Development and Evaluation of the 'Pocket Plant Guide' to Support the Observation and Identification of Indicator Plants for Vegetation Succession

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Abstract: We developed and evaluated a mobile system called 'Pocket Plant Guide' for support the observation and identification of indicator plants for vegetation succession. One characteristic of the 'Pocket Plant Guide' is that it uses sketches instead of photographs. This guide contains 3 representative functions that help students in identifying and observing of indicator plants. These functions include (1) coloured representations of leaves and fruits; (2) enlarged images of leaves and fruits; and (3) sketches of the backside of the leaves. We allowed Japanese sixth grade elementary school students (age 11–12 years) to use the 'Pocket Plant Guide' to identify and observe indicator plants. After this activity, we used a questionnaire to evaluate the ease with which the students used the guide, and validated the usefulness of the guide for identifying and observing indictor plants. The results indicated that the 'Pocket Plant Guide' was quite easy to use and was effective in supporting the identification and observation of indicator plants.

1 INTRODUCTION

In the area of the science education, an important aspect of studying plants is to observe these in nature, in addition to accumulating classroom knowledge. However, field identification and observation of plant types or names is often difficult when using a large textbook. In recent years, research has been conducted on using a mobile device to support the identification and observation of plants. Previous studies have shown the effectiveness of mobile devices in identifying and observing plants (Morita et al., 2004; Huang et al., 2010). Kusunoki et al., (2011) initiated the development 'Pocket Plant Guide' as a mobile system to support the efforts of students in identifying and observing indicator plants. The 'Pocket Plant Guide' is a system designed to present information on 12 types of representative indicator plants during the early, middle, and late stages of vegetation succession using an iPhone/iPod Touch platform. The indicator plants used in the guide were selected from vegetation succession studies conducted in the Rokko Mountains of Kobe, Japan. While previous systems used photographs, the 'Pocket Plant Guide' uses sketches, which is one of its defining characteristics. As is often stressed in scientific practice, scientists alter the natural world in some way to facilitate the observation of subjects, (Lynch, 1990). Scientific activity, such as the identification and observation of plants, are usually accomplished through sketches instread of photographs and this is because it is easier to visualise the characteristics of plants as a drawing, compared to photographs.

Inoue et al. (2012) conducted a preliminary evaluation of the pilot version of this guide. The results of this initial study indicated that the guide was effective in supporting the identification and

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observation of indicator plants. In addition, we obtained suggestions towards further development of the contents and interface for the current version of the guide.

We completed the development of the 'Pocket Plant Guide' by incorporating the feedback from the preliminary evaluation. The purpose of this study was to determine the ease of use of the 'Pocket Plant Guide' and to determine its effectiveness in supporting the identification and observation of indicator plants.

2 OUTLINE OF THE 'POCKET PLANT GUIDE'

Figure 1 shows the home screen of the 'Pocket Plant Guide'. Six types of indicator plants are shown as icons on this screen. Flicking the screen to the left reveals the remaining 6 types of indicator plants, also shown as icons in Figure 2. The teacher explained to the students that in order to display the remaining 6 types of indicator plants, the screen should be flicked to the left. When one of these icons is tapped, for example, *Rubus microphyllus*, a monochromatic sketch of the indicator plant in Figure 3 appears.

Figure 1: Home screen of the 'Pocket Plant Guide'.

This guide includes 3 fundamental functions that support the identification and observation of indicator plants. First, the characteristic parts of the indicator plant are shown as colour sketches. This function helps to identify indicator plants that have distinct leaf or fruit colour features. If the user taps the monochromatic sketch in Figure 3, the characteristic parts of the indicator plant are shown

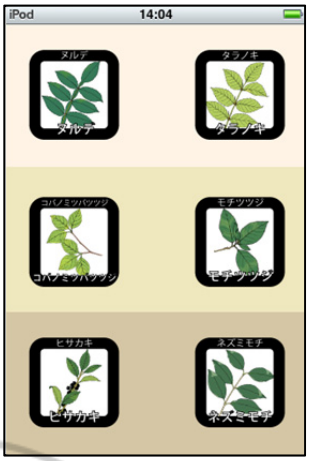

Figure 2: Screenshot of the remaining 6 types of indicator plants.

Figure 3: Screenshot of the monochromatic sketch of characteristics of the indicator plant.

in colour, and a comment describing the characteristic is displayed at Figure 4. In this colour sketch, the characteristic red fruit of *R. microphyllus* is shown.

A second function is the ability to enlarge the leaf and fruit sketches of indicator plants. This feature was included to support the identification and observation of indicator plants that have characteristic leaf shapes or leaf veins. If the loupe icon is tapped at the bottom of Figure 4, an enlarged leaf is shown. Figure 5 shows the upper side of the enlarged leaf of *R. microphyllus*. The characteristic 2 large notches of its leaf are shown. Tapping the x button at the top right corner of the screen returns the user to the previous screen (colour sketch).

Third, users are able to examine the backside of a leaf by rotating the indicator plant leaf. This feature may be used to identify and observe

Figure 4: Screenshot of the colour sketch of characteristics of the indicator plant.

Figure 5: Screenshot showing the upper side of an enlarged leaf.

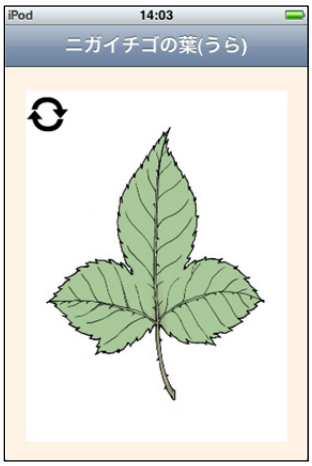

Figure 6: Screenshot showing the backside of an enlarged leaf.

characteristic leaf shapes and vein structures on the backside of indicator plants. If a user taps the enlarged image of the upper side of the leaf in the Figure 5, an enlarged image of the backside of the leaf appears. Figure 6 shows the backside of *R. microphyllus* leaf. The characteristic white colour of the backside of the *Rubus microphyllus* plant leaf is shown on this screen. Tapping the screen once more returns the user to the previous screen (upper side of the leaf).

3 EVALUATION OF THE 'POCKET PLANT GUIDE'

3.1 Evaluation Method

3.1.1 Purpose

The purpose of evaluation was two-fold: (1) to determine whether the 'Pocket Plant Guide' is easy to use for elementary school students, and (2) to determine the efficacy of the 'Pocket Plant Guide' in supporting elementary school students in identifying and observing indicator plants.

3.1.2 Subjects

The subjects were 35 elementary school students (age range: 11–12 years) from an elementary school attached to a Japanese national university.

3.1.3 Task

The research task was to evaluate the ease-of-use of the 'Pocket Plant Guide' and evaluate its efficacy in supporting the identification and observation of indicator plants. The questionnaire contained 13 questions, of which 7 were related to the ease-of-use of the 'Pocket Plant Guide.' Sample items included 'I could easily touch/tap the screen with my fingertips' and 'I could easily manipulate the plant sketch screen to the more detailed characteristics screen.' The remaining 6 items addressed the 3 characteristic functions of the 'Pocket Plant Guide' and its efficacy in identifying and observing indicator plants. For example, with respect to the coloured sketches of the indicator plants, items such as 'the coloured sketches helped me identify the real plant' were included. For each of these items, students were asked to select one of the following 4 options: I think so, I mostly think so, I don't quite think so, and I don't think so. Printed questionnaire sheets were distributed.

3.1.4 Procedure

The students were divided into groups of 6 and were asked to identify and observe the 12 types of indicator plants in the guide. The activity was conducted indoors. Each student was given the 'Pocket Plant Guide' for use. The activity time was approximately 20 min. After the identification of indicator plants, the students were asked to answer the questionnaire, which took approximately 15 min. The evaluation was conducted on November 17, 2012.

3.2 Results

Table 1 shows the students' response to each item in the questionnaire. We interpreted the responses 'I think so' and 'I mostly think so' as positive responses, whereas 'I don't quite think so' and 'I don't think so' were classified as negative responses. We then performed Fisher's exact test to identify patterns in the students' responses.

First, we discussed the results of the 7 items in terms of ease-of-use. In 6 out of the 7 items, significantly more students answered positively than negatively ($p < 0.01$). However, for item 6, no significant differences were observed between the number of students that answered positively or negatively ($p > 0.10$).

Next, we examined the results of the evaluation for the 6 items related to the guide's efficacy in supporting the identification and observation of indicator plants. For all 6 items, significantly more students answered positively than negatively ($p < 0.01$).

4 CONCLUSIONS & FUTURE WORK

We developed and analysed the 'Pocket Plant Guide' in this study. The characteristic functions of this guide are: (1) the colour display function of leaves and fruits; (2) the enlargement function of leaves and fruits; and (3) the backside view of leaves.

First, we discussed the ease-of-use of the guide. The results of the assessment showed that the number of positive responses was significantly higher for all but one item indicating the ease of use of the 'Pocket Plant Guide' by the students. However, no significant differences between the positive and negative responses for the questionnaire item 'I can easily switch from the enlarged image of leaves and fruits to the screen showing the plant characteristics.' were observed. One reason for this was that the button to return from the enlarged sketch of leaves

Table 1: Assessment of the 'Pocket Plant Guide'.

Ease-of-Use	ITS	IMTS	IDQTS	IDTS
01 I can easily touch/tap with my fingers **	14	14	7	0
02 I can easily switch from the plant selection screen to the plant sketch screen **	25	9	1	0
03 I can easily switch from the plant sketch screen to the screen showing plant characteristics **	20	12	3	0
04 I can easily switch from the characteristics screen to the enlarged images of fruits and leaves by tapping the loupe icon **	20	11	4	0
05 I can easily rotate the sketches to view both sides of the leaf **	18	9	7	1
06 I can easily switch from the enlarged images of leaves and fruits to the screen with the plant characteristics *	15	7	9	4
07 I can easily switch from the characteristics screen to the plant selection screen **	25	6	3	1
Effectiveness in plant identification and observation	**ITS**	**IMTS**	**IDQTS**	**IDTS**
[For sketches with coloured plant parts]				
08 It helped me to find the real plant **	27	7	1	0
09 It helped me to observe the real plant and its characteristics in detail **	24	10	1	0
[For enlarged sketches of leaves and fruits]				
10 It helped me to find the real plant **	26	8	1	0
11 It helped me to observe the real plant and its characteristics in detail **	25	10	0	0
[For rotatable images of leaves that allow the student to view both sides]				
12 It helped me to find the real plant **	21	8	5	1
13 It helped me to observe the real plant and its characteristics in detail **	19	13	2	1

$N = 35$; **$p < 0.01$; **n.s*: not significant; ITS: I think so; IMTS: I mostly think so; IDQTS: I don't quite think so; IDTS: I don't think so

and fruits to the screen with their characteristics was too small. In the future, further improvements to the interface of 'Pocket Plant Guide' will be necessary.

Next, we discussed the efficacy of the guide in supporting the identification and observation of indicator plants. For all items, the number of positive responses was significantly greater. We speculate that the following 2 factors affected this outcome: (1) sufficient information was included in the 'Pocket Plant Guide' that allowed the students to identify indicator plants by the colour of its fruits or leaves or the shape of the upper and backside of the leaves; and (2) a sufficiently permissive environment for the observation of plant characteristics was obtained through the coloured and enlarged sketches contained in the guide. On the basis of these observations, we conclude that the 'Pocket Plant Guide' is an effective tool in supporting the identification and observation of indicator plants.

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