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ORIGINAL ARTICLE

The effects of Embodiment-based TPR approach on student English vocabulary learning achievement, retention and acceptance

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Motion sensing technology;
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Abstract Research has shown that language learning with the form of human body could promote learner performance on the basis of theory of embodied cognition. Total physical response (TPR) has long been used to enhance vocabulary learning. However, TPR has its limitation that teachers are unable to attend to all individual students when the class size is beyond manageable. Thus, to enhance English vocabulary learning, this study proposes an integration of motion-sensing technology and theory of embodied cognition into the total physical response (TPR) approach, called Embodiment-based TPR approach. To test the effectiveness of the proposed approach, a total of 50 fifth-grade elementary students participated in this study. Experimental group adopted Embodiment-based TRP learning approach, while control group took conventional TPR learning approach. Cognitive performance and acceptance feedback for the proposed approach were collected in the experiment. Results showed that both the post-test and the delay test concerning English vocabulary learning performance between the two groups had no significant difference. However, the result of learning retention showed a significant regression for the control group while the experimental group's learning retention retained, which implies the Embodiment-based TPR approach could bring better learning retention than the conventional TPR approach. In addition, experimental group showed a highly positive level of acceptance toward the proposed learning approach.

1. Introduction

Due to the reality of global village in the 21st century, English learning has been an important educational issue in Asia. English is regarded as a foreign language and has been included in elementary schools' language curriculum in Taiwan. However, English and Chinese differ greatly in writing system, pronunciation, and grammar structure. As a result, students may find English learning quite a tough task and feel frustrated when it gets overwhelming. Furthermore, the environmental factors would limit the students to apply English in real life after school.

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There are various types of English teaching methods in elementary schools, among which, total physical response (TPR) developed by (Asher, 1966) is mostly used in conventional education settings. TPR is conducted based on the coordination of spoken and physical movement. It helps students develop listening comprehension and oral fluency by reducing their pressure and fear in an interesting learning process (Asher, 1968).

Many TPR related researches have shown positive effects on students' learning performance, learning attitudes, confidence and motivation (Asher and Price, 1967; Kunihira and Asher, 1966; Wolfe and Jones, 2008; Wong, 1983). It is especially effective for teaching English as foreign language (EFL). These studies mainly emphasize teaching English vocabulary and grammar. In vocabulary teaching, studies which expanded TPR approach to pronunciation (Wolfe and Jones, 2008) and meaning involving various word classes (Elliott and Yountchi, 2009) have observed positive learning outcomes. Other researchers have also shown the effectiveness of TPR in the aspect of English prepositions (Nugrahaningsih, 2007; Widodo, 2005). In traditional TPR teaching contexts, teachers usually conduct the activity using pictures and films for students to practice the pronunciations and actions for the given vocabulary in the course. Further, there is only one teacher whose main role is to give commands, monitor actions done by students and ensure that the TPR sequence goes on well. Thus, it is rather hard for the teacher to attend to every student's learning status and ensure his/her full concentration on the learning content.

Barsalou (2008) proposed the theory of embodied cognition, indicating that the nature of the human mind can be largely determined by the form of the human body. Barsalou argued that embodied cognition is all aspects of cognition that are shaped by surroundings, simulation, situated action, and aspects of the body. Embodied cognition is an essential research topic in social and cognitive psychology, covering issues such as social interaction and decision-making (Borghi and Cimatti, 2010). The aspects of the body include the motor system, the perceptual system, the body's interactions with the environment and the ontological assumptions about the world that are built into the body and the brain (Wilson, 2002). Much research concerning embodied cognition emphasizes the importance of body interactions with the environment. For example, Macedonia, Muller, and Friederici (2011) demonstrated that gestures accompanying speech have an impact on memory for verbal information in the speakers' mother tongue and foreign language learning. That is, meaningful and iconic gestures could help learners retain the verbal learning material.

With the combination of computer, Internet, and many other technology devices, some technology-assisted teaching methods have been developed in the digital education, such as computer-assisted learning, mobile learning, Virtual Reality (VR), Augmented Reality (AR) and Motion sensing technology in the educational fields. Among these technologies, Motion Sensing technology (e.g., Kinect and Wii, etc.) has been applied in various subjects. It has been used in the entertainment, media, advertisement, healthcare and daily life (Chang et al., 2011). It started from a video game console named Wii which was released by the Nintendo Company in 2006. User can perform specific actions with a wireless controller in their hands. The controller can detect hands, gesture and movements, based on which the system can give different responses. More recently, research on learning activity embedded with Kinect technique has been conducted, such as media advertisement, healthcare and digital education. In healthcare, researcher designed a system to assist the patients in the physical rehabilitation. The result showed that it could reduce the patient's rejection of rehabilitation and increase their motivation (Vernadakis et al., 2012). In language learning, a study examining retention on English phrases by asking the participants to enact the vocabulary, found that the experiment group outperformed the control group on the vocabulary recall test. This finding suggests that motion-sensing technology has a positive effect on language learning (Chao et al., 2013).

Based on the above-mentioned studies, the Kinect technique embedded into learning activity has proved effective in many learning domains. In addition, the theory of embodied cognition is taken into consideration in this study. Thus, we proposed an Embodiment-based TPR learning approach for

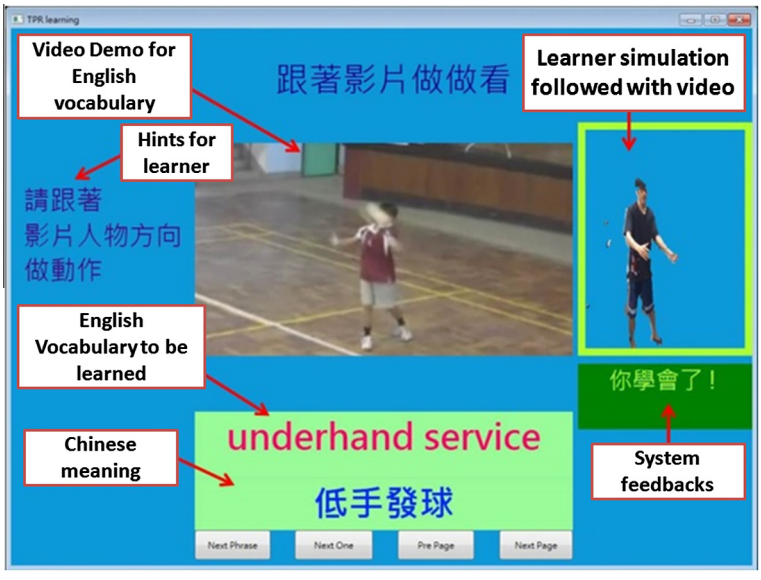

Figure 1 English vocabulary learning scenario in the Embodiment-based TPR system.

enhancing learning in the EFL classroom. To examine the effectiveness of the proposed approach, fifty fifth-grade elementary school students participated and were distributed into two groups; the experimental group was conducted with the Embodiment-based TPR approach, and the control group was managed with the traditional TPR approach. The research questions are addressed below:

(1) Is there any significant difference in learning performance between the Embodiment-based TPR approach group and the traditional TPR approach group?
(2) What is the level of acceptance of students in the Embodiment-based TPR group?

2. Learning system

2.1. System design

The Embodiment-based TPR learning system used Microsoft's Kinect sensing devices that enable wireless control and interaction by capturing full-body 3D motions. The learning application was designed using C# in Windows Presentation Foundation. The system was designed with four learning stages based on the principles of TPR including watch stage, listen-watch-do-repeat stage, listen-do-repeat stage, and group race stage respectively, as shown in Fig. 1. It can attend to each individual learner by encouraging acting-out of the vocabulary, providing corrective feedback, such as images and videos related to the given vocabulary, and engage learners to work at their own pace.

2.2. Implementation of learning system

2.2.1. Stage 1: Watch stage

This stage only offered a chance for students to watch the demonstration of a teacher for the given vocabulary shown on the screen without system assistance as traditional TPR approach.

2.2.2. Stage 2: Listen-watch-do-repeat stage

This stage is designed to help learners acquire new vocabulary through immitating and acting out (see Fig. 2). At first, learners are introduced to the learning activity. Then, a video demonstrating a sport movie is played in the center of the screen. Learners are prompted to act out according to the video within 10 s. When time is up, the system will automatically proceed to the next practice trial. Throughout the whole learning stage, learners can see themselves on the screen so as to adjust their movements. The system constantly responds to the moving body, based on which the immediate feedback is provided. All learners take turns taking part in this stage.

2.2.3. Stage 3: Listen-watch-do-repeat stage

This stage is designed to strengthen the connections between the sport movie and the newly learned vocabulary or phrases (Fig. 3). After the introduction, the system starts by giving voice commands and verbal commands as shown on the screen which require learners to act out. If a learner fails to act out correctly, a video will be provided as corrective feedback. All the missed trials will be given as extra practice at the end of the stage. All learners take turns taking part in this stage.

2.2.4. Stage 4: Group race

This stage serves as a review section. System only gives verbal commands for learners from each group to compete with each other (Fig. 4). The verbal commands are given in Chinese or English. When a Chinese verbal command is given, learners are required to act it out and say its corresponding English translation (e.g., Chinese-English or English-Chinese). The system will record the time spent on acting out the command, and serve as the competition report. All learners take turns taking part in the group race.

3. Methods

3.1. Participants

A total of 50 fifth-grade elementary students, 25 males and 25 females, aged 10–11, participated in this study. They were divided into two groups, the control group (n = 25) and the experimental group (n = 25), respectively.

3.2. Materials and measuring tools

The learning materials were selected and verified by two senior English teachers, including fifteen English vocabularies related

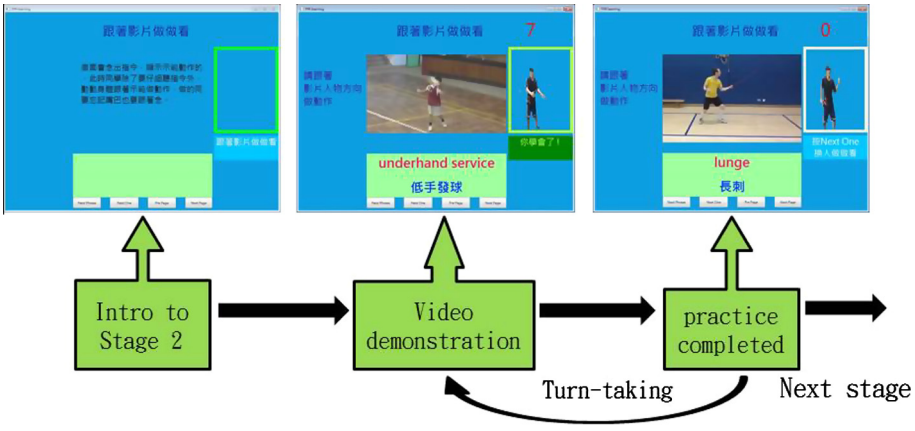

Figure 2 Listen-watch-do-repeat stage.

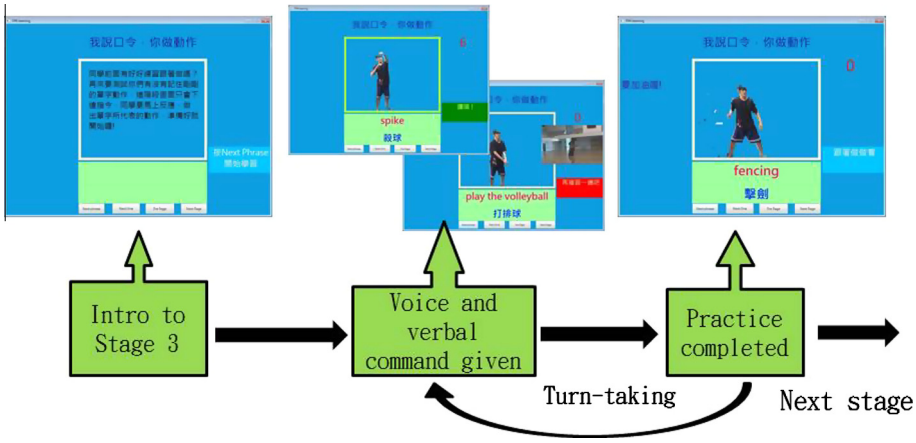

Figure 3 Listen-do-repeat stage.

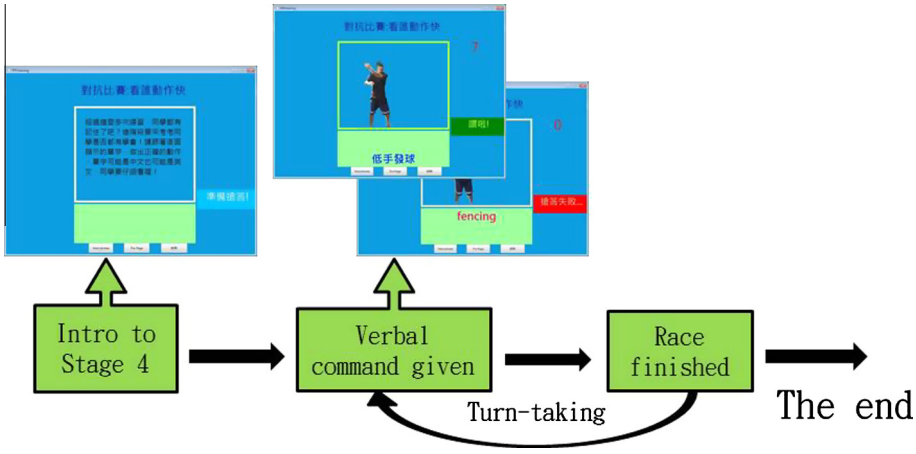

Figure 4 Group race stage.

to four categories of sports, volleyball (spike, toss, underhand service), fencing (on-guard, lunge), boxing (boxing glove, straight punch, uppercut), and taekwondo (front kick, side kick, forward stance). The vocabularies concerning volleyball and fencing were arranged in the first cycle of TPR learning session, while those concerning both boxing and taekwondo were set in the second learning session.

In the study, an English vocabulary test was developed by two senior English teachers, and used as the pretest, post-test and delay retention test with both multiple-choice quizzes and blank-filling questions concerning the vocabulary learned. The inter-rater reliability of the assessment reaches a Cronbach's α of 0.83 between the two senior English teachers, showing high internal consistency between the ratings of the various teachers (Cohen, 1988). As for acceptance measurement, learning attitude scale (4 items, Cronbach's $\alpha = .96$) adapted from Liang et al. (2011), investigates the students' perceptions of the extent to which they perceive the influence of Embodiment-based TPR learning is useful, and intention to use scale (3 items, Cronbach's $\alpha = .95$) adapted from Davis (1989) measures the level of student intention to use the proposed approach in the learning activity in the future. The acceptance measurements adopted a 7-point Likert-type response scale (1 = strongly disagree, 7 = strongly agree).

3.3. Experimental procedure

The experiment was conducted by applying the four stages of TPR approach in a vocabulary learning session as shown in Fig. 5. A pre-test including a vocabulary test was given. In stage 1 (watch stage), the teacher introduced the to-be-learned vocabulary to the whole class for 30 min. In stage 2 (listen-watch-do-repeat stage) and stage 3 (listen-do-repeat stage), students worked in groups and went through the stages led by either the teacher or the system, according to the groups they were assigned to. An additional system instruction was given to the experimental group. For the experimental group, during stage 2, the system served as a commander, leading the students to imitate and repeat the word by following the video. All the students took turns in interacting with the system for 10 min. During stage 3, the system served as a commander again, having the students act out and repeat following the verbal and auditory command. This stage lasted for 10 min. In stage 4, the system presented a game-based

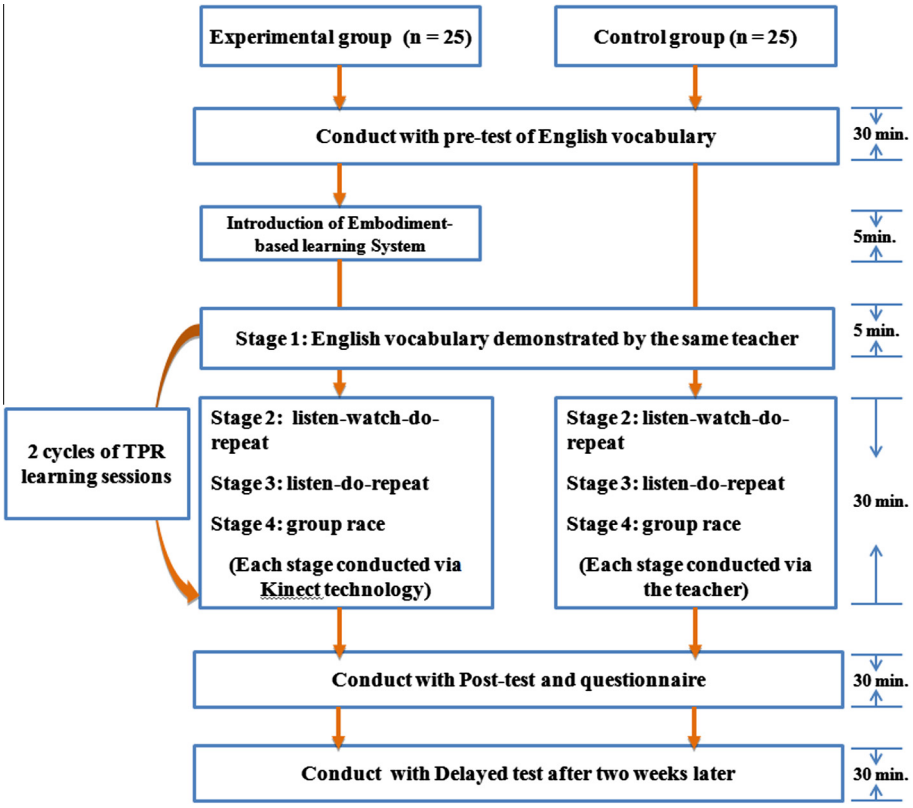

Figure 5 Experimental procedure for the two groups.

context in which students were required to act out in response to the test questions randomly presented by the learning system for 10 min.

The procedure in the control group was identical to that in the experimental group except the teacher leading the activities. Corrective feedback was also provided for both groups throughout the three stages. Upon the completion of the whole learning session, a post-test was conducted for 30 min and questionnaires were given for collecting students' immediate learning performance and emotional responses. Finally, a delay test was given to collect student's learning retention after 2 weeks.

4. Results

4.1. Analysis of learning performance

First of all, normal distribution test was conducted before the formal variance analysis. It was found that students of control group present results of abnormal distribution by means of the Kolmogorov–Smirnov and the Shapiro–Wilk tests. Non-parametric Statistical analysis was employed to analyze the learning performance difference between experimental group and control group. Independent samples *t*-test with Man–Whitney was conducted to investigate the difference of post-test and difference of delay-test between two groups. The result shows no significant difference of both post-test ($Z = -0.89$, $p = > .05$) and delay-test ($Z = -1.86$, $p = > .05$) between two groups, as shown in Table 1.

To further examine the retention of learning performance of each group, paired-sample *t*-test with Wilcoxon analysis was used to test the difference between post-test and delay-test in a group. The result showed no significant difference in the experimental group, while there was significant difference in the control group ($Z = -3.10$, $p = 0.003 < .01$), as shown in Table 2. The result implies that students of experimental group have better learning retention for English vocabulary in comparison to those of the control group. On the contrary, students of control group present significant regression in learning performance for English vocabulary. In other words, the proposed learning approach for English vocabulary learning could enhance students' learning retention in the English vocabulary learning context.

4.2. Analysis of acceptance measurements

The Acceptance measurements of experimental group consisted of two dimensions of the scale, learning attitude and intention to use, which were measured and analyzed using Independent sample *t*-test analysis method. Table 3 shows the significant statistical difference of learning attitude ($t = -3.17$, $p < .01$), intention to use ($t = -2.72$, $p < .05$) and acceptance ($t = -3.15$, $p < .01$) between two groups. The acceptance measurement for experimental group student presents the high mean scores, ranging from 6.12 to 6.29, for three dimensions respectively, indicating that students revealed a highly positive response to the learning activity under the Embodiment-based TPR approach.

5. Discussion and conclusions

English vocabulary learning is one important step for the mastery of English, especially for those who regard English as a

Table 1 Independent samples t test with Mann–Whitney analysis for post-test and delay-test between two groups.

Dependent variable	Test	Experimental		Control		Z
		Mean	SD	Mean	SD	
Learning performance	Post-test	81.17	18.03	85.35	16.89	−0.89
	Delay-test	85.48	15.92	74.00	20.99	−1.86

Table 2 Paired-sample t-test via Wilcoxon analysis for learning retention of two groups.

Group	Post-test		Delay-test		Z
	Mean	SD	Mean	SD	
Experimental	81.17	18.03	85.48	15.92	−1.86
Control	85.35	16.89	74.00	20.99	−3.10**

** $p < .01$.

Table 3 Independent samples t-test of Acceptance measurement between the two groups.

Dimension	Group	N	Mean	SD	t
Learning attitude	Experimental	25	6.29	0.95	−3.17**
	Control	25	4.87	1.93	
Intention to use	Experimental	25	6.12	1.35	−2.72*
	Control	25	4.68	2.14	
Acceptance	Experimental	25	6.22	1.08	−3.15**
	Control	25	4.79	1.89	

* $p < 05$.
** $p < 01$.

foreign language. Traditional total physical response (TPR) emphasizes the coordination of spoken and physical movement during the process of English learning, but the teacher can hardly attend to every student in the class at the same time, and ensure every student's learning status.

The research findings show that the posttest of English vocabulary learning performance between the two groups showed no significant difference. This result may be attributed to the number of learning vocabularies given within the limited time. During each learning session, students need to complete seven or eight English vocabularies within four learning phases in 40 min, implying that students would spend less than two minutes per vocabulary in each phase whether via Kinect technology or a teacher assisted learning context.

However, students of experimental group could retain better English vocabulary than those of the control group. This finding can be explained by the embodied cognition, which proposes that the body and the mind are inseparable in the constitution of cognition (Barsalou, 2010). On the contrary, students of the control group present significant regression in learning retention for English vocabulary learning. In other words, the proposed Embodied-based learning approach for English vocabulary learning could enhance students' retention in English vocabulary learning context, which conforms to the theory of Embodied cognition elaborating that different processes by which aspects of perceptual and motor processes are tightly joint to each other and higher order cognitive processes including language (Barsalou, 2008; (Hostetter and Alibali, 2008; Tellier, 2008), and the result is also consistent with research findings that the provision of assistive information technology during the learning process, such as additional visual images and feedbacks, can enhance learning retention (Cook et al., 2008; Karasawa and Maass, 2008; Levie and Lentz, 1982; Zwaan and Kaschak, 2006).

As for acceptance measurement, both learning attitude and intention dimensions for the experimental group students revealed a highly positive response to Embodiment-based TPR approach in the learning activity. This finding indicates that students of the experimental group think the Embodiment-based learning approach makes the activity of English vocabulary learning more engaging and acceptable than the conventional approach. Furthermore, they are willing to learn English via the proposed learning approach. The result of acceptance assessment is consistent with many studies concerning embodied cognition embedded in the learning activity (Gilakjani and Ahmadi, 2011; Niedenthal et al., 2005). Such an effective measurement can reflect learners' attitude toward the integration of innovative technology into the learning approach for the first time or at the beginning of a learning activity. In fact, the proposed learning approach provided learners with more natural interactions with computers via Kinect technology than ever before. Previous studies indicated that learning process with bodily action and environmental interventions may lead to a better learning performance and learning atti-

tude of learners (Borghi and Cimatti, 2010; Borghi, 2011; Clark, 2006; Claxton, 2012; Glenberg and Kaschak, 2003; Johnson, 2009; Karasawa and Maass, 2008; Zwaan and Kaschak, 2006; Weiskopf, 2010; Yang, 2013; Zwaan and Yaxley, 2007). For example, Cook et al. (2008) experimentally manipulated children's gesture during a learning activity of a new mathematical concept. Their research findings showed that asking children to gesture while learning the new concept would enhance knowledge gains during instruction. On the contrary, those who were required not to gesture while learning the concept showed no significant learning effects. Thus, they argued that gesturing could play a causal role in learning, an embodied way of representing new ideas, which improves children's learning performance by encouraging them to move their hands.

Another potential factor leading to student learning retention could come to the information-processing perspective, accounting for mental development in terms of cognitive changes (Atkinson and Shiffrin, 1968; Carifio, 1993). This change could directly facilitate encoding in long-term memory. In the study, presenting information with body movements, contextual information in the learning context may produce stronger memory traces for the experimental group than merely presenting information with unitary form of body action for the control group. Such a finding conforms to previous studies (Claxton, 2012; Essen and Nilsson, 2003; Yang et al., 2012).

To further evaluate the effectiveness of the proposed approach, we attempt to involve more English vocabulary and invite more participants from elementary and secondary schools. In the future, it is worth investigating other factors that might affect students' learning performance, such as gender difference, prior knowledge, and the grouping strategies, learning styles and the effect of integrating Kinect technique into collaborative problem-solving activities.

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