OBSERVE: Object Based learning to Support Education in Real and Virtual Environments

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Abstract

In the education of children, learning based on direct experiences is effective. However, many aspects of direct experiences present problems. Therefore, the authors have developed a learning support system that provides experiences in real and virtual environments. Learners can enjoy experiences such as touching and viewing in real and virtual environments by using this system. In the first stage of this study, we developed a larval mimesis experience system. This system consists of a Kinect sensor, larval models, and load sensors and is controlled in Arduino. By using this system, learners can exercise full body interaction on the virtual environment, i.e., they can experience the observation of larva models in the real environment. The experiment involved a learner from a primary school who used this system to evaluate its usefulness. This paper summarizes the current system and describes the evaluation results.

Keywords

Kinect Sensor, Arduino, Education, Full Body Interaction

1 Introduction

In the education of children, natural experiential learning is very important. The importance of natural experiential learning is recognized, and this requires teaching and learning that attaches great importance to a direct experience (Bueno & Marandino, 2015).

However, some things are difficult to experience directly. For example, the habits of extinct animals and plants, vegetation transition that is time consuming, and the habits of creatures with remote habitation environments.

Previous research conducted trials to enable simulated experience by the reproduction of the natural environment in the virtual environment. Yoshida et al. enabled a learning experience of extinct animals in using full body interaction (Yoshida et al., 2015). Additionally, learning to move the body as in full body interaction has a strong effect on learning (Yap, Zheng, Tay, Yen, & Do, 2013).

However, this experience is limited in the virtual environment. Thus, learners were not able to have a real experience such as touching. This is a problem that should be solved to improve the quality of experiential learning.

Therefore, the authors have developed a learning support system named "OBSERVE," which allows learners to experience the real and virtual environments. We used a tangible interface to realize an experience in the real environment (Ishii & Ullmer, 1997). This tangible interface is the user interface that can handle information intuitively by using a combination of physical objects and digital information. The tangible user interface can combine the experience of using virtual and real environments (Ishii, 20008). This enables learners to learn based on experience in both the virtual and real environments. The use of this system is expected to improve the learning experience.

In the first stage of this study, we developed a larval mimesis experience system, which can be experienced in the real and virtual environments. This system consists of a commercial sensor, larval models, projector, screen, PC, and board type computer. Learners observe larval models, perform interactions to identify larvae, and find latent larvae.

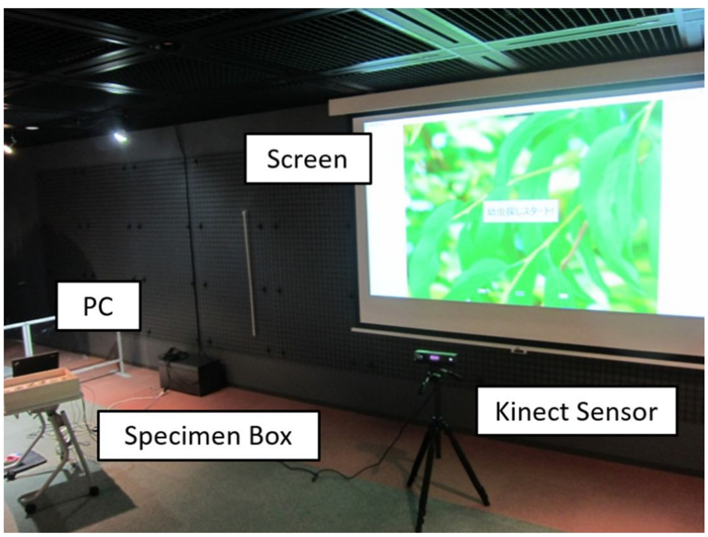
We expected learners to observe the larval models and virtual environment attentively, since the larval models are palm-sized. In this paper, we summarize the current system, the methods used for experimental evaluation, and the experimental result based on information gathered by way of a questionnaire.

2 OBSERVE system

2.1 Current system

The authors developed the system to realize experiential learning support. The flow of the system first requires learners to choose a larval model. Subsequently, an image corresponding to the selected larval model is displayed on the screen. The larva is hidden in the display. Learners play a game to find it. After finding the larva, the learners move their body and perform a motion to catch the larva. Then the larva begins to move and an explanation of the mimics is showed. Learners not only experience the observation of the larval model directly but also the observation of larva in the virtual environment. Realization of the system requires us to implement the following two functions:
(a)Creating a larval model as a tangible interface
(b)Operation using learner’s body motion
We can combine larval models and larva in virtual environment by implementation of function (a), and can perform experiential learning in the virtual environment by function (b). Figure 1 shows the setup of the system.

Figure 1: Setup of the system. Function (a) is performed in the specimen box. This consists of Arduino and FSR



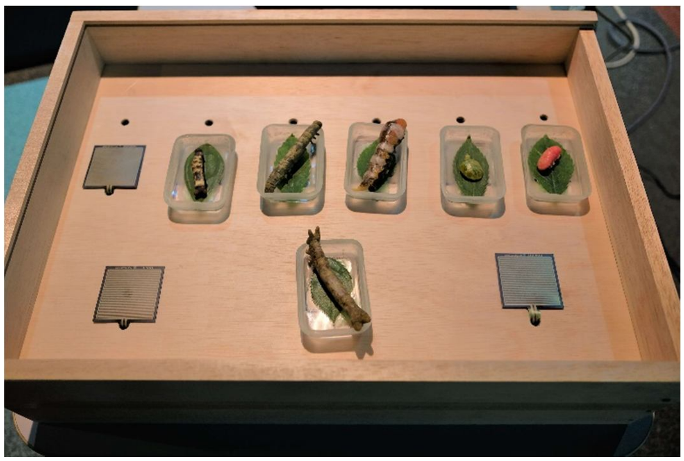
sensor. Function (b) is performed by the Kinect sensor.

2.2 Creating a larval model as a tangible interface

Displaying the chosen larva model in the virtual environment necessitated the development of a recognition function of the model. We used the board-type computer Arduino and load sensor FSR to recognize the model. Arduino is a single board-shaped computer, and the control of various sensors is possible (Balogh, 2010). We use Arduino and control FSR, which is a sheet-like load sensor, and the resistance level varies with the size of the added load. There are two reasons for using FSR. First, the value of the load is output in analog form. The system contained multiple larval models, and adjustment to react to all of them was necessary because the weight of each model was different. Second, FSR is not affected by the illumination and temperature. We carried out experiments in the laboratory and also in the museum for this study. Since the brightness of the illumination in the museum in particular differed from that in the laboratory, the use of a sensor that remained unaffected by this characteristic was desirable.

We incorporated Arduino and FSR in a larval specimen box. At first we placed the larval models on FSR. Since the model is separated from FSR when a learner picks up the model, the resistance level of FSR changes. The system understands that the learner picked up a model by reading this change in Arduino.

Figure 2: Top view of specimen box. There are 6 larval models and 9 FSR sensors. Six of the FSR sensors are hidden



under larval models. The others are revealed. Arduino is within the box.

2.3 Operation using learner's body motion

The system requires the ability to acquire real-time knowledge of the learner's movements and reflect these on the screen to enable learners to experience the virtual environment by moving their body. Therefore, we used a Kinect sensor to recognize the movement of the learner. This sensor is a range image sensor, originally developed as a home videogame device. Despite it being highly cost effective, the sensor can record advanced measurements about a user's location. Additionally, this sensor can recognize humans and the human skeleton using a library such as Kinect for Windows SDK. Because of this, Kinect sensor can measure movements associated with human body parts, such as hands and legs (Shotton et al., 2013). The system enables learners to operate in the virtual environment by using hand movement as an interface. When a learner moves their hand, the hand pointer displayed in the virtual environment undergoes similar movement. Learners look for a larva and carry a pointer to a larva if they find it. A pointer in the virtual environment of the hand can touch the larva when they perform movement to push the hand forward. The animation of the larva moving on the screen is played when the system recognizes the movement of the learner’s touch.

Figure 3: The learner is operating in the virtual environment.

3 Experiment

3.1 Methods

Participants : The participants were 13 fifth-grade students (four boys and nine girls) from a national university-affiliated elementary school.

Location: H Prefecture natural history museum

Subject: The participants experienced the system one by one. Six types of larvae were prepared as objects: Biston robustus, Vespina Nielseni, Hypopyra vespertilio, Deilephila elpenor, Apochima juglansiaria Graeser and Celastrina argiolus. The participants used all the objects and experienced the system as shown below.

The participants began by selecting and observing larvae from the six types of objects in the order of their interest. When an object is selected, animation that imitates the larvae of the selected object appears on a screen. Participants looked at the larvae from there and touched them with their hands. When they found the larvae, the participants referred to information on the object, which appeared on the screen. Participants performed this process for all six objects. Subsequently, the participants viewed related exhibits in the museum in groups of two and three.

Finally, we evaluated the system using a survey. There were 10 question items: four regarding the effect of the objects, three on the experience of physical movement, and three regarding information provided by the animation. Each question was scored on a scale of one to seven, where one corresponded to “strongly agree” and seven to “completely disagree.”

Figure 4: This learner is observing a larval model. The learner can see and touch the model.

4 Results

First, we classified the responses into positive responses of “strongly agree,” “agree” and “somewhat agree,” and neutral or negative responses of “no opinion,” “do not strongly agree,” “do not agree” and “completely disagree.” We then analyzed the number of positive replies and neutral and negative replies using directly established calculation: 1 x 2 population rate inequality.

Table 1 summarizes the results of the evaluation. The number of positive replies for “I was able to observe the larval models (objects) very well,” “I observed the larval models (objects) from several angles and understood some things about their ecology,” “I understood some things about the ecology of larvae by looking at the larval models (objects),” “The larval models (objects) looked real; like they were actually alive,” “I developed an interest in larval mimesis through the game where I moved my body to look for the larvae,” “I would like to learn more about larval mimesis through the game where I moved my body to look for the larvae,” “I developed an interest in other museum exhibits on mimesis through the game where I moved my body to look for the larvae” “I developed an interest in larval mimesis by looking at the displayed animation,” “I would like to learn more about larval mimesis by looking at the displayed animation,” and “I developed an interest in museum exhibits on mimesis by looking at the displayed animation” exceeded the number of neutral and negative responses. Additionally, a significant deviation was seen between the number of responses.

Questions	7	6	5	4	3	2	1
I was able to observe the larval models (objects) very well.	8	3	0	1	0	0	1
I observed the larval models (objects) from several angles and understood some things about their ecology.	7	4	0	0	0	1	1
I understood some things about the ecology of larvae by looking at the larval models (objects).	7	2	3	0	0	1	0
The larval models (objects) looked real; like they were actually alive.	10	2	1	0	0	0	0
I developed an interest in larval mimesis through the game where I moved my body to look for the larvae.	10	2	0	0	0	1	0
I would like to learn more about larval mimesis through the game where I moved my body to look for the larvae.	9	3	0	0	1	0	0
I developed an interest in the museum exhibits on mimesis through the game where I moved my body to look for the larvae.	10	0	1	0	2	0	0
I developed an interest in larval mimesis by looking at the displayed animation.	8	2	2	1	0	0	0
I would like to learn more about larval mimesis by looking at the displayed animation.	7	4	0	1	1	0	0
I developed an interest in museum exhibits on mimesis by looking at the displayed animation.	9	1	2	0	1	0	0
N=13 $p<0.01$ 7:Strongly agree 6: Agree 5:Somewhat agree 4:No opinion 3:Do not strongly agree 2:Do not agree 1:Completely disagree							

Table 1: Evaluation of the effect of the objects

5 Observations and future issues

This paper discussed system development and evaluation. For all 10 items in the evaluation, of which four on objects, three on the physical movement experience, and three on information provided by the animation, the number of positive responses exceeded neutral and negative responses. There was also a significant difference between the number of responses.

These results suggest that the experience of systems, including the use of physical objects and physical movement, elicited the interest and attention of the participants toward the larvae and led to effective learning through museum exhibits.

Furthermore, we understood that system information provided through animation motivated participants and supported viewing of not just the object larvae but also other related museum exhibits. A future consideration will be to increase the types of larvae. We will also consider a learning program that is not limited to the object larvae but includes observation of live larvae outside the museum.

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