

# Nurturing Learners' Communities by Creating and Sharing Maps

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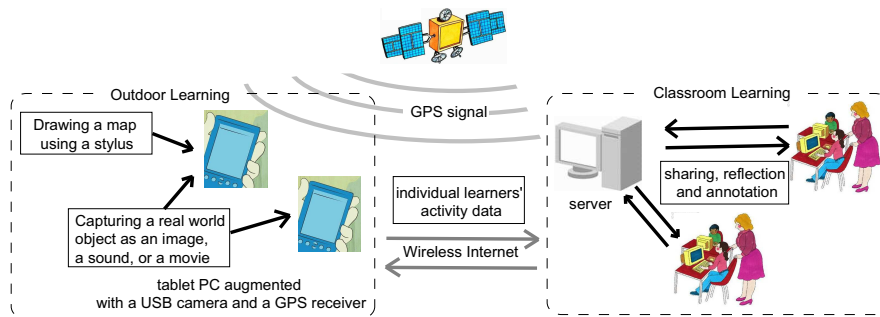
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**Abstract.** The SketchMap system that integrates indoor and outdoor activities for supporting children's collaborative learning is presented. Individual children create a map around their school in an outdoor environment using a SketchMap client. The map is uploaded to the SketchMap server for sharing among the other children who have created maps of different areas. Children can add new information to the maps or edit them in their classroom or in their home. The goal of the SketchMap project is to investigate if integrating outdoor and classroom activities and sharing children's experiences through the maps can actually promote their collaborative learning and nurturing learners' communities including children's teachers and parents. The SketchMap system has been used in the classes of "Safety Map" and "Nature Exploration" in a Japanese elementary school. The evaluation of the SketchMap system is in progress, and a couple of issues found through the educational practices are described.

## 1 Introduction

We have been developing systems to support collaborative learning [3][8][17][18] in elementary school education. The underlying philosophy of our research projects is that learners should be regarded as active creators, rather than passive recipients, of information and knowledge [5]. In order to make children active learners, our systems have been used to enhance their learning experiences [16]. The proposed system in this paper also shares the same philosophy and purpose with the previous systems. In this paper, a system called SketchMap [4][12][15] for supporting children's collaborative learning by integrating their indoor and outdoor activities is described. SketchMap is used (1) to allow children to easily record what they have found during their fieldwork, (2) to enhance their further learning using their maps, and (3) to support their knowledge sharing and construction processes by sharing individual children's experiences through the maps. In SketchMap, children are asked to create a map around their school. A tablet PC is used for their task, in order to retain the natural feeling of a sketch using pen and paper, and to overcome the difficulties of pen-paper based

sketches, for example, it is not easy to change a scale of a map or bothersome to modify it. Children draw a street with a stylus pen, or place an icon that represents a landmark by selecting it from the icon list. A tablet PC of SketchMap is augmented with a GPS receiver and a USB camera. Children can capture an image, a sound, and a video through the attached camera, and easily arrange it anywhere on the tablet PC display. During the map creation tasks, all the manipulations by children on the tablet PC with time and location data captured through the GPS receiver are logged. As the tablet PC is always connected through its wireless internet card to a server computer, a map being created by children can be automatically uploaded to the server. When children returned to their school or their home, they can access to the SketchMap server where the maps uploaded are presented. The children can edit their own map or add new information to the other children's map. The SketchMap project is in progress. Evaluations using the SketchMap system have been conducted in collaboration with a Japanese elementary school. Children used SketchMap for creating safety maps and nature exploration maps around their school. The paper discusses some results gained through the practices and shows future works.

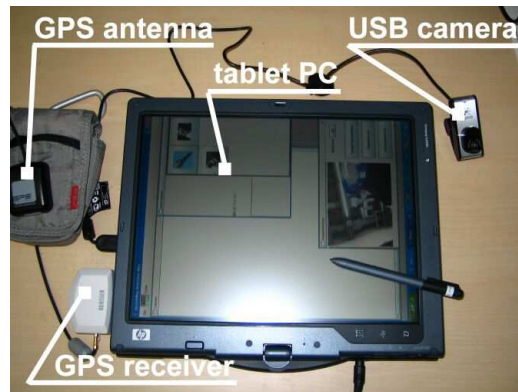


**Fig. 1.** An overview of the SketchMap system

## 2 Related Works

There have been many systems using mobile devices such as PDAs or cellular phones in a classroom or in an outdoor environment for pedagogical purposes, for instance, a participatory simulation for understanding the ecology of animals [1], an augmented reality simulation for environmental engineering education [14], a butterfly watching system [2] or a virtual botanical garden [19] using a mobile phone built-in camera, a system for supporting language learning based

on learners' situations [9], a PDA application for inquiry based learning through biology data collection [11], an environmental learning support system through collaboration between learners in distributed locations [10], a system that supports learning in a woodland using pervasive technologies [13], a system that enhances collaborative learning in a museum [21], and so on. Although there are similarities between these predecessors and SketchMap, it is different from them in the following points:



**Fig. 2.** A map creation support system of SketchMap

- The basic idea of SketchMap is that children's experiences are augmented by articulating and recognizing the real world, and by expressing it through sketching.
- SketchMap enhances conventional children's fieldwork by using a tablet PC that retains the features of pen-based interaction.
- In order to share individual children's outdoor experiences, utilize them for their further learning, and nurture learners' communities including schoolteachers and parents, SketchMap allows all of them to edit and annotate on maps through the server.

### 3 Configuration of SketchMap

#### 3.1 Overview

As shown in Fig 1, SketchMap is composed of multiple client computers and a server computer. The client computer is used to support children in creating a map in an outdoor environment, and the server computer is mainly used for supporting children's individual/collaborative learning using the maps in their classroom.

### 3.2 SketchMap Client

A SketchMap client is composed of a tablet PC (HP Compaq tc4400), a USB camera (Logitech Qcam for Notebooks Pro), and a GPS receiver (IO DATA CFGPS2) as shown in Fig 2. Children carry the client and create a map with a stylus pen. A user interface of the client is shown in Fig 3. When children draw a street or place an icon such as a hospital or a municipal office on the canvas (Fig 3(A)), they tap the menu in the upper part of the user interface (Fig 3 (B)) and select the corresponding item. A USB camera attached to the tablet PC is manipulated through the buttons on the popup window (Fig 3 (C)). Children can capture an image, a sound or a video with the camera. When the capture is completed, an icon that represents the captured image (thumbnail icon), sound (microphone icon), or video (thumbnail icon) is automatically added to the palette as shown in Fig 3 (D). Then, children can drag the icon from the palette to anywhere they like on the map. They can easily enlarge/shrink an image or a video, or replay a sound by tapping the corresponding icon.

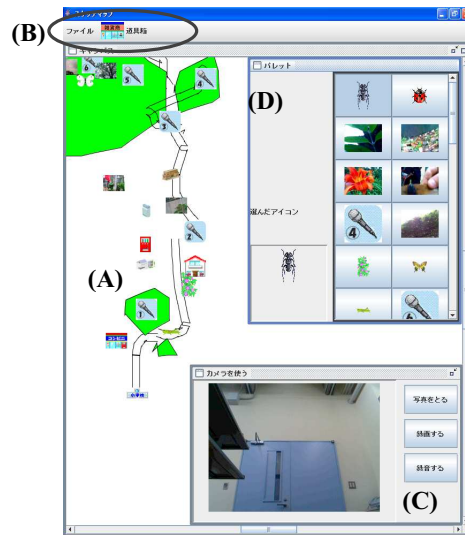
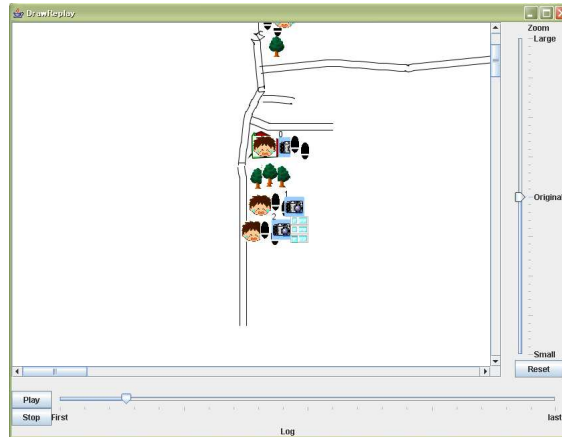


Fig. 3. A user interface of a SketchMap client

While individual children are creating a map in an outdoor environment, the SketchMap client always receives GPS signals. Children's usage data and location data given through the GPS are automatically logged in the following format: (time, latitude, longitude, user manipulation, item information). The user manipulation represents manipulations conducted by children using SketchMap, such as capturing an image, moving an icon on the canvas, and so on. The item information is written in the SVG/ XML format that describes a type of an item

(a street, a park, an icons, etc) and its graphical information (shape, points of x-y coordinate values, etc.). These log data are uploaded to the server through the wireless internet and managed by the server for sharing and annotating on them, as described in the next session.



**Fig. 4.** A user interface of replaying map creation processes

The design and development of the SketchMap client were conducted through discussions between schoolteachers and authors. Actually when the authors started the design of a SketchMap client, they investigated numerous commercial software for supporting children in creating a map. Through the investigation, the authors found that most of the software prepares a blank map and ask children to complete the map by putting a landmark icon (e.g. a police office or a fire department). However, in order to enhance children's learning experiences, allowing them to just place an icon onto a blank map is not sufficient, and enabling them to articulate the real world from the children's viewpoints is inevitable. Due to the same reason, automatically displaying streets on a children's PC by tracking its location using GPS signals seems inappropriate. Therefore, the schoolteachers and authors decided to design a SketchMap client that allows children to create a map on a white canvas from scratch by providing a moderate assistance.

### 3.3 SketchMap Server

In order to utilize the maps created by children in an outdoor environment for their collaborative learning, the SketchMap system on the server computer provides children with the following functions, which are available through a web browser.

- (a) A function for supporting reflection

SketchMap allows children to replay their map creation processes using the log data described in the previous section. Fig 4 shows the user interface of the replay module. The slider at the bottom of the figure represents the elapsed time while creating a map. Children can change the position of the slider and visualize the map that has been created at the corresponding elapsed time. The replay module is used to remind children of what they discovered during their fieldwork through their reflection: By viewing the map using the module, children can easily recall when and where they drew a map, took a picture, and so on.

(b) A function for making an annotation on maps

SketchMap allows children to add new information related to what they have discovered after their outdoor activities, or their experiences, to their maps. As all the children can view the map or information annotated by the other children, they can collaboratively construct and share information and knowledge on neighboring areas around their school. A web interface for editing and annotating on a map is shown in Fig 5 (a). When children click a hand-drawn map at the left part, a comment box with images, videos, or sounds recorded in an outdoor environment appeared at the right part. The web server is accessible not only at their classroom, but also their home or any other place where a public internet service is available. This allows children to add photos, sounds or videos that have been captured while they commute, and also, makes their parents involved with collaborative knowledge construction and sharing processes through their participation in the map editing and annotating. Fig 4 (b) is an example of a google map interface that also shows results of children's map creation tasks. A red icon represents that children recorded an image, a sound, or a video in an outdoor environment, and is placed on the photomap based on the GPS data. As a map created by individual children is often inaccurate in its scale or orientation, it may be difficult for the other children, teachers, or parents to understand the map. In this case, they can use the google map interface for their annotation tasks.

As for the implementation issues, the current version of SketchMap has been developed using the Java language (J2SE5.0), an XML database server (eXist), and a web server (apache), and executable on Microsoft Windows XP.

## 4 Educational Practices

### 4.1 Overview

We have started educational practices using the SketchMap system in collaboration with a local elementary school (Chiba prefecture, Japan) since February 2006. We first evaluated the SketchMap client that supports children in drawing a map in an outdoor environment. At the time of writing this paper, a four-week evaluation (one day for drawing a map using a SketchMap client and the rest of the days for collaboratively editing and annotating on the map through



Fig. 5. A web interface for editing and annotating on maps

the SketchMap server) is in progress. Therefore, in this paper, evaluations for the SketchMap client are discussed. The purposes of the evaluations are to investigate the usability of the client for children in an outdoor situation and how outdoor activities are expected to motivate children for their collaborative knowledge construction in their classroom or homes.

The SketchMap system has been used in the following two classes:

(1) Safety Map Class

Recently, the number of brutal crimes against children has increased and preserving their safety while commuting is one of the most critical issues in Japanese elementary schools [6]. One of the countermeasures for protecting children from such crimes is to create a safety map from children's viewpoints: Individual children create a map by using pen and paper, taking a photo with a digital camera, and complete the map after they returned to their classroom [7]. By using SketchMap that supports pen-based interaction with a tablet PC enhanced by a camera and a GPS receiver, it seems possible to clarify differences from the conventional paper-and-pen based method.

A map created by children is a useful resource for ensuring their safety and raising their awareness level of danger, and can attract the concern of not only children but also their teachers and parents. Therefore, it is expected that children, their teachers, and parents will access to the map, annotate on it, or discussing about it without forcing them to do so.

In the educational practice taken place in February 2007 (Fig 6), 25 sixth grader children (age 11-12) were divided into five groups of five. Each group was given one SketchMap client, and was asked to create a map of a specified area around their school, not only by drawing a street, taking a photo, but also by placing an icon that represents "empty street" or "blind spot" (these icons mean a sign of danger) and by recording interviews to inhabitants. The task lasted about 90 minutes. After children returned to their classroom, they reflected their activities by using the replay software. Finally each group

presented to the other groups what they had found through the outdoor activities by using their map.



**Fig. 6.** Children in the safety map class

#### (2) Nature Exploration Class

The purpose of a nature exploration class is to attract children's interest in living things, such as insects, plants, by creating a map around their school. The educational practice was conducted in July 2006 (Fig 7). 75 fourth grader children (age: 9-10) were divided into 15 groups of five. Each group was asked to create a map of a specified area around their school using the SketchMap system. The task lasted about 60 minutes. As in the case of the safety map class, children reflected their activities and finally presented what they have found by using their map, when they returned to their classroom.

In the two classes, a public wireless internet service that connects each SketchMap client for uploading a map was not used. Children's activities in outdoor and classroom environments were videotaped. Post-experimental interviews and questionnaires to children and their teachers were conducted.

## 4.2 Experimental Results and Discussions

Fig 8 shows the results of the post-experimental interviews in the nature exploration class. Children's responses were overall positive: they could enjoy creating a map by using SketchMap and its usability was satisfactory to them.

Video analyses during children's outdoor activities clarified several issues related to advantages and disadvantages of the SketchMap client. Some of them are summarized as follows:



**Fig. 7.** Children in the nature exploration class

- Five children in each group voluntarily discussed and decided their individual roles (e.g. capturing with a camera, drawing a map, discovering an object to be captured, managing individual children’s tasks, etc.) and changed them halfway through their task, although a group of children was not asked beforehand. This division of the roles allows children to smoothly conduct their map creation.
- Children could easily use the SketchMap system. During the fieldwork, in order to record what they had interest in, they frequently used a camera to take a photo (e.g. flower), capture a sound (e.g., piping of a bird), or a video (e.g., motion of an insect).  
The remarkable difference between SketchMap and the conventional map creation method is that children cannot only draw a street, but also immediately put a photo, a sound, or a video on a map. For example, if they do not like a photo on their map, they can immediately take a new photo again and easily replace by it. However, it is impossible for children to place photos, videos, or sounds on the map and then confirm if it is acceptable during the fieldwork, when they use a paper-based method. The comments from the teachers revealed that children seemed more motivated and engaged in the tasks by using SketchMap than by using the conventional method.
- Using a tablet PC in an outdoor environment was sometimes difficult for children due to the weather. In the safety map class, the weather was cloudy, and children could easily recognize what were shown on their tablet PC display. However, in the nature exploration class, the weather was sunny, and children could not easily recognize the displayed information and draw a map. To solve the problem, it may be better to use a tablet PC with a low reflection display.
- During the reflection time and presentation time in the classroom, each child could actively discuss about what he/she found through the fieldwork and exchange their experiences and knowledge. Using the replay module reminded

the children of what they had done using SketchMap (e.g., drawing a street, taking a photo, or put an icon on their tablet PC), which became clues for their discussions. This indicated that to enhance and share outdoor experiences was useful for children’s collaborative learning. However, as the SketchMap system at that time did not use functions to allow children or their parents to share information and experiences through their maps, more investigations and evaluations are required to confirm effects for supporting collaborative learning and nurturing learners’ communities.

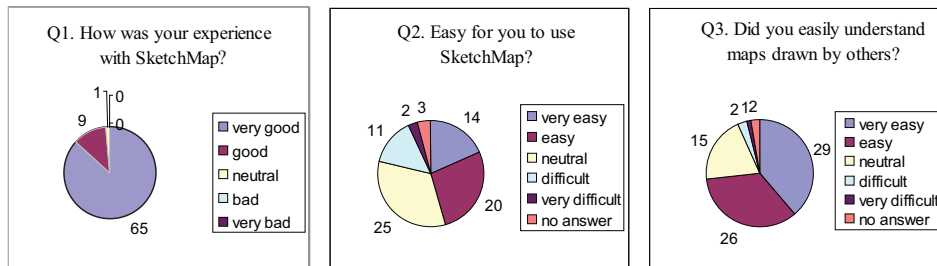


Fig. 8. Results of post-experimental interviews

## 5 Conclusions and Future Works

In this paper, a system called SketchMap was described. The evaluations through educational practices using the current version SketchMap system were discussed. Evaluations using the full-fledged SketchMap system are now in progress. Therefore, one of our future works is to conduct intensive analyses on effects of the system from the following points of view:

- Usability of the sever/client of SketchMap
- Effects of sharing and annotating on maps for enhancing collaborative knowledge construction
- Effects of nurturing learners’ communities by integrating outdoor and indoor activities and by making children, their teachers, and parents involved through maps.

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