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The Effect of an Immersive Virtual Reality Interactive Feedback System on University Students' Situational Interest and Learning Achievement: The Case of a Pour Over Coffee Brewing Lesson

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Abstract: This study aimed to examine the effect of an immersive virtual reality interactive feedback system on university students' situational interest and learning achievement in a pour over coffee brewing lesson. A total of 103 university students participated in this experiment. They used the immersive virtual reality interactive feedback system to learn the steps of making pour over coffee. In addition, they were required to complete a prior knowledge test, a situational interest scale, and a learning achievement test. The results of this study indicate that the immersive virtual reality interactive feedback system can trigger sub-dimensions of situational interest to an average level except for the challenge dimension, while it also improves learners' learning achievement. It is suggested that teachers can use an immersive virtual reality interactive feedback system to teach learners multiple-step lessons or trigger learners' learning motivation.

Keywords: Virtual reality, situational interest, learning achievement, coffee

1. Introduction

Virtual reality (VR) has been recognized and is accepted by an increasing number of people as a learning technology. It utilizes computer simulation to produce a three-dimensional virtual world and provides users with visual, voice as well as other sensory simulations (Mealy, 2018). The VR environment can be designed in different ways, including desktop VR, immersive VR, spherical video-based VR, CAVE-like VR (Ye, Liu, Lee, Zhang, & Chiu, in press), and video-capture VR (Yang, Chen, & Jeng, 2010). Past research has compared different VR systems and the results indicated that immersive VR improved learners' achievements in engineering education because it can bring more immersive experience (Alhalabi, 2016). In addition, learners can observe object from different angles and distances in an immersive virtual environment, which helps them to calibrate between the real object and virtual object in their mind (Blascovich & Bailenson, 2005). In brief, if the virtual environment resembles the authentic environment more closely, people can easily transfer their knowledge or skills to the real world. Their manipulative ability can also be enhanced by the immersive virtual space, and the learners' attention, motivation and imagination will affect their manipulative ability (Loomis, Blascovich, & Beall, 1999).

Pour over coffee emphasizes the manipulative ability to keep the high quality flavor of coffee. The maker needs to control the extraction pressure, time, and water-to-coffee ratios to make pour over coffee (Folmer, 2017). Nowadays, the ratio of 18-24 year-olds who drink coffee every day has increased to 50% in U.S. (FONA, 2017) and 79% of coffee lovers prepare their coffee at home (National Coffee Association, 2018). Therefore, since the 18-24 year-old group includes university students, they may have the demand to learn how to make coffee themselves. The key point of the training was to standardize the steps of making coffee. The aim of this research was to design an immersive VR interactive feedback system for pour over coffee training and to analyze the effect of this system on university students' situational interest and learning achievement. The following are the research questions, and the research framework is shown as Figure 1.

Research question 1: Can learners improve their learning achievement significantly after using an immersive VR interactive feedback system to learn to make pour over coffee?

Research question 2: Which sub-dimensions of situational interest were higher than average level after using the immersive VR interactive feedback system?

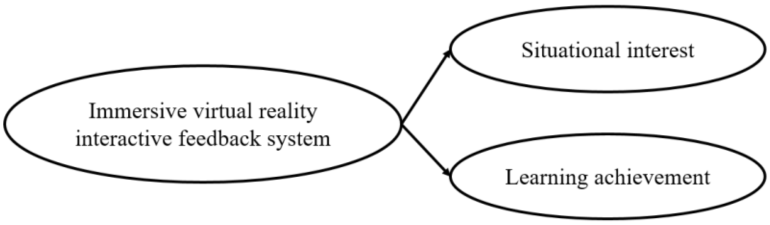

Figure 1. Research framework.

2. Related research

2.1 Situational interest

Interest is divided into two concepts: Situational interest and individual interest. Situational interest is defined as the affective reaction of a learner to face a specific environment, while individual interest is defined as a learner following the accumulation of time to structure stable affective reaction for a specific activity (Renninger & Hidi, 2016). Interest development is a sequential process. The four phases are "triggered situational interest," "maintained situational interest," "emerging individual interest," and "well-developed individual interest" in order (Hidi & Renninger, 2006). Situational interest plays an important role in triggering learners' interest and it is related to the learning environment. Chen, Darst, and Pangrazi (1999) developed a situational interest scale to analyze six sub-dimensions of situational interest. These six sub-dimensions include "exploration intention," which refers to the explorative inclination for a specific environment; "instant enjoyment," which refers to the instant feeling for activities; "novelty," which refers to the gap between new and existing information; "attention demand," which refers to the level of attraction between learners and activities; "challenge," which refers to the difficulty level based on learners' ability; and "total interest," which refers to an evaluation of overall interest of activities (Chen et al., 1999; Chen, Darst, & Pangrazi, 2001). Lin, Yu, Sun, and Jong (in press) indicated that the head mounted display (HMD) VR can significantly enhance learners' novelty and challenge dimensions of situational interest. Yu, Sun, and Chen (2019) also mentioned that university students' situational interest and remembering aspect of learning achievement was improved when they use an AR-based online wearable guide to learn museum content. Situational interest and the remembering aspect of learning achievement have a positive relationship. Therefore, the immersive VR interactive feedback system of this study may trigger learners' situational interest and its sub-dimensions. At the same time, learners' learning achievement may also improve.

2.2 Immersive VR in education

The HMD VR devices provide learners with an immersive VR experience (Ye et al., in press) and help them obtain first-hand and close-to-real perception (Kozhevnikov, Gurlitt, & Kozhevnikov, 2013). The HMD systems include HTC Vive, Oculus Rift, and so on. After undergraduate students wear the HMD VR display to learn relative motion concepts, their learning performance is significantly improved (Kozhevnikov et al., 2013). Alhalabi (2016) also mentioned that HMD VR for learning is better than other VR types. Past studies have found that immersive VR has a positive impact on learning performance in formal education. This research attempted to integrate immersive VR into standard manipulative ability training in a pour over coffee brewing lesson and to analyze the change of learning achievement.

3. Method

3.1 Participants

This study discusses the effect of a VR interactive feedback system on university learners' situational interest and learning achievement. The experiment involved 103 students over the age of 20 from two universities. The participants came from different departments. Among the 103 valid samples, 45 were males and 58 were females. There were 59 undergraduate students, 42 master's students, and 2 doctoral students. The average age of all participants was 22.41 (SD = 2.18) years old.

3.2 Experimental design

Before conducting the experiment, the participants needed to fill out a participant consent form which explained the experimental process, the experimental purpose, and that the participants had the right to leave the experiment at any time if they experienced discomfort. After they understood the content of the participant consent form and accepted it, they had to spend 5 minutes answering a prior knowledge test. Next, the participants were led to participate in the experiment. The researchers explained the operation of the immersive VR interactive feedback system and the participants tested it for approximately 5 minutes. The time of the experiment was about 35 minutes and participants used the immersive VR interactive feedback system to learn how to make pour over coffee. After the experiment, the participants completed a situational interest scale and a learning achievement test which took about 15 minutes. The experimental design chart is shown in Figure 2 and the status of participants using the immersive VR interactive feedback system is shown in Figure 3.

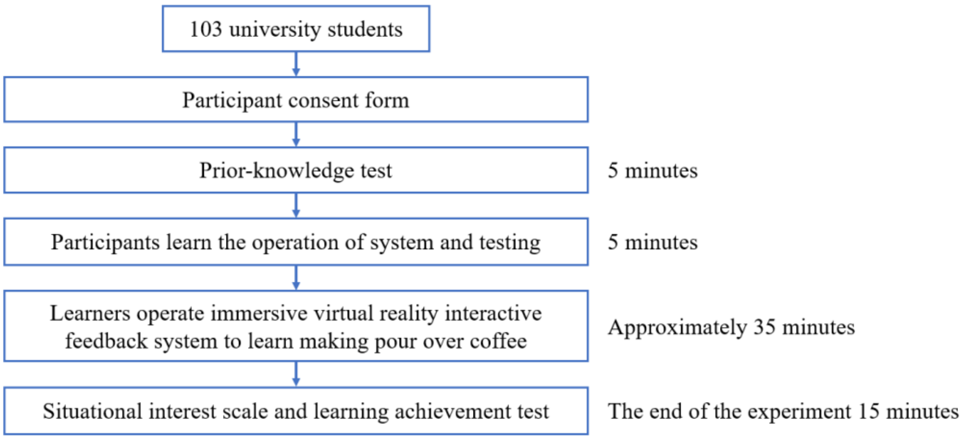

Figure 2. Experimental design chart.

Figure 3. The status of participants using the virtual reality pour over coffee system.

3.3 Instruments

3.3.1 Situational interest scale

The situational interest scale was adapted from Chen et al. (1999). The scale was divided into six dimensions: exploration intention, instant enjoyment, novelty, attention demand, challenge, and total interest. Each dimension had 4 items and the total number of items was 24. It was a 6-point Likert scale, from "1" representing *strongly disagree* to "6" representing *strongly agree*. The Cronbach's α of each dimension was .86, .90, .87, .95, .89 and .93, respectively, while the overall scale was .87.

3.3.2 Prior knowledge test and learning achievement test

The prior knowledge test and learning achievement test were the same and were based on the material of a professional barista lesson. There were 10 multiple-choice questions in the test and each question only had one answer. If the answer was correct, the participant could get one point. If the answer was false, they got zero points. All questions were verified by a professional barista, a professor of e-learning, and a professor of computer science and information engineering to achieve expert validity. After 30 university students filled out this test, the researchers analyzed the level of difficulty and item discrimination for each question. Finally, four items could be reserved, their difficulty level was within .3–.7 (Allen & Yen, 2001), and the item discrimination level was above .2 (Ebel & Frisbie, 1991).

3.3.3 The immersive virtual reality interactive feedback system

The learning topic is the step of making pour over coffee. For this study, the coffee tools 3D model for pour over coffee were downloaded from SketchUp, including the virtual coffee shop environment, swan neck kettles, electric kettles, coffee grinders, and electronic scales. On the other hand, filter cones, filter papers, coffee pots, and coffee cups were structured by 3ds max, and Unity was used to design the 3D animation production, the water flow model, and the water vapor model. Learners used HTC Vive to control the system.

This system was divided into six phases. In the first stage, the learners practiced moving and picking up objects in the VR environment. This phase helped learners to become familiar with the operation of the VR device without any narrators. When the learners understood the functions of the VR device, they could move to the second stage. In the second stage, the user interface displayed the learning steps. Learners could go through the content while trying to click the check button on a window. The third to sixth phases taught the steps of making pour over coffee. The third phase was the coffee tool introduction (Figure 4). When learners emitted a ray by the controllers to point to a coffee tool, the interactive feedback appeared above the tool. Learners could only obtain one instance of interactive feedback at a time. After all interactive feedback was shown to the learners, the next stage window would appear. The fourth phase was a making pour over coffee video which provided a professional sample to learners (Figure 5). The video showed the usage of coffee tools and used them to explain the posture of making pour over coffee and related knowledge. Learners could replay this video until they understood the content. The fifth phase was the pour over coffee unit program (Figure 6). The process of making pour over coffee was cut into three unit programs. Each unit had different interactive feedback. Interactive feedback can help learners to make pour over coffee step by step by themselves. The system can also specify to learners which part they are doing wrong and the corresponding correct procedures. They could also repeat practicing the programs until they were familiar with the process. All interactive feedback was displayed in black and red words on a window. Red words mean important keywords. The final phase was the final test which asked the learner to complete an overall process of making coffee without any interactive feedback in the VR environment. In this step, if learners did wrong operations, the system recorded the error and deducted points. The system stopped recording learning behaviors when the learner completed the whole process of brewing pour over coffee. At the end of the operations, the learner could get their final score and detailed criteria of the deducted points in order.

Figure 4. The interface of coffee tool introduction.

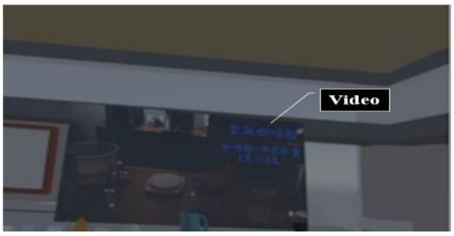

Figure 5. The interface of making pour over coffee video.

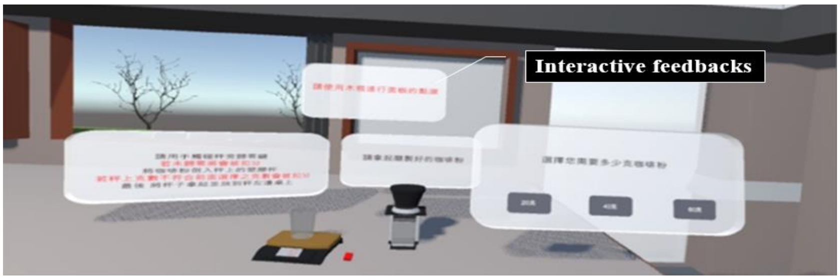

Figure 6. Pour over coffee unit programs.

4. Result and discussion

As shown in Table 1, the result of the paired *t* test revealed that the average score of the post-test (*M* = 3.01, *SD* = 0.94) was significantly higher than that of the pre-test (*M* = 2.03, *SD* = 1.04), and *t*(102) = -8.82 , *p* < .001. This finding means that learners can obtain more knowledge of pour over coffee after they use the immersive VR interactive feedback system, which conforms to the studies of Alhalabi (2016) and Kozhevnikov et al. (2013).

Table 1

The Result of the Paired t test of Learning Achievement

Variable	Pre-test		Post-test		*t*
Learning achievement	*Mean*	*SD*	*Mean*	*SD*	
	2.03	1.04	3.01	0.94	-8.82***

*** *p* < .001

As shown in Table 2, the average score of sub-dimensions of situational interest from high to low is total interest (*M* = 5.12, *SD* = 0.75), instant enjoyment (*M* = 4.88, *SD* = 0.89), attention demand (*M* = 4.85, *SD* = 0.99), novelty (*M* = 4.70, *SD* = 0.90), exploration intention (*M* = 4.60, *SD* = 0.81), and challenge (*M* = 2.96, *SD* = 1.17). Only the challenge dimension did not achieve an average level. This result revealed that the immersive VR interactive feedback system can trigger all sub-dimensions of situational interest except for challenge. As Yu et al. (2019) suggested, a high level of challenge may cause learners to reduce their learning willingness in informal education. This research topic is informal education and so did not require learners to get high scores or set goals. The difficulty of this system may not exceed the average level of learners' ability because of the low challenge score.

Table 2

The Result of Descriptive Statistics of Situational Interest and Its Sub-dimensions

Variable	*Mean*	*SD*	Rank
Situational interest	4.52	0.52	
Exploration intention	4.60	0.81	5
Instant enjoyment	4.88	0.89	2
Novelty	4.70	0.90	4
Attention demand	4.85	0.99	3
Challenge	2.96	1.17	6
Total interest	5.12	0.75	1

5. Conclusion

This study examined the effect of an immersive VR interactive feedback system on university students' situational interest and learning achievement. The results showed that the immersive VR interactive feedback system can trigger some of the sub-dimensions of situational interest to an average level and improve learning achievement. In the future, it is suggested that teachers can use an immersive VR interactive feedback system to teach multiple-step lessons or trigger learners' learning motivation. The future works can compare different pedagogies, demographics, and feedback types to obtain deeper understanding of the effects of immersive VR interactive feedback systems.

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