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Applying POE framework in a simulation system for facilitating physics learning with Tablet PCs

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Abstract: This study attempts to propose a model integrating real videos into the development of simulations on iPads to support students' science learning about motions based on Predict, Observation and Explanation (POE) framework. Motion examples in videos embedded in the simulation were employed to assist students in contrasting stimulated phenomena and real-world cases for meaning making about force and motion. A preliminary study found that the students, who were given with the video clips, exhibited significantly higher frequencies of modeling (manipulating variables to simulate the movement) and replaying (watching the simulation) than those who were not given with the videos while dealing with complex motion. Such a result suggest that integrating video clips into the simulation could be helpful to stimulate students' involvements in reviewing and revising the simulation while exploring more complex concepts.

Keywords: Simulation, science learning, iPads, video, POE

1. Introduction

Many researchers (Rutten et al., 2012; Smetana & Bell, 2012) have suggested that computer simulations could be a potential option for facilitating science learning and instruction. Computer simulations can offer many advantages to support students' science learning by ways of making abstract concepts and tacit knowledge of science visible and concrete. Students can see and interact with representational models of natural phenomena that would be hard to observe in the real world to carry out scientific discovery learning (de Jong & van Joolingen, 1998). However, researchers asserted that simulations should be carefully regarded as abstract models by its nature different from the physical entity in the real world, even though computer simulations are useful to the concretization of scientific concepts and phenomena (Horowitz, 1999).

Such a difference raises the concerns about how to strengthen the connection between stimulated representations and real-world situations. If students are engaged in conceptualizing science phenomena in the natural world, they actually learn science from real experience of what they were engaged in (National Research Council, 2011). For this reason, computer simulations demonstrated with real-world examples may be helpful to bridge the gap between the conceptual world and reality, and then help them develop better understanding of scientific principles and phenomena conveyed by the stimulated models. Therefore, this study attempts to propose a model integrating real videos into the development of simulations on iPads to support students' science learning based on Predict, Observation and Explanation (POE) framework. Motion examples in videos embedded in the simulation were employed to assist students in contrasting stimulated phenomena and real-world cases for meaning making about force and motion. Students are expected to acquire better understanding about scientific concepts related to the subject of force and motion within the research context conducted in this study.

2. The POE framework to apply simulations with video clips on iPads

In this study, pictures, texts, simulations and videos were employed to construct a series of multiple representations in support of science learning about force and motion on iPads. In the prediction phase, a descriptive question with an example illustration as shown in Figure 1 was offered to elicit students' idea of the particle movement being subject to the resultant of two different forces.

In the observation part, a simulation including a set of parameters (i.e., position, initial velocity, forces) was employed to demonstrate the effect of forces on the motion of a particle. Students were asked to choose a video clip that demonstrate a certain type of movement and simulate the movement by the use of the simulation system. Students were allowed to manipulate the given variables and observe the consequent movement of the particle as a way to validate their prediction made previously. The simulation system updates the value of the velocity to reflect the correct velocity of the particle's motion. The students were asked to construct at least two different combinations of the parameters in representative of the movement. The aim of combining hands-on simulation and example videos is to strengthen the connection between the stimulated and physical phenomena in support of students' knowledge transfer and integration.

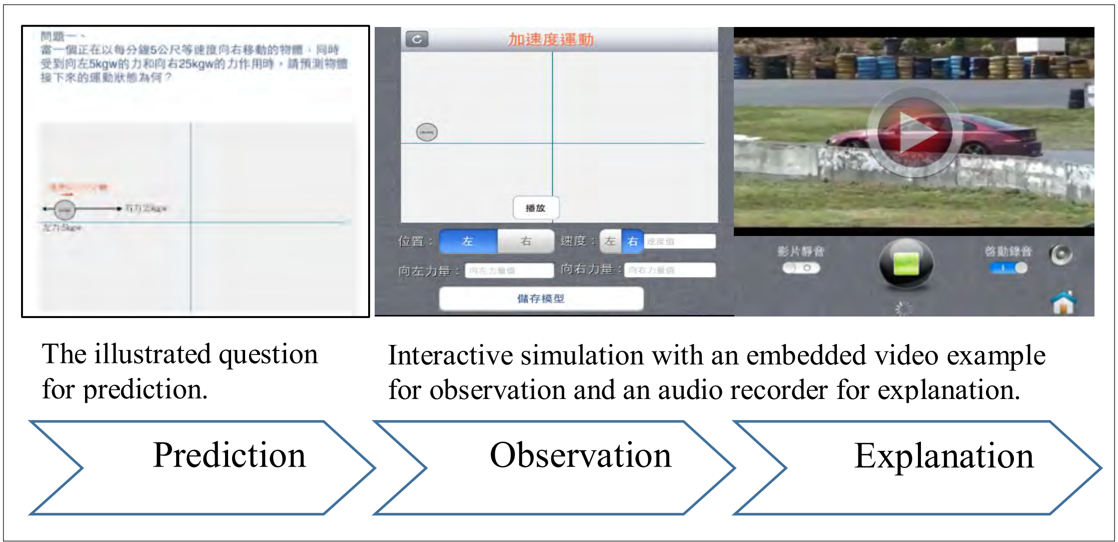

Figure 1. Interactive simulation with an embedded video example in a POE framework

Finally, a mechanism for voice recording is conducted to the explanation step that students are allowed to articulate their own explanations of what they observed and learned through the interaction with the simulation. The students are encouraged to describe the motion of an object by its position, direction of motion, and speed, as well as explicate how forces act on the object along a straight line and may cause changes in the speed or direction of the object's motion. The recorded explanations could be replayed and revised.

3. A Preliminary study

A preliminary study was conducted to understand whether video clips combined with the simulation is helpful to enhance science learning. Comparisons of activity log data between the control group (29 students given with simulation without video clip) and experimental group (28 students given with simulation with video clips) were made. The results indicate that the students in experimental group exhibited significantly higher frequencies of modeling (manipulating variables to simulate the movement) (2.92 versus 1.91, $p< .05$) and replaying (watching the simulation) (8.83 versus 4.76, $p< .05$) than those in control group while dealing with accelerated motion. There were no significant differences of modeling and replaying between the groups for the other two types of movements. The findings suggested that integrating video clips into the simulation could be helpful to stimulate students' involvements in reviewing and revising the simulation while exploring more complex concepts.

4. Concluding remarks

Through the application of the well-designed simulations and supportive mechanisms students would be facilitated to construct their own understanding through interacting with simulations about conceptual knowledge. This study aimed to support students' science learning on the topic of force and motion through interacting with a set of simulations. The POE approach was adopted as explicit guidelines to design and develop the POE-based simulations of force and motion for a normal science course in a classroom setting. The mechanism of video clips and sound recording were utilized to support the students' observation and explanation of the POE-based simulations in experimental condition. This combination is on the strength that everyday physical events may held great potential for students' interpretation of the relationships between scientific principles and real-world situations. Students' own observation and explanation are viewed as a critical enabler for their active and productive learning about force and motion.

Comparisons of the students' interactions with simulations between the groups revealed that the students in experimental group exhibited more frequent interactions with simulations for a particle motion with acceleration. It could be suggested that integrating example video clips into simulations could be helpful to stimulate students' engagements with simulations, especially for exploring some difficult concepts such as acceleration. On the basis of these findings, employing the POE-based simulations along with the application of analogous video examples may offer students an alternative ways to assess the ideas coming up with their interactions with simulations.

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