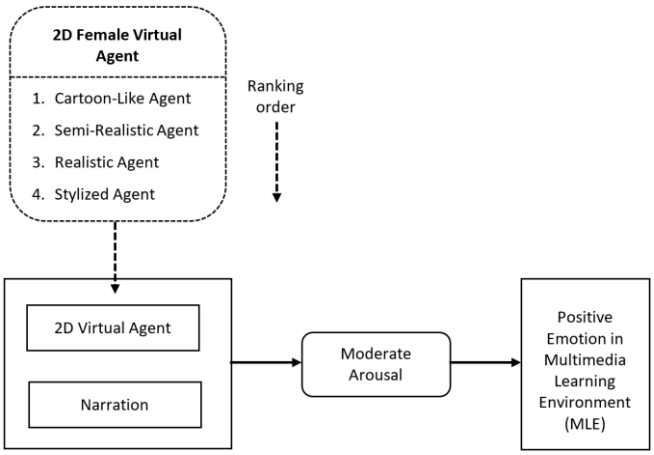


**Fig. 5: Conceptual Framework of Virtual Agents based Multimedia Learning Environment (VA-MLE)**

The conceptual framework comprises different realism designs of 2D female virtual agents in Q-MLE, individual emotions in the dimension of arousal and overall emotions in learning that interconnected to each other. First, the research emphasized on the design of virtual agents by representing in four different realism designs. This includes realistic, semi-realistic, cartoon-like and stylized agents. Each virtual agent has its own features according to its respective realism levels. These include skin texture, colour, attire and native Malay female look. Along with these, the virtual agents were presented with suitable young Malaysian female voice as narration that match well with the virtual agents. The role of realism in virtual agents with appropriate narration served as influence factors in order to stimulate students' emotional experience in the dimension of arousal. Arousal is a crucial dimension in this research since it represents students' affective experience that has influenced their overall emotions in learning through the interaction with virtual agent.

In fact, arousal plays a mediator role between the different realism designs of virtual agents and overall emotions in learning the Q-MLE. In other words, there is a significant relationship between virtual agents, arousal and emotions in learning. From there, it has been identified that cartoon-like agent is the best effective agent among the other virtual agents in inducing positive emotions in learning. This followed by semi-realistic agent, realistic agent and stylized agent respectively. As conclusion, the constructed conceptual framework for this research acts as a guideline for the development of virtual agents in any other MLE such as tutorial system, teaching aid and so on.

## VII. CONCLUSION

This research has focused on the realism factor on designs of virtual agents and its effect on emotions among students. The emotions are comprised in the dimension of arousal and emotions in learning process. It has been discovered that the four different realism designs of virtual agents were in the high arousal (positive). Evidently, the mean score value of semi-realistic agent was the highest for arousal followed by realistic agent, stylized agent and the lowest score for cartoon-like agent. It can be clearly seen that the students' score for the virtual agent depends on its design specifically on the realism factor. Students were excited and pleasure in viewing virtual agents that are in same age group as them. Besides that, the native Malaysian look, attire and other features of the virtual agents appeared to be beautiful and attractive to be viewed by the students.

In the other way around, when the virtual agents were implemented in Quiz based Multimedia Learning Environment (Q-MLE), the results were different where cartoon-like agent has scored the highest mean value for emotions in learning. As the students' activation increased during the learning process, they were triggered by the repeated exposure of virtual agent that stimulated them to demonstrate different responses. Clearly, it had been found that low arousing cartoon-like agent increased students' attention in learning that led to achieve highest score as proven in third hypothesis. Thus, it is proven that too high arousal may decrease student's attention and motivation to learn.

After all, the third hypothesis has revealed that arousal is perceived as a significant mediator to the relationship between different realism designs of the virtual agents and emotions in learning. Lower realism level of virtual agents has experienced lower arousal and subsequently they had higher emotions in learning. In overall, the present study had implications in determining the effect of realism designs of virtual agents on emotions in learning through the arousal as a significant mediator for the research.

## IMPLICATION TO MULTIMEDIA DESIGNER

A high skill is required to combine various multimedia elements in a production of interesting and effective Multimedia Learning Environment (MLE). In the current research, the Quiz based Multimedia Learning Environment (Q-MLE) was developed in the combination of all the multimedia elements by using narration as audio, interaction of virtual agent as combination of video and animation, graphic user interface as graphic and rules and regulations as text as well. Moreover, the placement and alignment of each multimedia element such as button and text and the choice of colour for interface design prototype of the Q-MLE were well-designed based on the previous studies. Adding to this, the content and structure of the Q-MLE are well-organized based on Gagne's Model.

Besides that, the findings of the research have contributed in the selection of appropriate virtual agent for Q-MLE that is effective in inducing positive emotions among the students in learning. Addressing these specific factors in the development of Q-MLE, the instructional designer was able to quickly create a new MLE for any other course material without spending more time on it.

In particular, the design of virtual agent plays an important role in determining the success of using it in educational settings. Thus, this research explored the experiences of pleasant and excitement in students' emotions when watching native Malaysian look virtual agents with different realism designs. The results of the research have shown a strong evidence that the use of the four designs of virtual agents for Quiz based Multimedia Learning Environment (Q-MLE) successfully stimulated positive emotions among students during the learning process. Therefore, the four virtual agents can be useful guideline for character designer in developing such characters for education purpose in order to elicit maximum effectiveness in learning.

## VIII. LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The findings showed that the four different realism designs of virtual agents scored high arousal (but not too high). This is especially due to the design of 2D female virtual agents which was emphasized on the native Malaysian look. Hence, it looks very familiar to the students and subsequently highly liked by them. However, the results may differ if virtual agents with male native look are used. Apart from that, the results may differ if the virtual agents are designed as different ethnics. Other than that, the present research is focused specifically about the emotions in learning. Thus, this research can be extended in order to investigate students' performance on the subject with different realism designs of virtual agents.

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