A SYSTEM WITH SIMULTANEOUS DATA ACCESS METHOD FOR IN-THE-FIELD LEARNING RELATED TO DEVELOPMENTAL STUDIES

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ABSTRACT
In this paper, the features and performances of a revised version of a learning-support system used in developmental-study-related fieldwork are described. We previously developed a multimedia data-management and sharing system to support users conducting fieldwork in developing countries. However, the functions and interfaces of the previous tool were quite statistic in terms of field data access, making it difficult for users to learn properly in the field. As a revised version of the proposed system, we have implemented a method for dynamically inter-connecting all field data with temporal and spatial information, called the simultaneous data access method.

To examine the performance of this revised system, two student experiments were conducted. The first is to determine the behaviours of the students when using the proposed system, for which the author observed some of the behaviours that are effective for learning while in the field. The second is to examine whether there is a significance difference between the students who used the revised system and those who did not when reporting their field data. In addition, the significant differences in the quantitative analysis of these reports were confirmed.

KEY WORDS
Fieldwork, ICT for Development, learning in the field, Simultaneous Data Access Method, Temporal and spatial information

1. Introduction
Fieldwork has become a key method for investigating and solving problems related to international development (such as public health, environmental degradation, primary education, and regional revitalization). Not only researchers but also governmental agents, designers, entrepreneurs, student volunteers, and local residents are required to conduct their own fieldwork to solve such problems through collaboration. As previous work such as participatory development [1], social entrepreneurship [2], and inclusive design [3] has shown, fieldwork is defined not as a specific research method in the area of anthropology, but as a set of general skills for “learning in the field.” In detail, people engaged in international development are required to improve their skills of observation, communication, and collaboration to find and solve problems related to international development. It is therefore very important to design tools to support them in improving their skills for learning in the field. In particular, designing such tools based on information and communication technologies is expected to be a good way to effectively improve their skills.

There are many digital devices that are useful for learning in the field, such as voice recorders, video cameras, personal computers, and smartphones. Moreover, many kinds of software and applications have been released, some of which are very useful when applied to in-the-field learning. The number of people who can access the Internet has increased day by day, not only in developed countries but also in developing ones, and the best use of ICT is sometimes a strong power that leads to changes in society or solves certain policy agendas that were not able to be previously solved [4].

Of course, there are a couple of ICT-based approaches that are useful for learning in the field, which mainly come from practices developed in the areas of anthropology and sociology. However, such approaches are difficult to apply for people who are engaged in international development for the following reasons. First, they are too professionalized. For example, Computer-Aided Qualitative Data Analysis Software (CAQDAS) is commonly used among sociologists conducting qualitative research [5]. However, CAQDAS was designed to support researchers in producing specific types of knowledge and theories based on a grounded theory approach, which is a very standard way of theory building in sociology [6]. Second, learning in the field costs quite a lot when relying on existing approaches. For example, collecting multimedia data in the field and creating archives of the collected data are commonly put into practice. As in “Our World 2.0” by The United Nations University (http://ourworld.unu.edu/en/), or the human development video archives by The United Nations Development Program, such multimedia archives are very useful for learning and sharing the realities discovered in the field. However, a sufficient number of staff members and collective support were indispensable in creating these archives. Moreover, copyrights and portrait rights are significant problems when using
multimedia data for presentations or reports. Finally, and foremost, these existing approaches do not consider the status of ICT in each area. In particular, a couple of practices using mobile devices and cloud services in sociological or anthropological researches have recently been reported [7][8]. However, because of slow Internet access and poor conditions for data-communication on mobile phone networks, it is difficult to use such mobile devices and cloud services in developing countries, rural areas, or remote sites.

As mentioned above, it is difficult for people working in international development to apply existing approaches into their in-the-field learning. It is therefore quite important to design tools based on suitable methods from one’s own particular perspective. With this understanding, and based on research experience in international development, we are designing an original system to encourage people who are learning in the field. We have already developed a prototype of the system, which includes two functions. This first is the ability to manage various field data (such as memos, photos, videos, voice messages, and GPS locations) using metadata such as categories, keywords, and temporal and spatial information. The second is to share these field data with collaborators in the field through the Internet [9].

However, the first function is only a simple tool to manage and share multimedia data. A more effective method for learning in the field should be intuitionnally implemented. Hence, we have focused more on implementing a method for understanding the field more intuitively based on temporal and spatial information, which is called a “simultaneous data access method.” In addition, we have examined the performance of the system by testing it on students majoring in international studies. In this paper, the revised version of the system and the results of these student experiments are described.

2. Related Approaches

To revise the tool, we adopted some previous studies. First, as the basic framework of the method used in designing the proposed tool, the theory of constructivism as used in education is described. Next, because they are important elements for learning in the field, some approaches used to treat temporal and spatial information are reviewed. Finally, functions and interfaces based on temporal and spatial metadata are discussed by reviewing other similar tools.

2.1 Constructivism as the Design Framework

Constructivism is a perspective in knowledge and learning, in other words, a theory on how we learn knowledge. From this perspective, knowledge is constructed based on contexts in society, culture, or even though one’s own experience. In education and learning, it is regarded that learning occurs when knowledge constructed by the learner’s prior experience. Therefore, the active process of learning in specific contexts should be regarded as important [10]. Constructivism is quite important as a design framework of the tools used for supporting fieldwork because the active process of learners based on their own experience is regarded as the exact essence of learning in the field.

There are two key points for re-designing the proposed system based on the constructivism approach. One is to make the learners behave more actively in learning on their own while in the field. Functions and interfaces that encourage learners to learn what they observe at a specific time and place from their own field data intuitionally should be implemented. Another is to encourage interactions between learners and their collaborators in the field. In constructivism, everyone engaged in the process of learning is potentially a teacher as well as a learner. Therefore, feedback and communication with collaborators in the field are very important for encouraging learning. Functions and interfaces allowing the learners and their collaborators to share with each other what they see at a particular moment and location, and not just sharing multimedia data, should be implemented. From these points, temporal and spatial information have quite an important role in encouraging learning (what learners see at a particular time and place) in the field.

2.2 Temporal and Spatial Information

All field data include temporal and spatial information. Such information is quite important because we are always concerned about the present moment and place as we make observations in the field. GPS is a particularly useful way to determine one’s location, along with the date and time. There are many kinds of services for sharing descriptions, photos, and so on using GPS, for example, Foursquare. Some note-taking and archiving services such as Evernote have also recently begun using GPS to determine where notes are taken. The GPS-based Groupware was developed and tested for supporting activities in local communities in Japan [11]. These services have become more useful when implemented on a smartphone [12].

However, these GPS-based services simply point out the location of the corresponding data on a map. They do not take the user’s context into consideration (for example, the situations under which the data were recorded, or whether the data were recorded at the same place as before). As shown in previous studies on a data-integration mechanism based on temporal and spatial information [13], functions that inter-relate all data dynamically using temporal and spatial information should be implemented.

2.3 Interfaces Displaying Field Data

Most existing approaches in displaying field data are quite statistic. Herein, the term static means that all of the data are separately displayed in every type of media. For example, CAQDAS such as Atlas.ti and The Ethnograph [5] is very useful for classifying and coding text-data. Some software has recently supported other kinds of data such as photos, voice memos, video, and location data.
[14]. However, most types of CAQDAS do not offer an interface for displaying the field data regardless of the type of media. In addition, when displaying a specific text, other related field data cannot be displayed at the same time.

On the other hand, as interfaces displaying field data, there are interesting works based on mobile devices applying some advanced technologies like augmented reality [15]. Of course, we will develop a mobile version of our proposed system. However, because of the reason mentioned above, it is still difficult to use those advanced technologies in developing countries, rural areas, or remote sites. An interface that displays any type of data simultaneously should be developed in the revised version of the proposed tool.

3. Revised Version of the Proposed Tool

In this section, we first review the basic features of the previous version of the proposed tool. We then show the function and interface of the revised version.

3.1 Previous Version of Proposed Tool

Further details on the basic features of the previous version of the proposed system are provided in [8]. Herein, we simply touch on these details and describe the aspects that should be revised.

3.1.1 Preconditions

The previous version of the proposed system was designed under the following two conditions. The first is the ability to operate on a low-performance laptop computer because not all people engaged in international development (in both developing and developed countries) have access to a state-of-the-art personal computer. In particular, those working in developing countries often use a three or four year-old model, or one bought second-hand at a cheaper price. The second condition is the ability to work under poor Internet access, since access to the Internet is not always available in the field. In particular, those conducting fieldwork in rural areas or remote sites cannot expect constant Internet access. The system should therefore implement certain functions allowing offline operation. These preconditions were not changed in the revised version.

3.1.2 Multimedia data management component

The multimedia data management component in the previous version was used to classify various data recorded in the field using conceptual, temporal, and spatial information. This component includes a local database file, the interface (consisting of a map, calendar and tree-classification explorer), and the functions for accessing each data file.

3.1.3 Multimedia data sharing component

The multimedia data-sharing component is used to share the data recorded in the field with collaborators through the Internet. This component uses existing cloud services such as Dropbox and SkyDrive as storage for data sharing. It includes the ability to upload/download each data file, and provides temporal and spatial information.

3.2 Point of Revision

The key revision focused on in the latest version of the proposed system is the capability to inter-relate the field data, temporal information, and spatial information. In the data management component, as shown in Figure 3.1, a method for selecting and displaying any kind of field data that correspond temporally and spatially should be implemented. When a user selects a specific day, the component should pick up the field data collected on that day. At the same time, the component should also trace and draw the route on the map where the user moved that day. When the user selects specific field data, the component should point out the date on the calendar when the data were collected. At the same time, the component should point out the collection location on a map.

In the data-sharing component, as shown in Figure 3.2, a method for selecting and displaying any collaborator’s field data that correspond temporally and spatially should be developed. When the user selects a
specific day and time, the component should pick out the corresponding field data that the collaborators collected by drawing a route of where they went on that particular day. When the user selects specific field data, the component should point out the date on the calendar when the data were collected. At the same time, the component should point out the collection location on a map.

To achieve these goals, we added the following method, which consists of database tables and functions, as well as revised interfaces, which we call the simultaneous data access method for the learning in the field.

3.3 Simultaneous Data Access Method

This newly added method consists of a database table holding GPS log data, functions for calculating the temporal and spatial simultaneity among the field data, and an interface for displaying the field data regardless of the type of media used.

3.3.1 Databases

In the previous version, temporal and spatial information are added into an index table that holds the information regarding all field data, such as the filename and file path. In this revised version, we added a simple table for holding temporal and spatial data captured from a GPS log file (which we now call a GPS log table). This table holds all of the GPS logs that the user recorded when in the field using a device or smartphone application that is able to record such logs.

In the data management component, the table simply holds the date, and the latitude and longitude (Table 3.1). Moreover, in the data-sharing component, the table holds the date, the latitude and longitude, and the collaborator’s ID to identify who recorded which GPS log (Table 3.2). The important point here is to set the data type of the date column as FLOAT or a type that is able to hold the information on the day and time in milliseconds in order to make the calculations run more smoothly. It is also important to keep a track name that shows when and where the users travelled.

Table 3.1 Schema of GPS Log Table
In the Data-Management Component

<table>
<thead>
<tr>
<th>COLUMN NAME</th>
<th>DATA TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>FLOAT</td>
</tr>
<tr>
<td>Latitude</td>
<td>FLOAT</td>
</tr>
<tr>
<td>Longitude</td>
<td>FLOAT</td>
</tr>
<tr>
<td>Track Name</td>
<td>TEXT</td>
</tr>
</tbody>
</table>

Table 3.2 Schema of GPS Log Table
In the Data-Sharing Component

<table>
<thead>
<tr>
<th>COLUMN NAME</th>
<th>DATA TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborator ID</td>
<td>INT4</td>
</tr>
<tr>
<td>Date</td>
<td>FLOAT</td>
</tr>
<tr>
<td>Latitude</td>
<td>FLOAT</td>
</tr>
<tr>
<td>Longitude</td>
<td>FLOAT</td>
</tr>
<tr>
<td>Track Name</td>
<td>TEXT</td>
</tr>
</tbody>
</table>

3.2.2 Functions

In the previous version, there are two simple functions related to temporal and spatial information. One is for importing the date and location information from the GPS log or the EX-IF data on any photos taken. The other is to point out the location on a map where the specific field data were recorded.

In the revised version, we added two additional functions to show the field data simultaneously. The first is for showing field data with the location automatically identified by searching for the day and time recorded in the field data index and GPS log. Table. The other is for showing the field data with the day and time automatically identified by seeking the movement routes recorded in the GPS log table.

I) Function for calculating temporal simultaneity

For this function, the user first inputs the range of day and time for searching the field data. The field data index is then searched to find the data recorded within the
requested time range. The function then checks the location of where the field data were recorded from the GPS log table and marks it on a map. Figure 3.3 shows the features of this function.

2) Function for calculating spatial simultaneity

For this function, the user first selects the track name stored in the GPS log table. Next, the field data index is searched and the field data recorded along the requested route are selected. The function then checks the specific day and time of the selected field data and shows it on the location presenting the temporal information. Figure 3.4 shows the basic features of this function.

3.3.3 Interfaces

In the previous version, three interfaces (map, calendar and tree-classification explorer) are used for accessing the field data. However, these interfaces each work separately. For example, in the previous version, if the user clicks on a day on the calendar, the system simply chooses the field data recorded on that day. It does not show any information on the map.

In the revised version, by implementing the additional functions described above, these three interfaces work in unison, as indicated in Fig. 3.5. When the user clicks on a day on the calendar, the system selects the field data collected on that day, and at the same time shows the route locations on the map where the user recorded the data. When the user selects a route, the system brings up the field data collected along that route. At the same time, it points out the day and time for each collection on the calendar. By implementing these added functions in the data-sharing component, the user is able to check the field data from other collaborators by referencing when, where, and along which route the data were collected, as indicated in Fig. 3.6.

4. Experiments

To grasp the effects this revised tool brings to the user’s skills for learning in the field, we conducted two experiments on students majoring in international development, regional revitalization, international studies, or other subject. One experiment was conducted to determine the student behaviors that are brought about when using the revised system (experiment 1). The second was conducted to verify the students’ performance when reporting their field data (experiment 2). A summary and the results of each experiment are described below.

4.1 Experiment 1

The purpose of this experiment was to discover some effective behaviors brought about when using the revised system. This experiment was conducted in a qualitative way based on observation and interviews regarding the usability of the system.

4.1.1 Experimental procedure

First, we selected the students and conducted a tutorial on how to use the tool. In addition, we ran tutorials on basic fieldwork skills. Next, the students were asked to conduct some minor fieldwork using the system for a couple of days. The students then reported their findings. We then interviewed the students for an hour or two hour regarding the usability of the system and their own behaviors while using the system when they conducted their minor fieldwork. Table 4.1 shows a list of questions asked during the interviews.

<table>
<thead>
<tr>
<th>Table 4.1 List of Questions Asked in the Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Behaviors in the fieldwork</td>
</tr>
<tr>
<td>1-1. How many photos, movies or memos did you take?</td>
</tr>
<tr>
<td>1-2. Is there anything you did consciously in your fieldwork?</td>
</tr>
<tr>
<td>1-3. Is there anything you observed carefully in the field?</td>
</tr>
<tr>
<td>2. About the use of the tool.</td>
</tr>
<tr>
<td>2-1. How long did you take to get used to this tool?</td>
</tr>
<tr>
<td>2-2. What functions did you mainly use to access your field data?</td>
</tr>
<tr>
<td>2-3. Is there any behavior or action attributable to the merits or advantages of the tool?</td>
</tr>
<tr>
<td>2-4. Is there any point that you changed by using this tool?</td>
</tr>
</tbody>
</table>
4.1.2 Student Characteristics

This experiment was carried out in December 2011, and additionally, in June 2013. For the experiment in December 2011, we asked five students to do their own fieldwork using the system in Tokyo or Kyoto. In the experiment in June 2013, we asked one student to do the same in Yokohama. At all of the locations where the students conducted their own fieldwork, it was easy to ascertain some topics related to developmental studies (such as internationality, urbanization, and regional revitalization).

Table 4.2 shows the basic features of the students who joined this experiment. None of them had any fieldwork experience, but two of them (A and B) are involved as volunteers at international non-governmental organizations. Table 4.3 shows the conditions of the fieldwork each student conducted. In their fieldwork, five of the students (B, C, D, E, and F) used devices enabling them to gather their GPS location, such as a GPS logger or digital camera with GPS data-gathering capability.

Table 4.2 Basic Characteristics of the Students

<table>
<thead>
<tr>
<th>ID</th>
<th>Grade</th>
<th>Period of experiments</th>
<th>Experience of Fieldwork</th>
<th>Experience of involving Works in the field</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3rd</td>
<td>December 2011</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>B</td>
<td>1st</td>
<td>December 2011</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>C</td>
<td>1st</td>
<td>December 2011</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>D</td>
<td>1st</td>
<td>December 2011</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>E</td>
<td>3rd</td>
<td>December 2011</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>F</td>
<td>2nd</td>
<td>June 2013</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

4.1.3 Results

As a result of this experiment, we observed two points regarding the effects of the revised system. First, the system allows users to walk easily around the field and gather their data. As shown in Figure 4.1, we checked the route of four students who used a GPS logger, and found that they walked easily around the field, and were not forced to stay in one location. Student A stated the following opinion regarding this aspect of the system: “Using the tool, and by gathering the location information through a GPS logger, it was easy to concentrate on observations even in unfamiliar locations. By concentrating on field observations, I was able to determine many things naturally, without intending to do so” (interviewed on December 7, 2011). That the students walked around quite a bit is a sign that they were eager to discover whatever they were interested in.

Table 4.3 Overview of the Students’ Fieldwork

<table>
<thead>
<tr>
<th>ID</th>
<th>Number of Photos taken.</th>
<th>GPS devices</th>
<th>Place of Fieldwork</th>
<th>Total times of Fieldwork</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>22</td>
<td>GPS Logger</td>
<td>Tokyo</td>
<td>1 hour</td>
</tr>
<tr>
<td>B</td>
<td>50</td>
<td>Digital Camera with GPS</td>
<td>Kyoto</td>
<td>4 hours</td>
</tr>
<tr>
<td>C</td>
<td>76</td>
<td>GPS Logger</td>
<td>Tokyo</td>
<td>3 hours</td>
</tr>
<tr>
<td>D</td>
<td>700</td>
<td>GPS Logger</td>
<td>Yokohama</td>
<td>3 hours</td>
</tr>
<tr>
<td>E</td>
<td>66</td>
<td>GPS Logger</td>
<td>Tokyo</td>
<td>2 hour</td>
</tr>
<tr>
<td>F</td>
<td>50</td>
<td>GPS Logger</td>
<td>Yokohama</td>
<td>2 hour</td>
</tr>
</tbody>
</table>

Figure 4.1 Student Routes Recorded in the Field

Second, the users (students) were able to concentrate well on gathering their field data (such as photos). Replying to question 2-3 (Table 4.1), five students (B, C, D, E, and F) mentioned an increase in the number of photos that they were able to take when compared with a time in which they walked around while on a trip or as a tourist. Student A also answered that he was able to take photos easily compared with times while on a study trip or tour (when he did not take any photos at all). Student F mentioned the comfort in using the system: “I was able to walk around comfortably and take many photos because I knew I could check my location later using the system.” (interviewed on July 26, 2013). Using the system, users are able to concentrate on gathering their field data comfortably because they do not need to be concerned about when and where they recorded the data.

These two points described above are indispensable for learning in the field. It is notable that these behaviors were confirmed from all six students regardless of their previous field experience (such volunteering at international non-governmental organizations).

4.2 Experiment 2

The purpose of this experiment was to verify the students’ performance based on reports of their findings in the field. We verified the results through a quantitative analysis of the reports from students who used our tool compared to those who did not. This experiment was conducted in spring of 2012 during a course of basic fieldwork skills for students majoring in international relations or development studies.

4.2.1 Experimental procedure

Table 4.3 shows the experiment schedule. Basically, the experiment was conducted by following the course schedule. First, the 26 students who joined that semester were divided into nine small groups for conducting their own fieldworks in groups. Next, we assigned them a fieldwork plan to conduct. In this point, we do not ask any groups to use our tool. After two to three weeks, we asked
them for an interim report about their findings as a mid-term presentation. After their mid-term presentation, we randomly selected four groups (10 students) to make one large group that use the tool in their own fieldwork. We then asked them to write a final report about their findings in the field as a final assignment.

The most important part of this experiment was how to evaluate the students’ findings. We conducted mutual evaluations of the students based on their mid-term presentation and final assignment.

During their mid-term presentation, the students were asked to evaluate in total the fieldwork activities and findings of the other groups. During the final assignment, the students were again asked to evaluate the findings of the other groups. The evaluations consisted of three items: 1) whether the field data were used appropriately in their report; 2) whether the group reported their findings appropriately; and 3) a total evaluation on the group’s fieldwork activities. For both the mid-term presentation and the final assignment, the students marked the scores of each item on a 4-point scale (4 being the highest, and 1 being the lowest).

### 4.2.2 Characteristics of the Groups

Table 4.4 shows basic characteristics of each group. All students were sophomores majoring in international studies, international relations, or developmental studies. The students firstly were divided into two large group (the group that used our system and the group that did not use the system).

Moreover, the students were divided in 9 small groups that conduct their own fieldworks in groups. As the characteristics of those small groups, we noticed students’ experiences of activities in the field. If at least one student who has such experiences belongs to a small group, we regard the group as the one who has experiences of activities in the field.

### 4.2.3 Results

Table 4.5 shows the average total evaluation score of the fieldwork activities and findings for each group. Table 4.6 shows the average evaluation score of each group. In addition, the table shows the results of a two-sample t-test between the groups that used the tool and the groups that did not.

In the evaluation of their final assignment, there was a significance difference in the “usage of field data” and the “total evaluation” between the groups that used the tool and those that did not (use of field data, \( p = 0.03 \) vs. total evaluation, \( p = 0.02 < 0.05 \)). These results show that, by using the system, users can report their findings based on their field data appropriately.

It is notable that this difference was confirmed regardless of whether the students had prior experience in the field. For example, the students in Group A were accustomed to going into the field and reporting their findings because they belonged to an international NGO, and frequently visited local sites in Vietnam and Myanmar to support primary education. In fact, their mid-term presentation score was 3.26, which was the second highest of all nine groups, and their total evaluation score for in the final assignment was 3.37, which was also the second highest. On the other hand, the students in Group B had no experience in the field, and were not familiar with going into the field and reporting their findings.
Their mid-term presentation score was 2.57, which was the lowest of all nine groups. Nevertheless, their total evaluation score for their final assignment was 3.41, which was the highest score for all nine groups.

Although it cannot be definitively concluded through only this one experiment, it can be stated that the tool has an effect in allowing students to use field data appropriately and in creating reports based on the data accumulated.

5. Conclusion and Future Plans

In this paper, a revised version of a system implementing a simultaneous data access method for supporting in-the-field learning was introduced. In addition, we reported the performance of the revised system through two different experiments. Based on these experiments, we found some behaviors and positive performances that encourage users when learning in the field.

In the future, we will conduct some experiments to determine the performance of this revised system under collaborative situations. In addition, we intend to develop a mobile version of this system for encouraging more in-the-field learning.

References