Preliminary Evaluation of a System for Helping Children Observe the Anatomies and Behaviors of Animals in a Zoo

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Abstract: In order to support children's scientific observation in zoos, we developed a system for helping children to observe the anatomies and behaviors of animals. This system provides viewpoints for observation via animations. Observing the anatomies and behaviors of animals is related to scientific observation. As a case study, we developed a system for learning about penguins and held a workshop at Kobe Municipal Oji Zoo. At the workshop, 19 elementary students used the system and observed how penguins swim and walk along with the skeletons of their legs and flippers. We examined the evaluations of children's enjoyment of this system. They responded to five items on their feelings about using this system on five-point scales. The number of affirmative responses was found to be more in number than neutral or negative responses. Children were able to enjoy using this system for observing the anatomies and behaviors of animals in a zoo.

1 INTRODUCTION

One of the informal science learning places is the zoo (National Research Council, 2009). Zoo provides chances to observe animals and emulates their natural habitats, thus strengthening students' connection to nature (Falk, 2014). Patrick and Tunnicliffe (2013) state that one of the roles of zoos is education that aims to aid visitors in learning the scientific interpretation of organisms. Wagoner and Jensen (2010) noted that children could acquire knowledge about animals by observing them with educational support. However, many zoos cannot appropriately support the observation of animals (Mallapur et al., 2008). Additionally, despite the educational aspirations, the zoology garden has become a place for leisure visit (Patrick and Tunnicliffe, 2013). For visitors, entertainment and recreation may be more important than the educational functions of the zoo (Webber et al., 2017).

Recently, a number of studies have explored technologies for zoo visitor education. It is said that technology-based education for visitors offers the potential for effective delivery of information (Perdue et al., 2012). Additionally, technology-based education has a greater impact than static signage and is attractive to young people (Webber et al., 2016). Guide systems are an example. They provide information about animals through pictures, videos, and explanations on tablets, and they are effective for education in zoos. (Suzuki et al., 2009; Ohashi et al., 2008). However, to the extent of our knowledge, only few studies so far have discussed observation in zoos by using animation.

Tanaka et al. (2016) developed and evaluated a system for supporting the observation of seals in a zoo by using animation. The contents of this system cover the features and behaviors of seals. Scientific observation of features and behaviors of animals are important activities in zoos. Patrick and Tunnicliffe (2013) have stated that zoos should support children to note simple morphological and taxonomic terms and the taxonomy of animals based on morphological attributes and similarities. In addition, Eberbach and Crowley (2009) explained that scientific observation involves the following:

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notice and describe relevant features and ignore irrelevant features using disciplinary structure (e.g., taxonomy).

This system uses animations because of three reasons. First, animation promotes better understanding due to its visualization (Betrancourt and Chassot, 2008). Second, animation makes it easy for children to understand movement because the advantage of animatronics is that they move in a planned sequence repeating their narrative (Patrick and Tunnicliffe, 2013). The third reason is that animation can help to motivate learning and to draw students' attention on particular subjects, which eventually facilitate better learning (Shreesha and Tyagi, 2016).

However, this system is not enough to support scientific observation because of lack of viewpoints about anatomies of animals. Patrick and Tunnicliffe (2013) said that taxonomic judgments could not be made without an understanding of the anatomy and behavior of organisms, but, in reality, children tend to lack knowledge about organisms of animals (Prokop et al., 2007; Tunnicliffe and Reiss, 2010). This is why we developed a new system helping children to observe the anatomies and behaviors of penguins in this study. We expect that because of the developed system using animations, children will be able to observe animals thinking not only about surface features, but also about invisible internal structure. They will also have a better opportunity to observe animals scientifically. Supporting observations of anatomy and behavior by animation thus aids children's scientific observation in zoo.

We ascertained whether the developed system using the content on penguins was effective in encouraging scientific observation of providing viewpoints on anatomy and behavior. In this study, we first examined whether children enjoyed using this system and whether it aroused their interests.

2 SYSTEM OVERVIEW

2.1 Development Environment

HTML and PHP5.3 were used to create the development environment of the server. The animations were played using GIF. The guide is Internet-based.

2.2 Details of This System

This system allowed children to predict and observe the anatomies and behaviors of penguins by referring to animations. Figure 1 provides a system overview and Figure 2 outlines the system flow. The system is made of four items that present the anatomies and behaviors of the penguins: walking, swimming, leg skeleton, and flipper skeleton. There are two stages in each item: Prediction stage and Result stage. Each stage includes a Question page, Animation page, and Selection page. Based on a request from the user, an appropriate question and three options of the question are displayed on the Question page. On the Question page, the bottom part of each option includes the "Watch animation" button and "My prediction" button. The user can

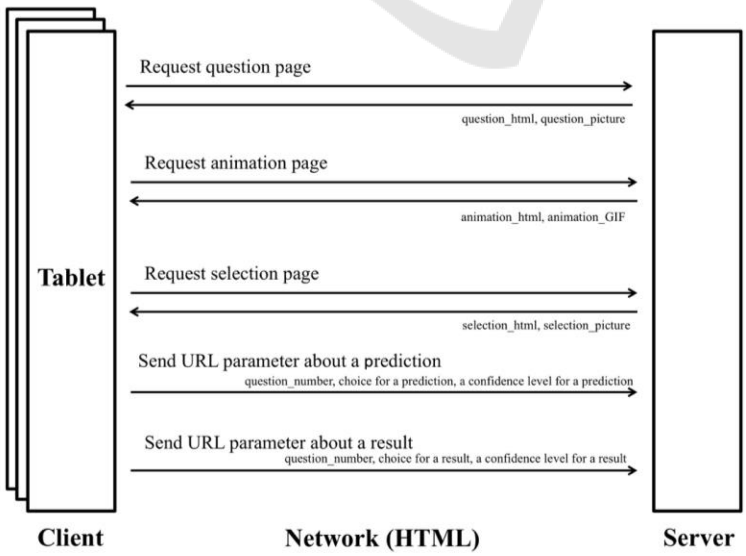

Figure 1: The system overview.

watch an animation on the Animation page by clicking the "Watch animation" button. The number of times they play the animations depends on each child. Children can choose only one option as a prediction by clicking the "My prediction" button. They can also indicate their level of confidence in their prediction on the Selection page. When the children indicates their level of confidence on a five-point scale, the option and the level of confidence of each child are sent to the server as a URL parameter and saved as a PHP file, which is used later to display the prediction stamp that has been described below.

The next stage is the Result stage. The same question and options are displayed as on the Question page on the Result stage. The Question page on the Result stage is almost the same as on the Prediction stage without a prediction stamp appearing on the top of the option that has been selected by the children as their predictions. While observing actual penguins or a skeleton of penguin, they can again watch the animations by clicking "Watch animation." After observations, the children need to select one option to represent their observation and click "Result" to indicate their choice. They also indicate the level of the confidence in the result by observation. When the children indicate their level of confidence, the choices and the level of the confidence of each child are sent as a URL parameter and saved as PHP files. The flow is repeated four times.

Figure 2 shows the choices for the skeleton of flippers: 1. Five finger-bone, 2. Flat bones, 3. Many thin bones. Figure 3 shows the choices for ways to swim: 1. Swims using legs, 2. Swims using flippers, 3. Swims using legs and flippers. Figure 4 shows the choices for walking: 1. Walks slowly 2. Jumps and walks, 3. Walks on tiptoes. Figure 5 shows the choices for the skeleton of legs: 1. Short legs, 2. Long legs, 3. Bent leg.

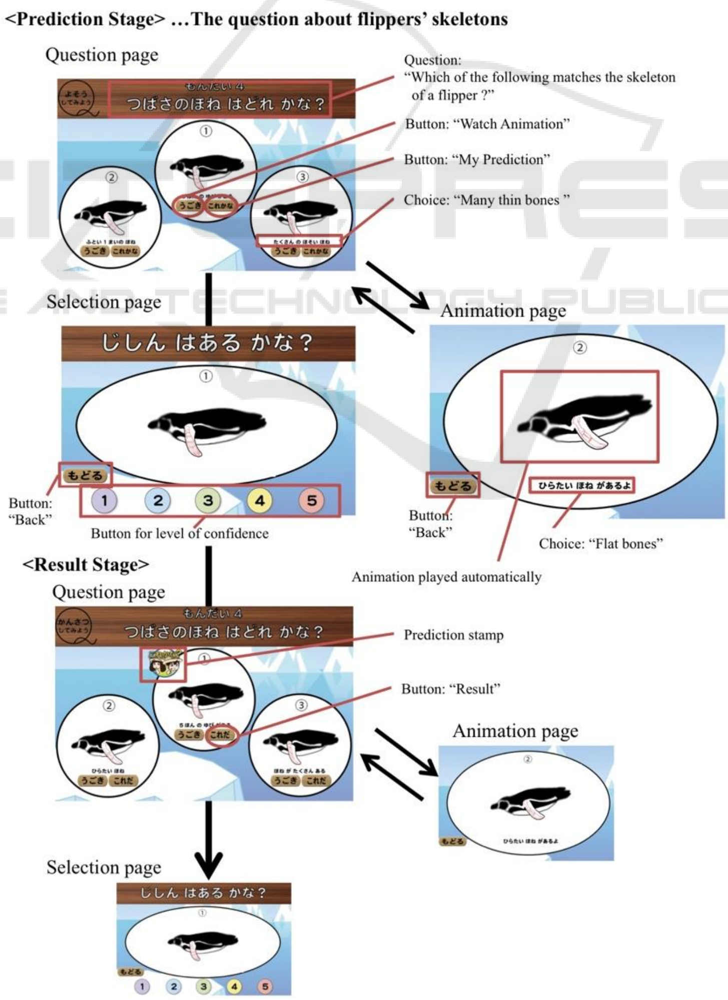

Figure 2: System flow.

3 RESEARCH METHOD AND DESIGN

3.1 Workshop

In order to assess the effectiveness of this system, we held a workshop using this system in Kobe Municipal Oji Zoo on December 1, 2016. The workshop was held as follows. At first, the staff asked a question and provided options for the question from the system. Next, children watched the animations for each choice and predicted the answer at least one time (Figure 6). Third, children observed penguins or skeletons of penguins referring to animations (Figure 7, 8). After observation, children again made selections. The staff members told them the correct answers after children made their choices, and explained some more details about the item. This flow, which takes about 10 minutes, was repeated four times for swimming, walking, leg skeleton, and flipper skeleton.

Figure 3: Question about swimming.

Figure 4: Question about walking.

Figure 5: Question about leg skeletons.

Figure 6: Children making a choice as a prediction.

Figure 7: Children observing a live penguin.

Figure 8: Children observing a penguin skeleton.

Table 1: Evaluation results for the system.

Item	5	4	3	2	1
I enjoyed using this system very much. **	15	4	0	0	0
This system was fun to use.**	11	7	1	0	0
I would describe this system as very interesting.**	13	3	1	2	0
I thought this system was quite enjoyable.**	12	4	3	0	0
While I was using this system, I was thinking about how much I enjoyed it.**	16	3	0	0	0

N =19

5: Strongly agree, 4: Agree, 3: Neutral, 2: Disagree, 1: Strongly disagree

$^{**}p < 0.01$

3.2 Participation

The participants were 19 second- and third-graders from elementary school (13 boys and 6 girls). One or two adults accompanied each child during the observation of the penguins, and each child received a tablet to use for this exercise.

3.3 Data Source and Analysis

After the workshop, participants were interviewed. At the interview, they evaluated the system using five items on a five-point scale ranging from "strongly agree" to "strongly disagree."

First, we classified the responses: "strongly agree" and "agree," were classified as affirmative responses while "neutral," "disagree," and "strongly disagree" were classified as neutral or negative responses. Subsequently, the affirmative responses and neutral or negative responses were analyzed using a 1 x 2 uneven distribution binomial test.

4 RESULTS

Table 1 presents a summary of the evaluation results for the system. For all the five items, the number of affirmative answers exceeded the neutral and negative answers (as the students indicated, "I enjoyed using this system very much," "This system was fun to use," "I would describe this system as very interesting," "I thought this system was quite enjoyable," "While I was using this system, I was thinking about how much I enjoyed it"). A significant bias was found in the number of responses for all items ($p < .01$).

Some details of their answers are given below: "I enjoyed the quizzes and observed penguins," "Animations about penguins were useful, using the system was enjoyable for me," "It was first time I observed animals using a tablet, so during observation, I really enjoyed the activity with this system".

5 CONCLUSIONS

This paper described the development and evaluation of children's enjoyment of the support provided for their observations in a zoo by using animations. In the evaluation, the number of affirmative responses exceeded the number of neutral and negates responses for all five items. Moreover, there were significant differences in the number of responses. These results suggest that the system was enjoyable and that it spurred children' interest in observing animals' anatomies and behaviors in zoo.

Future tasks include the more specific analysis of the effectiveness of this system regarding whether this systems supports the scientific observation of anatomies and behaviors of penguins by using animation. In addition, future tasks can include the development and implementation of the system for other animals.

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