Ogata, H. et al. (Eds.) (2015). Proceedings of the 23rd International Conference on Computers in Education. China: Asia-Pacific Society for Computers in Education

The Potential of Embodiment-based Learning Environments on Basic Music Accomplishment

Hsin-Hsien LU [1], Chun-Wang WEI[2], Sie Wai CHEW [1] , Nian-Shing CHEN [1]*
[1] *Department of Information Management, National Sun Yat-sen University, Taiwan*
[2] *Department of Management Information System, Far East University, Taiwan*
*e8416752@gmail.com, cwwey@cc.feu.edu.tw, chewsw@mis.nsysu.edu.tw, *nschen@mis.nsysu.edu.tw*

Abstract: This study aims to investigate the effects of embodiment-based and traditional-based learning system on the learning performance of Staff Notation and its sounds. Based on the perspective of embodied cognition and rhythmic learning, this study applied embodiment-based technologies to design the system by involving rhythmic body movements in the learning and mixing a variety of senses to help learning Staff Notation. 43 students were recruited and randomly assigned to two groups. Students in embodiment-based groups used body movements to control the system, and others in traditional-based groups used paper and the training video. The result shows that there is significant difference on the performance of learning Staff Notation between these two groups. The satisfaction survey analysis of the system shows that embodiment-based learning environments can lead to higher attitude toward behavior to improve the user's willingness to participate in learning.

Keywords: Rhythm learning, embodiment-based learning, music staff, learning performance

1. Introduction

Many studies indicate that music can bring more benefit to the learning process, especially for music with training by supporting and improving the cognitive skill during reading, abstract spatial ability, creativity ... etc. (Hurwitz, Wolff, Bortnick, & Kokas, 1975; Lamb & Gregory, 1993). Dr. Georgi Lozanov, who is a Bulgarian doctor of philosophy and psychiatry expert advocate "Suggestive Teaching (super learning)" suggested that smooth rhythmic music assist in stimulating and adjusting the learners' brainwave in order to eliminate tension, synchronizing the rhythm of the music (Lozanov, G., 2004).

In music subjects, Notation is the cornerstone of the development in Western music, most people use staff notation in the notation. Staff notation is very important in music as it is like a musical text in communicating any emotion and thinking using different instruments. Hence, if we want to learn the music skill, we must to learn staff notation.

It is found from related research of Cognitive Neuroscience (de Koning & Tabbers, 2011) that individual cognitive situation are affected by body movement. Therefore the thoughts and perception of the body will affect each other, meaning that we should take into account the aspects of the body physically and mentally to further understand the human cognitive processes (Barsalou, 2008). Literature of embodied cognition suggests that human cognition consists of mental model simulation, environment, situated action and bodily state including imitation by body movements (Banchi & Bell, 2008; Barsalou, 2008, 2010). The Embodied Cognition suggest that the formation of body movements and cognition are related. Furthermore, the environment has a strong positive correlation between hypothesis cognition forming and body movements (Barsalou, 2008; Gibbs, 2006; Wilson, 2002). Hence, the rhythm of learning is formed through the combination of body movements and music rhythm, resulting learners to execute rhythmic body movements to assists them in cognitive learning. Total Physical Response (TPR) is a relevant application originally developed by James Asher, an American professor of psychology in the 1960s. TPR is based on the theory that the purpose of teaching is enhanced through the association with physical movement and voice to interact (Kuo, Hsu, Fang, & Chen, 2014).

Learning staff notation by traditional learning strategies usually involves the usage of paper and verbal instruction, even though the technology has remained mostly by using voice media. However,

these learnings only use a few body movements to interact with the learning system. The process mainly emphasize on the interaction of the mind and brain with the lack of connectivity to achieve high interactive participation with body movements and learning subjects. However, according to the embodied cognition, body movements combined with the learning content can effectively help cognition, whereas the rhythm of learning through voice along with the body movements with the rhythm involved in the learning process help in learning the concepts.

Therefore, this study aims to investigate the difference between embodiment-based and traditional-based learning system on the performance of learning staff notation and its sounds. Based on the perspective of embodied cognition and rhythm learning, this study applied embodiment-based technologies in designing the system, leading to rhythmic body movements involved in the learning and mixing variety of senses to help reinforce learning staff notation (Chao, Huang, Fang, & Chen, 2013).

2. The Design of the Staff Notation Cognitive Learning Systems

2.1 Learning Content

In this study, we used the most basic staff notation octave as the learning content. There are two main learning objectives. Firstly, showing users the location of the staff notation and indicate its musical meaning. Secondly, playing users the sounds of the staff notation and indicate its musical meaning.

Our aimed subjects are users who have no knowledge about staff notation or have not been exposed to staff notation for the long time. They will use the learning system to practice the staff notation with five practice modes in a certain time. The learning system can help users to remember the sounds and the location of the staff notation including octave (e.g., do, re, mi, fa, sol, la, si, do).

2.2 Learning System

The Microsoft Kinect sensor was used in this study to build the learning environment that is capable of sensing the learners' movements. The learning system can link the eight locations of the staff notation with eight body movement. In this learning system, hands pat knees is do, hands pat thigh is re, co-production with both hands in the stomach is mi, co-production with both hands in the chest is fa, hands pat shoulder is sol, co-production with both hands in the face is la, hands racket head is si, hands held high is do. The practice mode of the system is designed to use the body parts to correspond with the staff notation. The main purpose is to enable learners to use their body from the bottom to the top, starting from the knee, stomach, shoulders, head, respectively, as the first to third line of the sheet music. Hence, by each movement of the respective body part, it is as though playing the note corresponding the staff notation's location on the music sheet, whereby the learners' body part represents the music sheet.

The learning system was developed in C# and the learning environment contains a laptop and a Microsoft Kinect, external display. Learners have to stand in front of the sensor, which is about 2~3 meters away, making the laptop screen too small. Hence, an external display is prepared to provide learners with a big visual area to watch the game details. Embodiment-based learning system operation consists of five modes (Figure 1). The first mode introduces ways to operate the system. The second mode uses special body movement to control the learning system and produce corresponding notes and sound. The third mode uses the body movement to perform the correct special action when the learning system gives a special note in the staff notation. The fourth mode uses the body movement to perform the correct special action when the learning system gives a special note's sound in the staff notation. The fifth mode uses the body movement to do the correct special action when the learning system give a special note and the note is moved to the red line. In the fifth mode, if the learners had completed all the body movement correctly when the note is moved to the red line, it will produce the song called "bee" to help learner do special rhythm learning.

Traditional-based learning system is divided into memorizing the staff notation and pitch training (Figure 2). The training of memorizing the staff notation begins by teaching the learner staff notation via videos and memory formulas. Then a blank staff notation paper is given to the learners with five examination where the learners must to fill in the blank to participate in the training freely. Finally,

we will provide the answer of the examination. Pitch training will provide the eighth order musical scale along with five music files and spectrum plane corresponding to music files for listening and training.

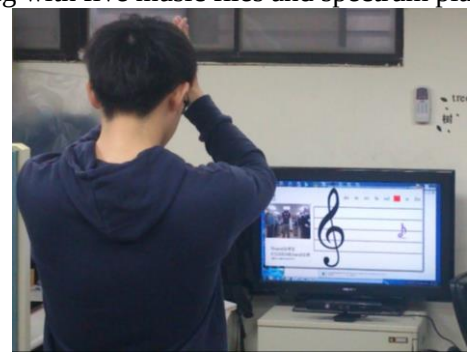

Figure 1. Embodiment-based learning

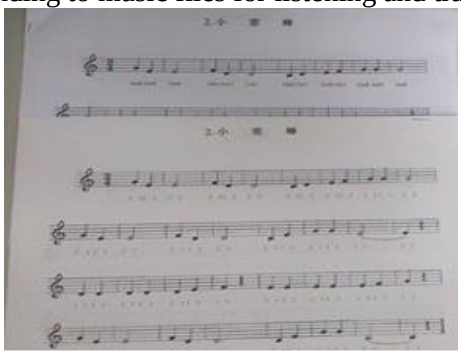

Figure 2. Traditional-based learning

3. Method

3.1 Architecture

Based on the rhythm learning and embodied cognition views, in this study, the learning system used the body movement, visual and auditory multisensory to form the embodiment-based learning system, assisting learners in cognitive abstraction and also to help learners understand the location and sound of the staff notation. In the traditional-based learning, the learners only learn through paper and film, but in the embodiment-based learning, the learner uses body movement to control system and uses five mode ways to adjust the rhythm learning.

3.2 Experimental subjects

A total of 43 college and graduate students who had not learn the staff notation or had not been exposed to staff notation for the long time were recruited to participate in this experiment. 22 of the participants are male and 21 of the participants are female. The average age is 22.024 with 2.1125 standard deviation.

3.3 Experimental pretest and posttest performance tool

This study used two system tools to examine the pretest and posttest score to measure the performance of their learning. The first system will provide a random note that appear on the stave C tone octave position, the learners must click the top button to answer the question on the meaning of the note in this position (Figure 3 (L)). The duration for the question is two seconds, if the learners did not answer the question in the time, system would provide the next random note. The system will provide 25 questions in total. The second system will provide a sound of stave C tone octave, the learners must click the top button to answer the question on the meaning of the sounds in this staff notation (Figure 3 (R)). The second system works similarly as the first system on other terms. And the reason the system is designed to have learners answering within 2 seconds is to ensure that learners are able to identify the notes immediately without going through the notes from "do" onwards. Most of the music staves applications requires instant judgment on the staff notation. Hence, by doing so, learners will achieve the ability to quickly determine the staff notation.

3.4 Experimental questionnaire measuring

The posttest questionnaire contains the system satisfaction survey, immerse survey and sentiment survey. The system satisfaction used the Davis's Technology Acceptance Model (TAM, 1989) with items on the usefulness of the system, the system's ease of use, attitude toward behavior, behavioral intention (Davis, F. D., 1989). The immerse survey used Webster et al. (1994) proposed immersion scale to measure learners' experience in the learning process(Webster et al., 1994). The items of

immerse survey contains attention focus, curiosity, intrinsic interest, control. The sentiment survey used the 7-point scale to measure happiness, willing, integration activities, focused, positive, excitement, and satisfaction.

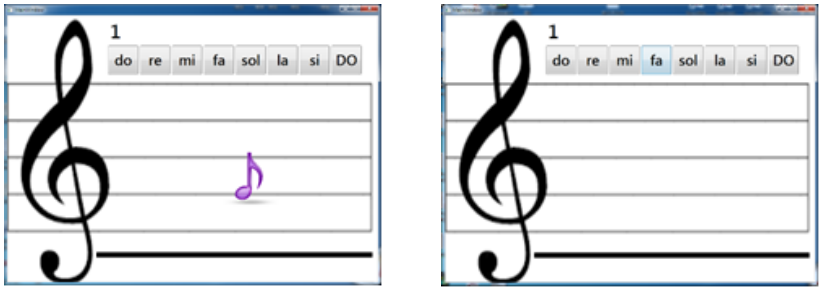

Figure 3. Pretest and posttest performance tool (L) note position; (R) note sounds

3.5 Experimental process

As mentioned before, the pretest of the two systems were used to examine the learners' knowledge level on staff notation in the beginning for five minutes. After the pretest, the learners were randomly and equally divided into embodiment-based and traditional-based learning system. An instructor would introduce the entire process to the learners for five minutes. The practice time in the two learning systems were twenty minutes. In the embodiment-based system, the learners can use the five modes to practice freely, without limiting the practice to be in a standard order, allowing users to follow their habit in rhythm learning. In the traditional-based system, the learners practice memorizing staff notation and pitch training for ten minutes respectively. In the posttest, the learners used two systems tool to examine the performance and fill the questionnaire for ten minutes.

The learning time is designed as so primarily because the note of the staff notation are quite simple, e1ven without method to learn them, as long as there is enough time, the learners can easily familiarize with the notes. However, we want to explore whether can the learning pace and performance increase by using embodiment-based learning compared to the traditional way of learning. Hence, we set the learning time of 20 minutes, to exclude the factor that long time exposure to the octave notes will familiarize learners with the staff notation.

4 Results

4.1 Learning performance analysis

For the learning performance, an independent-sample t-test was used to test the difference between the embodiment-based learning group and the traditional-based learning group. This study used the score difference between pretest and posttest to evaluate learning performance. The result shows that there are no significant difference of learning score in the two learning system in the pretest (Table 1). It represents that the learners' starting level are equal in two learning systems. The learning performance analysis result shows that the embodiment-based learning group has better performance in cognition location of the staff notation than the traditional-based learning group (t = -2.254, p = 0.03 < 0.05). No significant differences were found in cognition sounds of the staff notation (Table 2). The result show the embodiment-based environment can help rhythm learning performance on cognition location of the staff notation.

4.2 Questionnaire analysis

For Questionnaire, an independent-sample t-test was used to test the difference between the embodiment-based learning group and the traditional-based learning group. This study used the system satisfaction survey, immerse survey and sentiment survey for analysis. The analysis of the questionnaire's reliability by Cronbach's α is greater than 0.7, representing that the questionnaire is dependable. Then, the satisfaction survey analysis result indicates that there are no significant difference on perceived usefulness (t = -1.128, p = 0.266 > 0.05), perceived ease of use (t = 1.262, p =

0.214 > 0.05), behavioral intention (t = -0.479, p = 0.634 > 0.05), but there are significant difference on attitude toward behavior (t = -3.959, p = 0.000 < 0.05). However, the immerse survey and sentiment survey analysis result shows that there are no significant difference. The result show the embodiment-based environment with rhythm learning can improve attitude toward behavior on learning the staff notation.

Table 1: Independent-sample *t*-test result of pretest score.

Type	**Embodiment-based learning group (*N*=23)**	**Traditional-based learning group (*N*=20)**	***t* (*p*)**
	Mean (*SD*)	**Mean (*SD*)**	
Cognition location	7.74 (5.224)	8.85 (4.534)	0.739 (0.464)
Cognition sounds	6.04 (3.772)	7.35 (5.254)	0.945 (0.350)

* $p < 0.05$

Table 2: Independent-sample *t*-test result of learning performance.

Type	**Embodiment-based learning group (*N*=23)**	**Traditional-based learning group (*N*=20)**	***t* (*p*)**
	Mean (*SD*)	**Mean (*SD*)**	
Cognition location advance	10.35 (5.228)	7.1 (4.038)	-2.254* (0.030)
Cognition sounds advance	1.3 (4.597)	3.6 (4.740)	1.610 (0.115)

* $p < 0.05$

5 Conclusion

This study aims to investigate the effects of embodiment-based and traditional-based learning system on the performance of learning staff notation and its sounds. Through the introduction of the new technology learning system, we hope to understand the difference in the learning performance of users compared to traditional learning. The study result shows that there are no significant difference of the learning score in the two learning system in the pretest. After participating in the system training for twenty minutes, the result shows that the embodiment-based learning group has better performance in cognition location of the staff notation compared to the traditional-based learning group. Thus, the embodiment-based system is more effective for the cognition location of the staff notation. However, the study result shown that there are no significant differences in the cognition sounds of the staff notation between both learning systems. It is deduced that the reason for this could be due to the lack of richness in the instructional design for the sounds of the staff notation, or it could be due to the learners not having enough time to practice.

For Questionnaire, the immerse survey and sentiment survey analysis result shows that there are no significant difference. However, in the system satisfaction survey, the result shows that the embodiment-based learning group has better attitude toward behavior than the traditional-based learning group. Therefore, this study imply that embodiment-based learning using rhythm learning view to design the body movement to control system can improve the learning of the location of the staff notation. It also imply that the embodiment-based environment improves learners' willingness to learn.

One of the research limitation for this study is that the embodiment-based system do not possess a special standard, maybe we could search for a better instructional design for the staff notation learning. The future research can consider designing the system with richer teaching material for the staff notation learning or seek for new study subjects to research the rhythm learning performance in the embodiment-based environment.

In the future, this study aims to investigate the effects of embodiment-based learning system on rhythmic music learning, but we can explore if the learning time become longer or learning content become complex, the result also have the significant in the performance and questionnaire. And we also can investigate the other subject by combining the embodiment-based technology to find the how impact the embodiment-based technologies with other subject.

Acknowledgements

This research was supported by the Ministry of Science and Technology, Taiwan under project numbers MOST103-2511-S-110-002-MY3,MOST104-2511-S-110-007-MY3,MOST 104-2511-S-110-009-MY3 and MOST 104-2511-S-269 -001-MY3.

References

Banchi, H., & Bell, R. (2008). The many levels of inquiry. Science and Children, 46(2), 26-29.

Barsalou, L. W. (2008). Grounded cognition. Annual Review of Psychology, 59, 617-645.

Barsalou, L. W. (2010). Grounded cognition: past, present, and future. Topics in Cognitive Science, 2(4), 716-724.

Chao, K. J., Huang, H. W., Fang, W. C., & Chen, N. S. (2013). Embodied play to learn: Exploring Kinect-facilitated memory performance. British Journal of Educational Technology, 44(5), E151-E155.

de Koning, B. B., & Tabbers, H. K. (2011). Facilitating understanding of movements in dynamic visualizations: An embodied perspective. Educational Psychology Review, 23(4), 501-521.

Gibbs Jr, R. W. (2006). Embodiment and cognitive science. Cambridge University Press.

Hurwitz, I., Wolff, P. H., Bortnick, B. D., & Kokas, K. (1975). Nonmusicol effects of the kodaly music curriculum in primary grade children. Journal of learning Disabilities, 8(3), 167-174.

Kuo, F. R., Hsu, C. C., Fang, W. C., & Chen, N. S. (2014). The effects of Embodiment-based TPR approach on student English vocabulary learning achievement, retention and acceptance. Journal of King Saud University-Computer and Information Sciences, 26(1), 63-70.

Lamb, S. J., & Gregory, A. H. (1993). The relationship between music and reading in beginning readers. Educational Psychology, 13(1), 19-27.

Wilson, M. (2002). Six views of embodied cognition. Psychonomic Bulletin & Review, 9(4), 625-636.

Lozanov, G. (2004). Suggestology (Vol. 2). Routledge.

Webster, J., Trevino, L. K., & Ryan, L. (1994). The dimensionality and correlates of flow in human-computer interactions. Computers in human behavior, 9(4), 411-426.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS quarterly, 319-340.