Research Paper

Development of Teaching Material Using a Cellphone to Connect to the Internet - For Collecting Liverworts to Use Them for Observation Activities in the Classroom and in the Field

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Abstract

Recently, teachers have begun to focus on web teaching materials that would be effective in class activities.   So, we have developed web teaching material which is accessible by a cellphone through the Internet.   It helps teachers and students to collect liverworts in the field.   We could refer to the following four advantages of the teaching material for cellphones.   1) Possibility of collecting liverworts throughout the year, 2) Possibility of using the teaching material anywhere, even in field activities, 3) Relation to classroom activities, 4) High accessibility for teachers and students.   We compared this teaching material for cellphones with the other teaching materials.   We found other advantages and disadvantages to it.   As for advantages, the cellphone is easy to carry, teachers and students are able to exchange information and research data anywhere, and they can use the material provided in the classroom or in field activities. One of the major disadvantages is the limited memory of cellphones to download a heavy page from a web site.   In addition, as the markup languages have not yet been standardized among Japanese cellphone companies, we needed to develop different file adapted to each different cellphone company.

Key words: *Cellphone, development of teaching material, field activities, Internet, liverworts*

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Introduction

Teachers have recently begun to focus on teaching materials that would be effective in class activities using computers.   There are various precedent studies in biological education on using computers in class activities. Development and implementation of a database in reference for seed plant identification revealed some good results (Ohkawa 1997, 1999,

2000, 2001-02, Ohkawa and Okazaki 2001). The software "Scientist Library" developed by Mitsuishi *et al*. (1999) can give teachers and students some information about Japanese biology researchers. Provision of teaching material through the Internet is another good example. Nowadays, almost all teachers can use many web sites on the Internet in class activities for obtaining information and research data. These sites are made and opened by laboratories, companies, teachers and students.

There have been some studies on biology education through the Internet such as the provision of material for teaching the reproduction of plants on a web site (Ohshika and Ikeda 1997), and the assessment of developed web teaching materials (Ohshika *et al*. 2001). The advantages of developing and using web teaching materials are as follows: Ease of content renewal, simultaneity in teaching and learning, and interactivity of releasing and receiving information (Ohshika *et al*. 2001).

However the use of computers in class activities is restricted. For example, since the costs for purchasing and maintaining computers are still expensive for schools, most activities are limited to classroom or computer room. The Japanese government has provided with a few dozen of computers in computer room for all of the public schools, and teachers can use them in their teaching activities. Recently, the government has started to set some computers in each classroom and to link them to Local Area Network (LAN). But, we consider that some activities are still limited to the exchange of information.

Meanwhile, as a social trend in Information and Communication Technology (ICT), laptop computers and Personal Digital Assistant (PDA) are spreading in developed countries.

In 1999, NTT DoCoMo, Inc. (one of the companies providing cellphone service in Japan) started the service of connecting cellphones to the Internet. Nowadays, this service is offered by the other cellphone companies in Japan. The cellphone has spread rapidly among Japanese secondary school students. They are using cellphones as their main tool of telecommunications (conversation and e-mail).

Some web teaching materials for cellphone have been developed for science education, such as simulation of chemical reactions ("i-mode Kagaku" http://www2d.biglobe.ne.jp/~chem_env/i/), the encyclopedia of birds ("Mijikana Toritachi" http:// www.pleasuresky.co.jp/hi/nature/bird/), etc. But, some of these teaching materials are not yet designed well enough to match the classroom environment.

We have developed teaching material for cellphones on a web site for collecting liverworts. Teachers and students can collect different kinds of liverworts in the field by accessing the web site by cellphone and by comparing their characteristics.

Materials

We selected six common species of liverwort: *Marchantia polymorpha*, *M. paleacea*, *Dumortiera hirsuta*, *Reboulia hemisphaerica*, *Conocephalum conicum*, *C. supradecompositum*.

Development and composition of our teaching material

In Japan, there are three main companies providing cellphone service. They are "NTT DoCoMo, Inc," "J-PHONE" and "KDDI CORPORATION." The names of their Inter-

net services for cellphone are "i-mode[®]," "J-sky" and "ez-web," respectively. Each of them is made up of different markup language and has a different format system of displaying image files. Furthermore, the upper limit of memory per page of web site is different. Therefore, we needed to make three different files of our teaching material to adapt to each Internet service.

Before we developed our teaching material as these three files, we examined the markup languages adopted by each company (Table1). "NTT DoCoMo, Inc." has adopted C-HTML (Compact Hyper Text Markup Language). It is a simplified version of HTML (Hyper Text Markup Language) that is usually used for making web sites for computers. "J-PHONE" has adopted MML (Mobile Markup Language) which can run on HTML. For "NTT DoCoMo, Inc." and "J-PHONE," we could use the software "Notepad" for making our web teaching material. On the other hand, "KDDI CORPORATION" has adopted HDML (Handheld Device Markup Language). HDML is not compatible with HTML, and therefore

we had to use the software EZ@EZ (ver.1.0-c) for cellphones from this company.

The contents of our web teaching material were composed of original image files (photographs and sketches), explanations and link buttons. Taking the monitor size and limited memory of cellphones into consideration, we reduced the contents of each image files to be as simple as possible.

How to use our web teaching material

When teachers and students connect their cellphones to the Internet and access our web teaching material (Fig. 1), they can refer to the "Front page." Then, they can acquire some information about the identification of liverworts. After that, they can proceed to "Shall we find Marchantiales?" where there are two link buttons: "1 = From photographs" and "2 = From reference." Depending on which link button the users choose, they can proceed to the next page where they can identify liverworts using either a photograph or a reference key.

Table 1   Comparison of the characteristics of cellphones among the 3 main companies in Japan

	Corporation		
	NTT DoCoMo, Inc.	J-PHONE	KDDI CORPORATION
Internet service	i-mode[®]	J-sky	ez-web
Markup language	C-HTML	HTML MML	HDML
Image format	BMP*	PNG**	PNG**
Upper limit of memory per page	10KB	6KB	---***
Cost for downloading our teaching material	¥180	¥150	¥60

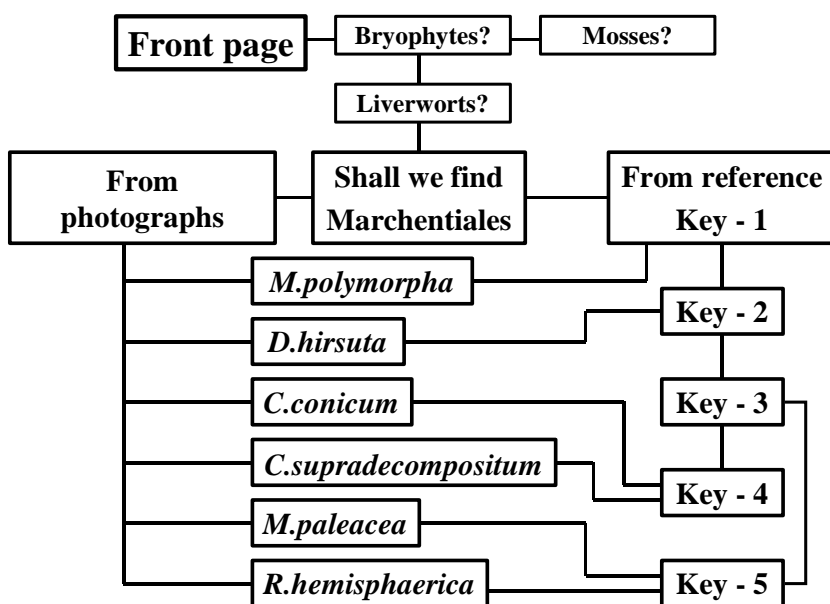*Bitmap, **Portable Network Graphics, ***The data was not indicated by this company

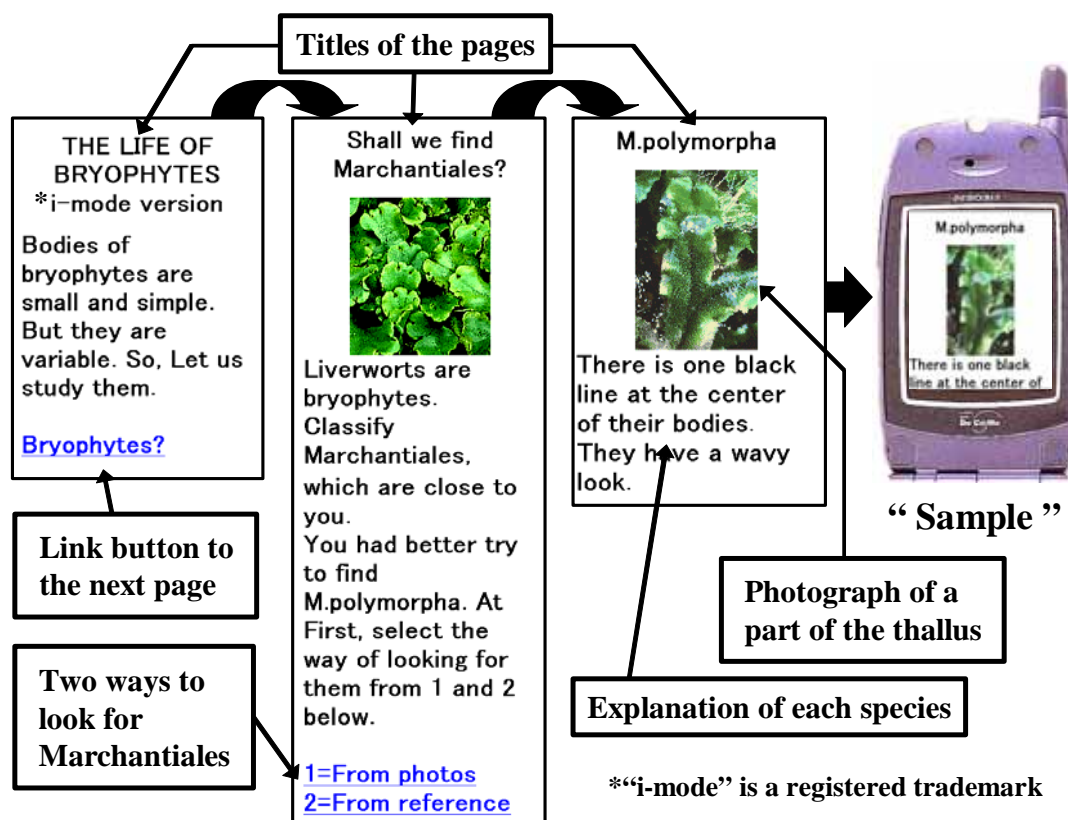**Figure 1   Composition of our teaching material for cellphones**

Figure 2   Mobile version of "THE LIFE OF BRYOPHYTES"

On the page "From photographs," there are six scientific names of Marchantiales with link buttons.   Then, users can refer to the page for each species that is composed of a scientific

name, a color photograph showing the surface of the thallus and an explanation of its characteristics.

On the other hand, on the page "From reference," there are a reference of key characteristics and two link buttons. Depending on which link button they choose, they can refer to the page of the identified species (Fig. 2). For the use of ordinal computers, the "Return" button is helpful for the users to return to the previous page or front page of the web site. However, since the monitor on a cellphone is very small, cellphone users need to scroll to see different parts of a page.   It is difficult to know where they are in the web site.   So, we did not set the "Return" button on the cellphone page.

Advantages of our web teaching material

Following are four advantages of our teaching material for cellphones.

1. *Possibility of collecting liverworts throughout the year*

Morphological identification of Marchantiales is usually based on characteristics of the female receptacle, the male receptacle and ventral scales.   But, among species, female and male receptacles are formed at particular times.   Ventral scales formed on the lower surface of the thallus are very small.   Therefore we need to observe them under a microscope.   Hence, it is difficult to identify Marchantiales for teachers and students.

On the other hand, the six species can be identified according to the upper surface characteristics of each thallus which is shown in our teaching material.   In all species thalli grow throughout the year, so users can identify them at anytime.

2. *Possibility of using the teaching material anywhere, even in the field*

Our teaching material utilizes the telecommunicational function of cellphones to connect to the Internet within the service area.

From the results of our own observations of liverworts, we have set the explanations of species and reference to key characteristics at the level of naked-eye observation.   Then, if users carry their cellphones, they can identify Marchantiales in the field without any extra information such as a monograph or an illustrated book.

3. *Relation to classroom activities*

We had developed another web teaching material for ordinal computers entitled "THE LIFE OF BRYOPHYTES" on a web site.   We tried to use it in biology class activities (Sato *et al.*, in preparation).   If teachers and students could use the present teaching material for cellphones, collecting Marchantiales for biology class activities might become much easier. After they come back from the field activity using cellphone, they can refer to the web teaching material for ordinal computers in classroom activity.   Then, they may have much more detailed information by using the column "Observation of *M. polymorpha*" in the computer as the observation manual.

4. *High accessibility for teachers and students*

According to the research data obtained in one high school in Hiroshima, Japan in the year 2001, 58% of male students and 74% of female students had their own cellphone or PHS (Personal Handy-Phone System) equipment (Information unit of PTA, Attached Junior-senior High School of Hiroshima University 2001)**.**   In one class of this school, over half of the students (20 students out of 38) had their own cellphone which could connect to the

Internet by contract with "J-PHONE" or "KDDI CORPORATION."

Assessment of the present teaching material for cellphones in comparison with the web teaching materials for ordinal computers

We compared this teaching material for cellphones with web teaching materials which are used on ordinal computers. As a result, we found some advantages and disadvantages to the teaching material for cellphones.

One of the major advantages is its accessibility. The Internet was limited to use in classrooms and computer rooms at schools until recently, but nowadays we can access the Internet by a cellphone from anywhere in Japan. If users use this basic telecommunicational function of cellphones effectively, they can release and receive information from anywhere. We consider that the use of cellphones will increase the opportunities of long distance telecommunications and information exchange will become more effective.

On the other hand, one of the major disadvantages is the memory limitation of cellphones. The cellphone memory available for the Internet is not enough to download a large memory file. The upper limit of memory is 10 KB for "NTT DoCoMo, Inc" and 6 KB for "J-PHONE," but it is uncertain for "KDDI CORPORATION" (Table 1). If you make a page requiring memory over the limit of the cellphone on your web site, the page cannot be displayed correctly on the monitor of a cellphone. For example, when we access "THE LIFE OF BRYOPHYTES" developed for ordinal computers using a cellphone, we can read only the letters; none of the image files can be seen in the cellphone monitor because the

memory size of each file is heavy. In addition, as a cellphone has a very narrow monitor and has only the vertical scrolling function, we need to compose a file with simple pages. When you develop teaching material for cellphones, you should choose the contents which can match the characteristics of cellphones. When you arrange some image files in the material, you should compress the memory size of each image file.

Another disadvantage is that, the file systems have not yet been standardized among the models of cellphones provided by the three companies (Table1). Both the markup language and the display system of image files are different among these companies. If you develop web teaching materials useful for all cellphones, you need to make different types of files which can match different systems, although the content is the same. It takes a lot of time to edit them. These systems should be integrated into a world standard and be compatible with each other.

We calculated the communication expenses; we found that our web teaching material can be used with less than ¥200 in total (Table1). If used in a group, the cost could be cut down.

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Addresses of the web sites in this paper

"THE LIFE OF BRYOPHYTES"
for computer:
http://scied123.ed.hiroshima-u.ac.jp/koke/index.html
for i-mode[®]:
http://scied123.ed.hiroshima-u.ac.jp/koke/i/index.html
for J-sky:
http://scied123.ed.hiroshima-u.ac.jp/koke/j/index.html
for ez-web:
http://scied123.ed.hiroshima-u.ac.jp/koke/e/index.hdml
"THE LIFE OF BRYOPHYTES" English version for computer
http://scied123.ed.hiroshima-u.ac.jp/koke/indexe.html