ORIGINAL ARTICLE

Investigating effects of avatars on primary school children's affective responses to learning

Yin-Leng Theng · Paye Aung

Abstract Costly time and resources have been invested to produce virtual learning environments with avatars as companions or tutors to enhance learning experiences. However, there is little research carried out to get feedback on these purposefully designed artifacts for learning. The paper describes a follow-up study applying the OCC, a well-referenced, cognitive theory of emotions, to investigate learners' emotional experiences and motivations while using a learning package designed for primary school children (6–8 years old). Specifically, the study aims to examine whether the expressions of avatars have an influence on these young children's emotional responses and motivation towards learning. Preliminary findings with twenty-four young children participants showed that they loved avatars and influenced by avatars' expressions on their performances. The participants also expressed feelings of satisfaction and fun in their learning interactions with their selected avatars. There was a gender-biased towards the 'gender' of the avatars. The paper concludes that avatars implemented with appropriate underlying pedagogical considerations and purposes can be beneficial to learners in virtual learning environments, especially young children.

Keywords Avatars · Emotion · Motivation · Learning · Primary school children

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1 Introduction

Recent design of virtual learning environments sees an increased use of avatars as pedagogical agents and these avatars can act as intermediary learners or groups of learners between system and learners. Avatars, also called virtual assistants, are virtual characters designed to make communication between the users and the learning environments more natural and interactive. By means of a computational emotional model based on cognitive theories, Ortiz, Oyarzun, Carretero and Garay-Vitoria [10] argued for avatars to be given the capacity of having and expressing emotions.

In designing learning environments for children, avatars are often used as pedagogical agents/tools for the simple reason that children love avatars, and are naturally drawn to the fun of "playing or learning together" with virtual characters [2]. Avatars in e-learning systems may appear as virtual teachers (virtual coaches), virtual instructors and sometimes they can be seen as virtual co-learners to the children. Avatars are widely deployed in the domain of education and learning, and are used to add the fun element and enhance children's learning experiences. Many learning packages use avatars as virtual teachers to attract children's attention and make them more engaged in learning and more motivated. Maldonado and Nass [8] state that avatars when properly deployed may generate additional interest and motivation in the content presented.

In this paper, we describe a follow-up study, applying the well-referenced cognitive theory of emotions to investigate primary school children's (6–8 years old) emotion experiences and motivations while using a learning package. Specifically, in contrast to earlier studies, this follow-up study aims to examine whether expressions of avatars have an influence on young children's (6–8 years old) affective responses in learning. Section 2 discusses related work and

the challenges faced. Section 3 explains underlying theories, and Sect. 4 describes the study with findings and analyses discussed in Sect. 5. Section 6 concludes with implications of avatars for the virtual learning environments.

2 Related studies

In the Web 2.0 virtual learning, avatars as virtual instructors in learning systems also include emotions such as showing happy or sad expressions drawing learner's attention to the learning systems and contents. Fabri and Moore [3] advocate that emotional expressiveness of avatars in real-time communication in virtual learning environments is likely to affect learners' experiences. According to Bartneck [1], learners may feel joyful and fun when interacting with avatars while learning. In embodied characters, emotions represent an essential part of the system to interact with the children. An emotion is a mental and physiological state associated with a wide variety of feelings, thoughts, and behavior [10].

Emotions are subjective experiences, or experienced from an individual point of view, and are often associated with mood, temperament, personality, and disposition. Bartneck continues to suggest that for maximum effect, avatars or animated characters need to reveal the right emotional expression with the right intensity and at the right time [1]. In the real world, emotions may have an impact on users in terms of their decisions and emotional states [3]. For example, emotional expressions of other people can influence our emotional responses, that is, we feel joyful when confronted with joyful emotions. Similarly, we feel upset or angry when we experience other people's angry emotions, etc.

Studies (e.g. [4]; etc.) suggest that positive emotions are fundamental and play important roles in improving creativity and flexibility in problem solving, while negative emotions have negative impact on the process. Similarly, in the virtual learning process, learner's learning experiences could be dependent on virtual agent's "emotional expressiveness".

Okonkwo and Vassileva caution that the usage of avatars as personified agents in the virtual world should be investigated in more depth to examine the actual usefulness of avatars in learning environments [9]. Further, there are few empirical studies to understand the impact of avatars on learners' emotions and motivations in learning to investigate the state of emotions as experienced by the learner when interacting with the avatar co-learner or instructor. Conati and Zhou [5] adapted the OCC theory of emotions explicitly to identify user emotions in their educational game [11]. In another study, Katsionis and Virvou [7], focus on how the goals and standards of the students are related to their emotional states and provide a formula to calculate the intensity of the students' emotional states.

To-date and to the best of our knowledge, few studies have explored the effects of avatars on learners and impact on their learning [6]. We feel it is important that avatar's expressions be further investigated to understand their impact on learning experiences since much resources have been invested by incorporating sophisticated and graphically appealing avatars at much cost.

In our studies, we focus on young children (6–8 years old) attending Primary 1 or Primary 2 in local schools in Singapore. We selected this age group because we observe that children of this age group like avatars or cartoon characters, and most of them even have favourite characters such as action heroes. Tapping upon their extrinsic interest in avatars or cartoon characters, our series of studies aims to investigate whether avatars in virtual learning environments can create positive experiences in children, and hence influence their emotional responses and motivation towards learning.

We conducted two pilot studies in 2008 and 2009. In Pilot Study 1 [14], five boys (aged 6–8 years old) took part. In Pilot Study 2, we repeated Pilot Study 1 with 5 girls. Initial findings show that the participants liked interacting with avatars of the same gender as themselves.

This paper describes a follow-up study to Pilot Studies 1 and 2 with more subjects (6–8 years old) in a local primary school to investigate whether:

- *positive* emotional expressions from avatars will create positive affective responses from young children, hence positive motivation to learning; and
- *negative* emotional expressions from avatars will create negative affective responses from young children, hence negative motivation to learning.

3 Underlying theories

3.1 Theories on emotions and measurements

To address the study objectives, we reviewed related studies on emotions and their measurements. Well-cited works include a communication-based theory developed by Weiss and Cropanzano [13] that looks at the causes, structures, and consequences of emotional experience (especially in work contexts). This theory suggests that emotions are influenced and caused by events which in turn influence attitudes and behaviors. Another well-established cognitive theory, the OCC theory of emotions [11], named after the researchers Ortony, Clore and Collins, has been referenced as the standard model for emotion synthesis in which it has been used to generate emotions for embodied characters and model user emotional states [7]. As our study was focused on the emotional states of young children as a result of interacting with avatars with emotional expressions, we adapted the OCC model which divides emotions into three types [11]:

Fig. 1 Opening screen of the learning package

- *Goal-based emotions*. The assumption here is that the learner has goal(s) for learning, and the intensities of emotions experienced in learning are dependent upon the successes or failures experienced by the learner. In the OCC theory of emotions, variables are used to measure an anticipated event, falling under these 3 states: (i) "unconfirmed" with no feedback given; (ii) "confirmed" with feedback given, success in meeting goal(s); and (iii) "disconfirmed" with feedback given, failure in meeting goal(s). If a goal is confirmed/disconfirmed as "success" or "failure", emotions of "joy" and "distress" are respectively generated. However, if a goal is unconfirmed, emotions of "relief or fears-confirmed" are experienced.

- *Standard-based emotions*. This refers to the degree of judged praiseworthiness or blameworthiness of the action of an agent/user as a result of effected standard. That is, when action is attributed to one's self, emotions of "pride" or "shame" will result, but when attributed to an external agent, "admiration" or "reproach" could result.

- *Attitudes-based emotions*. Under the OCC model, attitudes come as love or hate, and it is the degree to which an object is considered appealing or unappealing.

3.2 Theories on emotions and measurements

We implemented a window-based learning package based on Primary 1 and 2 science syllabus with learning and tutorial sessions. Figure 1 shows a screen dump of opening screen introducing the learning package.

The prototype was designed with three different learning sessions and three tutorial sessions. After each learning session, a tutorial session was designed to assess how well the children learned. The tutorial sessions consisted of simple, factual questions based on the science lessons. So, if the participants concentrated on the science lessons, they would be able to answer the questions. We used only factual questions as it was not the intention of the study to test the depth and levels of learning.

The prototype allowed the learners to choose from a group of four avatars (1 male senior, 1 male junior, 1 female senior and 1 female junior) as shown in Fig. 2. The selected avatar would then appear as virtual instructor in all the three learning and tutorial sessions displaying either happy (confirmed answer is correct), or sad (disconfirmed answer as incorrect) expressions.

Although learners have goals, and we discussed about goal-based emotions for anticipated or unanticipated events previously, the OCC theory of emotions can also be viewed as three main branches [16], corresponding to the three ways people react to the world: (i) first branch relates to emotions coming from aspects of objects; (ii) second branch relates to emotions as a consequence of events; and (iii) third branch relates to consequences of events.

For our study, we focused on the second branch and specifically on the "Prospect-Based" emotions category referring to emotions hope, which can be either confirmed as satisfaction or disconfirmed as disappointment, and fear which can be either confirmed as fear-confirmed or disconfirmed as relief and well-being expressed in emotions of joy and distress [16].

In our study, emotional inputs into avatar's emotional expression are characterized, for example, as reactions to, that is being pleased or displeased about, the prospect of an event, or to the confirmation or disconfirmation of the prospect of an event [11]. Confirmed emotion is that a person is pleased about the confirmation of prospect of a desirable event (e.g. satisfaction) and disconfirmed emotion means that a person is displeased about the disconfirmation of prospect of a desirable event (e.g. disappointment) [11]. In our prototype, four avatars were designed with emotional expressions of "satisfaction/joy" or "disappointment/sad".

Fig. 2 Four types of avatars used: 2 boy avatars (John—older; Mike—younger) and 2 girl avatars (Jasmine—older; Cherry—younger)
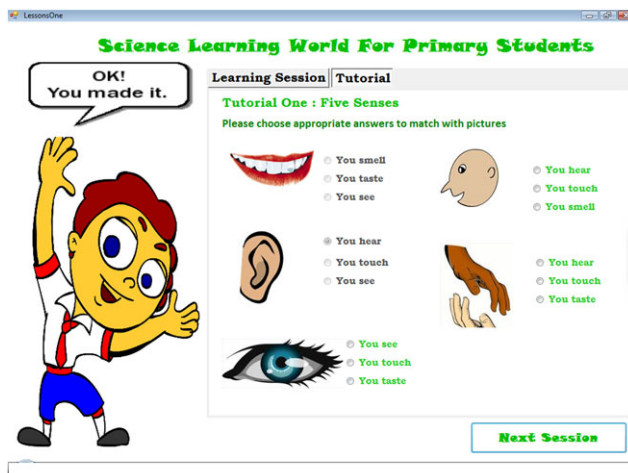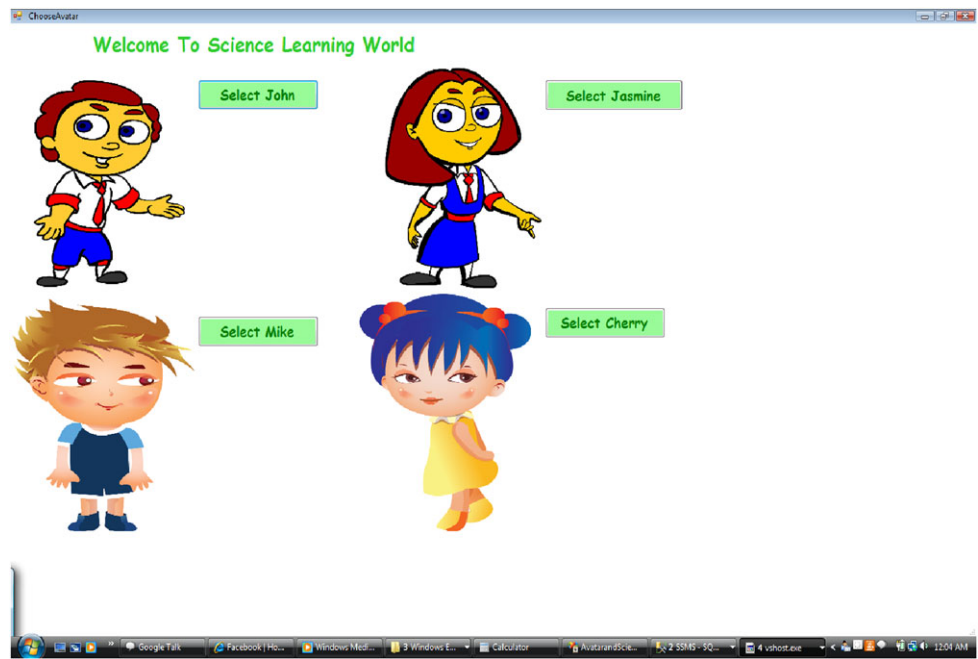

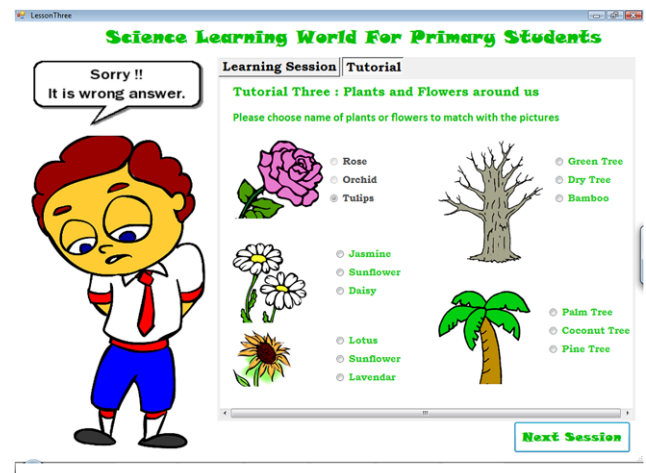**Fig. 3** Screen showing a happy avatar

Fig. 4 Screen showing an unhappy avatar

For example, in the tutorial sessions, emotional expressions of avatar could be changed according to learner's correct answers to the tutorial questions. If the learner chooses the right answer from the given options, then the expression of avatars would be changed to a "satisfied" emotional expression whereas the expression of avatar would display a "disappointed" emotion when the learner chooses the wrong answer from the given options (see Figs. 3 and 4). Based on the Prospect-Based emotions category (that is, display of confirmed and disconfirmed emotions), we added these prospect-based emotions into the avatars. For this experiment, three different emotional expressions of the avatar were used: (i) confirmation/disconfirmation in Part I; (ii) only confirmation in Part II; and (iii) only disconfirma-

tion in Part III. In other words, the three learning sessions were designed so that:

- In Part I, avatars were programmed to respond with *disconfirmed/negative* emotional expressions for *incorrect* answers, and respond with *confirmed/positive* emotional expressions for correct answers given; and
- In Part II, avatars were programmed to respond with *confirmed/positive* emotional expressions regardless of *correct/incorrect* answers given; and
- In Part III, avatars were programmed to respond with *disconfirmed/negative* emotional expressions regardless of *correct/incorrect* answers given.
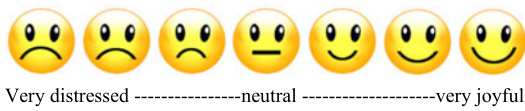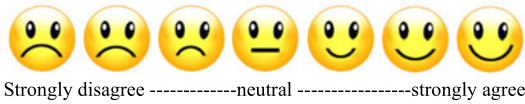
Fig. 5 Picture-based emotion assessment tool

Very distressed ----------------neutral --------------------very joyful

Strongly disagree -------------neutral -----------------strongly agree

Fig. 6 Picture-based emotion assessment tool

Measurements include the impact of expressions of selected avatar on children's emotional responses and their motivation in learning. To study children's emotional responses, we also borrowed the concepts discussed in the cognitive structure of emotions by [11]. In capturing the goal-based emotions, for instance, the concept of "well-being" emotions suggests desirable (e.g. joy) or undesirable (e.g. distress) response to an event. For standard-based emotion, children's emotional responses (e.g. satisfaction and disappointment) to getting confirmation or disconfirmation to correct/incorrect answers were recorded. Finally, for attitude-based emotion, we looked at measurement of children's emotional response to the "attraction" emotion is to gather children's feedback to an appealing object (e.g. like) or to an unappealing object (e.g. dislike).

A picture-based 7-point scale questionnaire was developed based on different types of emotions displayed such as well-being, attraction and prospect-based emotions (see Figs. 5 and 6). The value component of student motivation involves student's goals for the task and their beliefs about the importance and interest of the task [12].

In this study, we focused on children's self-efficacy and intrinsic value to the learning. As the study also investigates children's motivation during the three learning sessions, for the measurement tools for motivation, we adapted some items from the Motivated Strategies for Learning Questionnaire (MSLQ) [15].

Figure 7 gives an overview of study to investigate the effects of avatar expressions, and their effects on children's emotional responses, and their motivation in learning.

4 The study

We recruited twelve male (B1–B12) and twelve female young participants (G1–G12) aged 6–8 years old, attending a local primary school in Singapore. Some participants had no prior experiences in learning science but some had basic knowledge in science. Formal education of science learning begins in the upper primary levels (aged 10 years and above). For this study, it was intended to be qualitative in
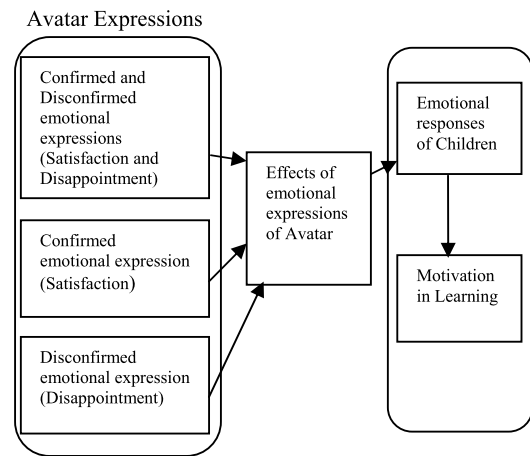

Fig. 7 Overview

nature so in-depth observation and interview with the participants were important. The study was conducted in laboratory in a local, primary school after school hours. In each session, there were six participants and each participant had a one-to-one session with the student researcher. A training session was conducted for all student researchers. They were briefed and given instructions to follow the standard, experimental protocol, to ensure consistency.

The experiment began with the student researcher briefing the young participants on the prototype. The participants were asked to fill up the questionnaire regarding their self-efficacy with the student researcher around to answer any queries. The briefing and questionnaire section took about 10–15 minutes. The entire experimental session consisted of three parts with science lessons (5 minutes) and accompanying tutorials (5 minutes) followed by 5-minute breaks in between each part: Part I includes the confirmed/disconfirmed emotional expressions of avatar; and Parts II and III have only confirmed and only disconfirmed emotional expressions of avatar respectively. All the participants had to go through all 3 parts of the learning session.

After completing the three parts, the participants were asked to complete a simple questionnaire on the avatar, emotion and motivation towards learning. This was followed by a short interview session which took about 10 minutes probing participants' experiences on the learning sessions, their feedback on expressions displayed by avatar and their preferences on avatar's expressions. For the measurement of the participant's emotional responses, as mentioned previously, we developed a set of picture-based 7-point scale questionnaire so that young participants could easily point out how they felt. Similar type of picture-based questionnaire was also used for measuring their motivation to learning (see Figs. 5 and 6).

5 Findings and analyses

We report our findings and analyses answering the research questions on whether positive expressions from avatars will create positive affective responses from the young participants. In the same way, whether negative expressions from avatars will create negative emotional responses from children. Based on observation data and participants' feedback to questionnaire and interview, we made the following general observations, and they are also in congruent with prior studies [14]:

a. *Participants liked avatars of their gender*. When the participants were asked to select their avatars, except for B4 and G8, 10 of the 12 participants selected avatar of their gender. Most of participants selected the young avatars except for B1, B2, G7 and G8. Comments such as "*she/he looks very cute*", "*he looks like my friend and he looks so funny*".

b. *Participants liked appropriate and/or positive confirmation from avatar*. In Part II of the experiment, it was found that the participants liked the always "Satisfied" confirmed emotional expressions of avatar (mean = 6.3 and SD = 1.1). The reasons as explained by B1 and B2 were: "*I can be happy too*" and "*I feel happy if I see always happy avatar*". According to feedback, most participants liked to have positive confirmation from avatar even if they gave the incorrect answers. In general, it seemed to suggest that positive affirmation of avatar creates positive responses in these children (see Table 1). Although the participants were young, and it was commonly assumed that children liked only positive responses the participants were more sensible and matured. They liked the appropriate responses better (mean = 6.51 and SD = 0.56), that is, if they preferred happy avatar if they got the answer right, and sad avatar if they got the answer wrong (see Table 1). That is, they liked the appropriate emotional expressions of avatar based right or wrong answers given. This observation suggests that participants were affected by the emotional expressions of avatar but not all participants appreciated the appropriate responses from the avatar.

c. *Participants disliked negative confirmation (disconfirmation) of avatar*. In contrast, in Part III, it was obvious that participants disliked negative confirmation of avatar (mean = 3.8 and SD = 2.3), showing "disappointed" emotion because it made them upset. Protests from participants included: "*I gave right answers*"; "*I gave the right answer. What is wrong with the system*". Ultimately, all the participants mentioned that they all disliked the always negative confirmation (disconfirmation) from avatar. Hence, negative confirmation (disconfirmation) of avatar seemed to have an impact on children's emotional responses, making them feel "unhappy" or

Table 1 Emotional responses of the participants (out of a 7-point scale)

Participants	Session I (happy/sad)	Session II (only happy)	Session III (only sad)
B1	7.0	7.0	7.0
B2	7.0	7.0	7.0
B3	7.0	7.0	3.6
B4	7.0	7.0	1.0
B5	7.0	7.0	7.0
B6	6.3	6.3	4.0
B7	6.7	6.7	6.7
B8	6.7	7.0	6.7
B9	5.3	4.0	1.0
B10	5.0	4.0	1.0
B11	6.7	5.0	1.6
B12	7.0	7.0	7.0
G1	6.7	7.0	5.0
G2	7.0	7.0	4.3
G3	6.0	7.0	1.0
G4	6.0	7.0	4.0
G5	6.3	6.7	1.0
G6	7.0	7.0	4.3
G7	7.0	7.0	6.7
G8	6.0	4.3	2.0
G9	6.3	7.0	2.0
G10	6.7	6.3	3.3
G11	6.7	6.3	3.3
G12	6.0	4.0	1.0
Mean	6.5	6.3	3.8

"upset" if there was no positive affirmation given to them when they gave the correct answers (see Table 1).

d. *All participants liked avatar with affective expressions*. Based on the interview sessions, most participants said that they preferred avatar displaying affective expressions (see Table 2). Hence, this observation suggests that avatars with affective expressions make learning fun and joyful. The participants explained why they would recommend inclusion of avatars in virtual learning environments. Comments include: "*It is very useful*"; "*It can support what I need*"; "*It is enjoyable*"; "*Avatar can teach me*"; "*I like avatar as my guide*"; etc.

e. *Participants' motivation to learning varied*. Although learning sessions were short with only 5–10 minutes, motivation levels of all participants vary from session to session. The motivational levels to learning beyond the lessons seemed highest in Session II (mean = 6.0 and SD = 1.4) with lowest in Session III (mean = 5.4 and SD = 1.9), indicating that the participants were less mo-

Table 2 Reasons why participants liked avatars with affective expressions

Participant	Comments
B1	"It is more expressive"
B2	"It is easy to understand"
B3	"I feel happy to see avatar's emotion"
B4	"I feel very happy to see avatar's happiness"
B5	"It is very expressive responses"
B6	"I feel happy too"
B7	"I think it is easy to guess"
B8	"I can easily know the answer"
B11	"I like it much and I feel happy"
B12	"I feel it is easy to know the result"
G1	"It makes me happy"
G2	"It is realistic"
G3	"It is true emotions"
G4	"I feel very happy"
G6	"It is better way"
G7	"It is good to understand"
G9	"I like it"
G10	"I like it"
G11	"It is cool"

tivated in the Session III with only a "sad" avatar, not giving praise even if their answers were correct.

f. *Positive correlations with affective responses of participants, enjoyment in learning and motivation towards learning.* We carried out paired-samples T-Test and found that there is a significant correlation between affective responses and enjoyment in learning ($t = 0.278$, df $= 23$, $p < 0.05$), enjoyment in learning and motivation towards learning ($t = 0.278$, df $= 23$, $p < 0.05$) for Session I. Similarly, for Sessions II and Sessions III, we also found that there is a significant relationship between affective responses and enjoyment in learning, and enjoyment in learning and motivation towards learning. This means that when young children are happy interacting with the virtual learning environments, there is a greater feeling of enjoyment in learning and hence may lead to increased motivation towards learning.

6 Conclusion and on-going work

Observation-based design projects on avatars and learning are still few in number and primarily exploratory in nature are just beginning to provide concrete examples of the value of bringing knowledge about learners' feedback to a close relation to the designed artifacts such as avatars. This is on-going work for us. This paper described a follow-up study to two prior pilot studies by applying the well-referenced OCC

cognitive theory of emotions to investigate young children's (6–8 years old) affective responses while using a learning package. Confirming the earlier pilot studies, findings with twenty-four young children participants showed that they loved avatars and were influenced by avatars' affective expressions to their performances:

- The young children participants appreciated the appropriate emotional expressions displayed in Part I in which confirmation/disconfirmation affective expressions of avatar was displayed. When they gave the right answer, they saw the "satisfied" avatar and when they gave the wrong answer, they saw the "disappointed" avatar.

- In Parts II and III, they noticed that the affective expressions of avatar were not appropriate. However, in Part II with the "always confirmed (satisfied)" affective expression of avatar displayed, all the children liked the positive confirmation of avatar. On the other hand, in Part III, it was observed that most participants felt upset seeing the disconfirmation (disappointed) of avatar although some participants ignored the disconfirmed expressions of the avatars. In generally, they disliked seeing the disconfirmed emotional expression of avatar. The participants also expressed feelings of satisfaction and fun in their learning interactions with the selected avatar.

Observations showed that young children loved avatars/characters as virtual tutors in the learning environments but there was a clear gender bias towards the male avatars from these young male children. Based on responses from the questionnaire, with the exception of one participant, there were significant improvements in their self-efficacy. Similar to the pilot studies, although affective expressions of avatars had an influence on these young children's emotions, there was no significant relationship on motivation in learning, except we saw changes in motivational levels. The motivational levels to learning beyond the lessons seemed highest in Session II and Sect. III, indicating that positive feedback is important to motivate learning.

Empirical observational data from our study suggest that avatars could be appropriate, and they could make learning more fun for learners, especially young children (6–8 years old). Our findings concur with other studies, for example, Yavuz, Hatice, Kursat [6] advocate that avatars can positively impact learners and their motivation towards learning, as avatars form a bridge between learners and learning contents, especially children who love avatars or animated characters. We also saw that the participants had fun with the avatars, and that designing avatars with underlying pedagogical principles and purposes, in our study, as virtual tutors, could be beneficial to learners, especially young children in virtual learning environments.

This preliminary work has created interesting observations on avatars, affective learning and motivation to learning. Certainly, more can be done: careful analysis of data;

refinement of the emotion taxonomy of embodied actions and greater understanding of how actions can be interpreted to support design of virtual leaning environments incorporating avatars.

The study is without limitations. Although we felt that these young participants might get bored and learning effects carried over from Part I to Part II to Part III, hence, the rating results were asked after completion of the whole learning session. From hindsight, it would be better to ask them after each part, as it might affect the rating results if it were conducted after all the 3 parts. In addition, we would carry out experiments using avatars with expression and without expression, so that conclusion will be evidence-based. Our study was only focused on young children (6–8 years old). To conclude with sound evidence that avatars could be appropriate, and they could make learning more fun for learners, future studies should be conducted for comparison with different age groups. Future study will address these limitations.

The pilot work suggests many exciting avenues to research in greater depth. We will be carrying out longer-term observational studies with more children to study the impact of affective responses of avatars on effectiveness and satisfaction of learning.

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