Design and Practical Evaluation of a Field Study Support System in Primary Education

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初等教育における屋外学習支援システムの設計と実践的評価

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Abstract

Due to prevalence of mobile technologies, children tend to use technologies such as portable game devices and cell phones in the outdoor environment as proficient as adults do. In academia, recent studies on learning support systems have shown possibilities to improve learning experience of children by novel technologies. Based on those possibilities, our study motivated to design and to evaluate a field study support system called SketchMap. SketchMap consists of three components; a tablet PC based system for field studies, a backend system to summarize data captured in the outdoor environment, and web sites for reviewing the field studies. The system was designed based on practical requirements from school teachers in a public elementary school and theoretical learning characteristics of children, and aimed to shorten the class in order to condense quality of field studies and to stretch learning experience by giving pupils opportunities to keep reflecting what they learned in the field study. The SketchMap system was evaluated practically in field study classes at a primary school. Many qualitative and quantitative aspects of the SketchMap system were revealed through these evaluations. Finally, based on the requirements the SketchMap system should fulfill, we discuss how the learning support system in the outdoor environment should be designed and what the system should provide to pupils in practical education.

概要

携帯端末の普及により、子供達が大人と同様に携帯ゲーム機や携帯電話などの機器を屋外で使うようになってきている。一方で、学習支援システムに関する先行研究によれば、それら新規的な技術を学習に適用することで子供たちの学習経験をより良くする試みが多数行われている。そこで本研究では、屋外での学習を支援するスケッチマップというシステムの設計とその評価を行った。スケッチマップは、タブレット PC 上で屋外での作業を支援するシステム、屋外で行われた作業を取りまとめるシステム、そして屋外での学習を見直すことができるウェブサイトの三つのシステムから構成される。システムは公立小学校に勤める教職員からの実用的側面からの要求と子供たちの理論的な学習特性に基づいて設計され、授業時間短縮による濃密な学習経験と子供たちにいつでも学んだことを振り返ることができる場を提供することを目的としている。公立小学校における屋外学習の授業の中でスケッチマップの評価を行い、その過程でシステムが持つ多くの定性的、定量的側面が明らかになった。それらを踏まえ、屋外学習において学習支援システムはどうあり、どんな支援が子供たちにとって必要であるのかを議論する。

Acknowledgement

This study could not accomplish any fruitful insights without supports from all people engaged parts of this study.

I would first and foremost like to extend my gratitude to my supervisor, Associate Professor Masanori Sugimoto, for giving me a great opportunity to investigate a challenging research theme. My same gratitude goes to Pamela Ravasio, who launched this study and gave me insightful comments. This study did not get off a good start without her brilliant achievements. I would also like to express my gratitude to Yumiko Ueno who is a school teacher and managed classes at the elementary school where we held user tests. Her dedicated efforts in order to conduct the classes were invaluable for this study.

This study was founded on many voluntary efforts, and I greatly appreciate students who participated in the user tests, joined development, and gave us worthy feedbacks and pupils who participated in our user tests. Their cooperation and sincere expression when they used our system made me highly motivated to accomplish this research.

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1 Introduction

Environment around children is changing rapidly because of novel digital technologies. It is not surprising to see that children use cell phones and handheld game devices when we walk around shopping complex and railroad stations. Inappropriate uses of these technologies by children such as dating service sites and browsing pornographic representation are getting focuses by mass media because of adverse influences by those services. However, these digital technologies can offer new positive feasibilities to children. For instance, digital technologies can go across physical distances. It is easy for cell phones and handheld game devices to connect children who have not met yet each other. Although it is imposing to focus on undesirable aspects of novel technologies, the important thing is to offer appropriate ways of using those handheld devices which are accessible even for children. Researchers who engage to improve learning activities and to develop learning support systems have been studying ways for children's learning using digital technologies mainly within classrooms (see e.g. [1, 4]). Although some projects such as Concept Mapping [13] and Ad Hoc classroom project [14] used mobile technologies such as PDA and laptop computers, the envisioned scenarios were only for studies within classrooms.

On the other hand, after abductions were addressed frequently by mass media in Japan, parents and teachers were becoming more sensitive about the safeness of their local environments than ever. Some elementary schools regularly have parents or teachers accompany pupils on their way from school to home. Furthermore, it is being recognized by school teachers and parents that improving children's consciousness of safeness is a significant activity so as to avoid getting caught their children by strangers. In this context a class called Security Map Creation is been getting attentions among teachers and officers engaging education in public organizations. According to primary school teachers, Japanese ministry for education offered respective schools to make a map which indicates potentially dangerous places around the schools and to display the map to share the information with pupils. The Security Map Creation class is one of the studies using fieldwork in which pupils are asked to gather information of locations on their way to and from school. Places where naturally hide figures of children such as tunnels and parks surrounded by thickset woods and where neighbors do not tend to pay attention such as parking fields and spaces near walls drawn graffiti. Then, they sketch these on a map, and share and discuss the gathered information with their classmates in order to raise the level of their personal security consciousness. This methodology invented originally by Professor Koyama [3] majored in criminal sociology mainly uses pens, papers, and sometimes voice-recorders for interviewing the locals in order to make the security map.

Based on the social demands and the technological feasibility offered by mobile technologies, our study aimed at designing a system that offers children a means for general field studies in primary education using novel mobile technologies. Although there are not many cases which offer novel technologies to pupils in elementary schools, it is significant to introduce new ways of learning that give digital experiences to make children's learning more active. The system developed by us, called SketchMap, provides children supports to draw a map during the field study by providing respective groups a tablet PC equipped a web camera and a GPS device and to discuss and to share

remarkable findings in the field studies after the class. While it is not difficult to only envision a system which looks promising, this study strongly focuses on practicality of the system since the system concerns learning of children and how children learn using the system is only seen through practical use of the system. Accordingly, this study held user tests in a public elementary school. Based on the user tests, this study argues the validity of the envisioned system and reveals a way of supporting field study in primary education.

In the following of this thesis, how a field-study in primary education is in practical educational settings and prospective requirements to the support system are discussed in Chapter 2. A system which fulfills the requirements is introduced in Chapter 3, and ways of evaluating the system are shown in Chapter 4. Then, Chapter 5 discusses the evaluation based on two user tests. Finally, conclusions of the SketchMap system based on the evaluation and future recommendations are described in Chapter 6.

2 Requirements for SketchMap

2.1 Field studies in primary education

First, it should be specified what field studies are preferred in primary education as a start point of investigating the problem domain. Fig.2.1 indicates steps how the security map creation class is taken. There are mainly five steps: preliminary study, organization of groups, field study, drawing security maps, and presentation as depicted in the middle of Fig.2.1. First, pupils learn what places are potentially dangerous and safe around their environments during an indoor lecture. Potentially dangerous places mean that the places may offer opportunities to occur crimes. For instance, Fig.2.2 a) shows one park surrounded by fences made of steel. This fence hinders children playing there to be seen from outside of the park. It is expected that no one may take notice of activities when crimes happen inside the park. Another example recognized as a potentially dangerous place is near walls drawn graffiti like Fig.2.2 b). If things impressing negative feeling such as graffiti and garbage are left around places, such places mean that neighbors tend not to pay attention to there and the probability of exposing crimes near the places is quite low. Therefore, children should not approach such places if it is not needed. After pupils learned what the potentially dangerous places are, pupils organize groups for the field study. Each group consists of one leader, one sub-leader, one photographer, one or two cartographers, and one or two interviewers. After pupils checked what they do during the field study, they plan how to walk assigned areas. Then, each group goes out to find the target places. During this field study photographers take pictures of potentially dangerous and safe places, interviewers ask neighbors living around places the pupils found how the atmosphere of the places usually is, and cartographers write down their findings on the map with pencils. After pupils finish the field study and go back to school, they start to summarize what they found in the field studies. They draw outline of the assigned fields such as streets and parks, paste pictures taken during the field studies, annotate the map with their own comments and transcripts of interviews, and highlight matters of importance with markers and colored papers. Then, pupils prepare what they would like to mention for the following presentation and hold a presentation session within the class. According to Koyama [15], it is recommended to perform these steps of the Security Map creation class for eight school hours (45 minutes per one school hour) in elementary schools. In our opinion, eight school hours seem long for pupils to hold all steps of the class in a day. Hence, the class should be divided into several days. For convenience sake Fig.2.1 divided the steps of the security map creation class into three days.

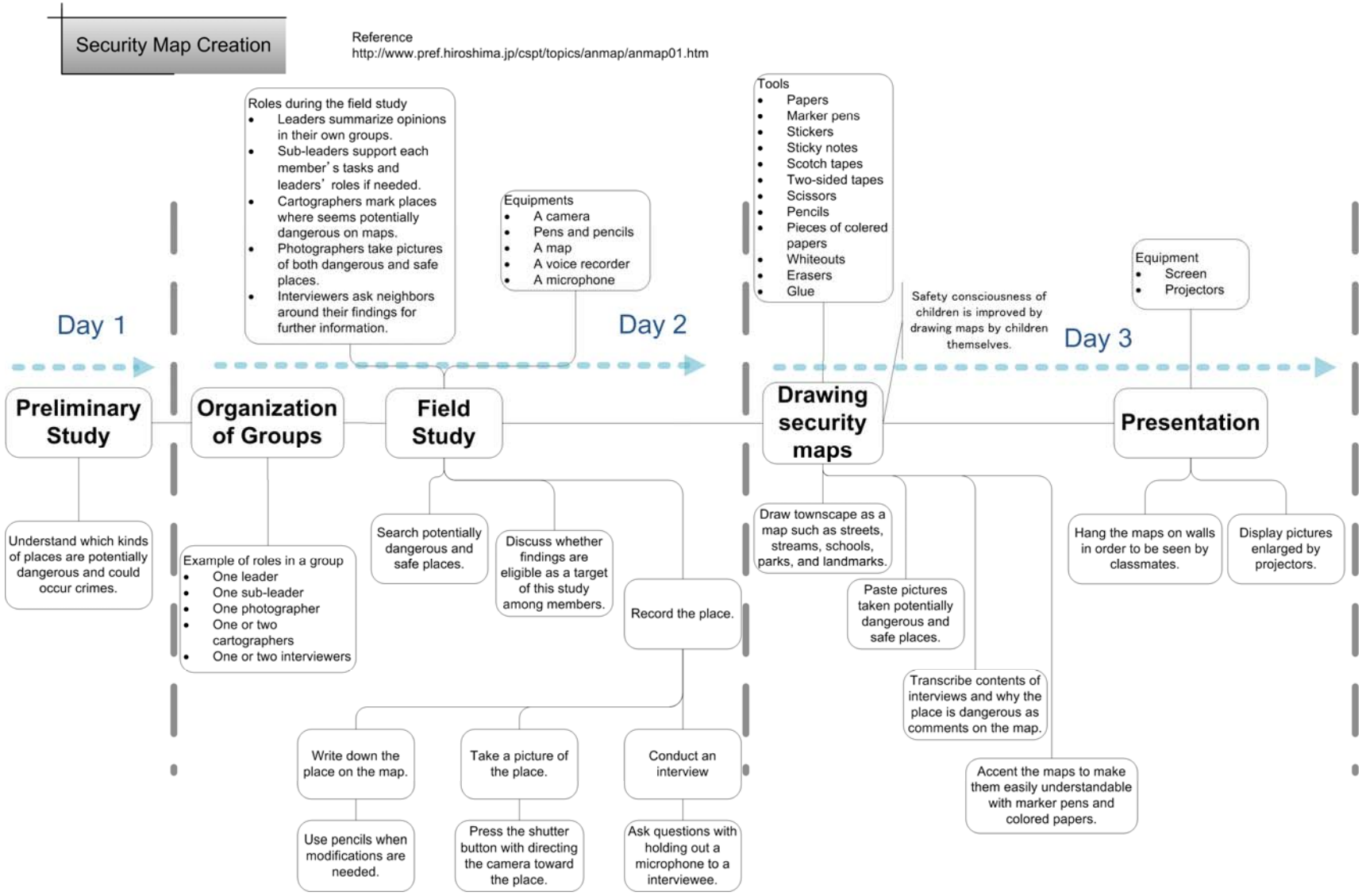


Figure 2.1 Steps of the Security Map Creation class
(Made by us based on http://www.pref.hiroshima.jp/cspt/topics/anmap/anmap01.htm)

a) b)

Figure 2.2 Examples of potentially dangerous places [15]
a) a park surrounded by fences, b) a wall drawn graffiti

2.2 Challenges in field studies

Some problems which pupils face during the class were conceivable in advance from the processes introduced in Fig.2.1.

- Limited drawing abilities of pupils

In field studies pupils depict what they found on a paper. However, their ability of drawing is not matured. First, pupils sometimes modify what they drew with erasers in the outdoor environment. There are not many stable surfaces to write something on a paper in the outdoor and drawing by pupils on the paper will gradually look dirty because of the traces of erasing. In order to draw neat primitives huge effort and time may be needed for pupils. Secondly, pupils use different representation among group members to write down same findings on a memo during the field study, and these representations are shared within the group to discuss what they found after they go back to school. Pupils will find representation which is not understandable on others' maps and need explanation from pupils who drew them. This is a cumbersome step so as to start summarizing maps. Thirdly, proportions of distance of respective places may be drawn wrongly. Correction of the proportions of drawing by pencil requires deleting and rewriting plural parts of the maps and lots of time.

- Time Constraints to hold the class

In views of ordinary class schedules and attention span of children it is not practical to have all eight school hours within a day. There are lots of things to do as regular activities in primary education and eight school hours for the field study may squeeze time for other activities although the field study is significant to learn concepts of safety in environment pupils live. Some pupils may endure to do from field studies to presentation in a row. However, in general setting of public elementary schools there are pupils having wide range of capability and some cannot endure such a long class. So it is preferable to separate the class into a few days. However, the longer the class is, the more difficult it is for pupils to keep remembering what they learn in previous class is.

- Stuck achievements

Maps as achievements of the class are stuck personally and physically. The author of the maps can understand what information is contained on the map and may rearrange new information since the authors have experience of the field work. But it is difficult for

pupils who did not attend the class to match things on the map with what the pupils know since the pupils do not even know which mark indicate which object in their environment. Therefore, valuable information in the achievements tend to stick on the authors involved in the class and the achievement may not offer pupils who did not attend the class less information than the pupils involved in the class. Field studies treat lots of information regarding one environment, and the environment contains other stakeholders living in there such as pupils' parents. The stakeholders also did not involved in the class, so they may not understand lots of information on the map as well as pupils who did not attend the class. Moreover, the achievements are hanged on a wall in elementary schools. People living in the environment and having no opportunity to visit the elementary school will never see the achievements although the achievement may contain valuable information for those people. So, the achievements of the field study will be stuck on somewhere in the elementary schools and cannot be shared among stakeholders in the environment except the pupils involved in the class.

2.3 Related Works

2.3.1 Technologies in field studies

There are lots of support systems for children's learning within classrooms, but only a few studies for learning of children outside classrooms have done ever. One of the learning supports outside classrooms is the SENSE project [8]. The SENSE project aimed to support an environmental science class for children aged 11-14 years. In this class children measure carbon monoxide (CO) with a CO sensor, an anemometer for wind speed, and video recorder. CO readings were recorded and displayed by a PDA attached to the CO sensor. By getting not only CO readings but also contexts of the sights children could progress discussions deeply through reviewing videotapes and sharing achievements with children who have studied same topics in another school. Benford, et al. [5, 7] developed an educational game called Savannah in which children learn about the ecology of the African savannah. Children having PDA with WiFi and GPS capabilities walk around a playing field covered by the WiFi network. As they walk around and enter one terrain specified by GPS data, they encounter some events as a lion such as "Do you attack the elephant in front of you?" Through the role-plays as a lion and reflective learning in a space where can offer children various information regarding habits of lions, the children learn how lions live for a year in the African savannah. Although the savannah project mainly studied as to feasibilities of location-based applications, they concluded that children could develop an understanding of the key features of the Savannah environment and the strategies and choices faced by lions in interaction with the Savannah environment through experience, trial and error, and reflection on game play strategy [7]. Kravcik et al. [9] developed a system called Mobile Collector for collecting data during fieldwork. Mobile Collector equips a camera, a microphone, a web browser, videoconference systems, and etc. Learners can choose one of them depending on what they would like to collect and add annotation to the findings with predefined items or audio annotation. These devices are deployed on a tablet PC and have been evaluated by 6 girls in the age between 10 and 14, and Kravcik reported that the system was easy to be used by school pupils. Iacucci, et al. [10] developed a photo collection management system for students majored in architecture although this project is not learning support system for children. The system arranges photos having time and position information acquired by GPS on a map

so as to reflect students' visiting experience and data repositories for architectural projects. As a not learning but working support system, Yeh, et al [2] developed a system called BatterflyNet for field biology practices. ButterflyNet supports to manage heterogeneous data field biologists have to treat. ButterflyNet translates handwritten notes into digital formats via the Anoto digital pen system [10] and captures a finding with a 2D barcode so as to connect not only a physical finding with an annotation. All notes captured by BatterflyNet are integrated on the ButterflyNet Browser that displays notes, pictures, and GPS data where each picture and note are captured.

2.3.2 Comparison with our study

All these works gives valuable insights to adapt novel technologies in practical educational settings; however, no studies which aimed supports for children and studies which use drawing as a means for communication have done yet. ButterflyNet is similar with our study since our target study also aims to capture something which is not prearranged, but the target users are different. They focused on adult field biologists, but our studies focus on pupils as users. There exist differences of computer literacy between adults and children. So it is assumed that the way of support system design for children is completely different from for adults and contains lots of unrevealed problems which related studies did not focused on.

Challenges mentioned in Chapter 2.2 can be supported somehow by novel technologies. Although the related works showed attempts to solve problems of activity supports in the outdoor environment, the problems came out in the field studies of our problem domains are different from what the related works indicated. The field studies in our domain uses drawing as a communication medium. Handwritten maps convey some information regarding local environments. SENSE project [8] supported to measure CO's scale and treated only numeral and graphs made by the numeral. ButterflyNet [2] supported to capture targets in the outdoor environment and rearrange findings later in the indoor. ButterflyNet can treat drawings by pen, but they targeted the field biologists who are good at representing findings in drawing and work individually. In the Savannah project [7] participants used hand-written maps as memos for characteristics of respective area, but any technologies did not support writing maps and it is discussed in [7] that development of a map creation facility is one of the practical next steps. It is one of our problems to support pupils' drawing abilities with novel technologies.

Second challenge, time constraints, is a practical problem and may highly depend on each context of our study. In order to avoid abductions there are other measures such as commuting with parents and bringing in school buses. Instead of devoting physical assets such as school buses the Security Map Creation class aims to grow safety consciousness. The time-constraints are not appeared in related works introduced above and are recognized as problems of pedagogy; however, it is significant to investigate the possibilities to conquer the problem when our study is applied to the practical settings.

The viewpoints of sharing achievements are appeared in the SENSE project [8] and Mobile Collector [9]. In the SENSE project pupils participated in the study belonged to two different schools located distantly. After respective pupils finished their CO studies, they held a video-conference together in order to discuss CO issues and each

achievement and successfully got new hypotheses regarding CO's behaviors. Mobile Collector aimed to produce means for discussion between outdoor and indoor during field studies from the very first. Both two related works could produce discussion among participants; however, there is no concept to make stakeholders living around the target field involve in. Sharing achievements beyond the classroom with stakeholders living in the target field is an idiosyncratic problem, but should be examined its practical possibilities in our study.

2.4 Requirement for SketchMap

Based on the discussion in chapter 2.3 we came up with following problems which should be examined in our study. The problems are:

a) To induce children's learning motivation and engagement through digital experience produced by SketchMap.
b) To provide children a new means that is easy to use and endures practical use in field study classes in public elementary schools.
c) To integrate learning experience seamlessly between outside and inside classrooms.
d) To share achievements of the field studies amongst communities in which children live.

a) is one of the common and minimal objectives amongst projects studying learning support systems. Teachers have almost all classes without any digital technologies such as PC and handheld devices and for the teachers the technologies are just unnecessary if there are no merits to use the technologies in class. It is not so easy to induce engagement of children since poorly designed technologies easily make children's motivation to learning lower by leading the children's attention out of purposes of the class. For better or worse novel technologies can attract children's attentions; hence, it is important how the system is designed so as to keep children's attention within the focus of the classes.

In related works participating in the user tests has somewhat special meanings for the pupils since participants were carefully selected out of classes. Ideally, learning support systems should be used practically in primary education in the near future and the systems should envision to be used by children having wide range of learning capabilities. So the system in our study should not only support children's drawing capabilities but also be easy to use for pupils having wide range of capabilities. Therefore, to fulfill b) is important in our study.

In field studies, it can be important to reflect what pupils found outdoors right after they come back to school since pupils will lose details of what they saw as time passes. And eight school hours are long for the school time schedule as we argued above. Hence, it is significant to integrate outdoor learning experience seamlessly between outside and inside classrooms in order to accomplish better learning experience. Supports by novel technologies can realize to integrate them somehow, e.g. calculating pen input sequence to make its appearance more smoothly than pupils actually drew and connecting findings with the GPS data as [10] did in order to make it easy to connect the findings

with places where they were found. Moreover, if the task of drawing maps was done only on the digital technologies, there are no tasks for translating from handwritten memo to a large sheet of paper with markers and colored pens and it is easy to transfer drawings to another location and translate them into another format. Providing these supports does not affect learning experience directly but reduce amounts of necessary tasks. Although such supports are indirect for pupils, it is conceivable that the supports enable children to concentrate on the purposes of the classes.

According to Bandura [11, 12], human beings can learn from observation of others' behaviors. Especially, children tend to observe and imitate their parents as a model. In the case of Security Map Creation class if parents have a conversation about car parks near their home with children, the conversation can be an opportunity for children to remember what children learned, and the parents' suggestions regarding the potentially dangerous places can be good advices for children. As well as their parents, stakeholders around the target field should also be able to browse the achievements of the field studies. The stakeholders may start to care the place where it is potentially dangerous after they read the pupils' opinions. In an extreme case, it is envisioned that sharing the achievements of the field study can contribute to make the community in the target field more safety by providing opportunities to think about dangers in their environment through pupils' achievements. As Lave [28] suggested, children are exactly legitimate peripheral participants[1] in the society of adults. The opportunity may be a first step for children to think about their community. Hence, it is significant that the system fulfills d) beyond the original purpose of field studies.

Consequently, our study envisioned to change field studies in primary education like Fig.2.3. Digital expression which is easy to use for pupils and seamless integration of tasks between outdoor and indoor environments can concentrate study sequences of the target field study on its original purpose. Moreover, although ordinary field studies are end after the presentation in the class, our envisioned system aims to provide a framework which is a means for reviewing and sharing what pupils learned during the field studies. That is to say, not only pupils participated in the study can review what they learned whenever the pupils want, but also stakeholders around the target field such as parents and neighbors can know their environments more and have a discussion with pupils and other stakeholders. Additionally, these sequences should be interesting enough for pupils and attract pupils' attention and induce their motivation and engagement in the field studies.

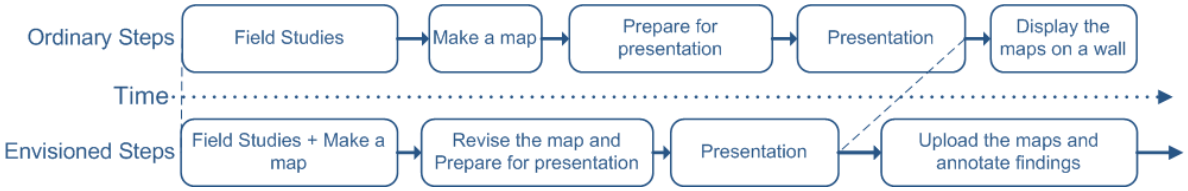


Figure 2.3 Differences between ordinary and envisioned steps of the field studies

[1] Newcomers who become members of a community initially by participating in minute and superficial yet productive and necessary tasks that contribute to the overall goal of the community. (Quoted from wikipedia.org)

3 Designing SketchMap

In order to realize the concept of SketchMap, total components of the system are connected as described in Fig.3.1.

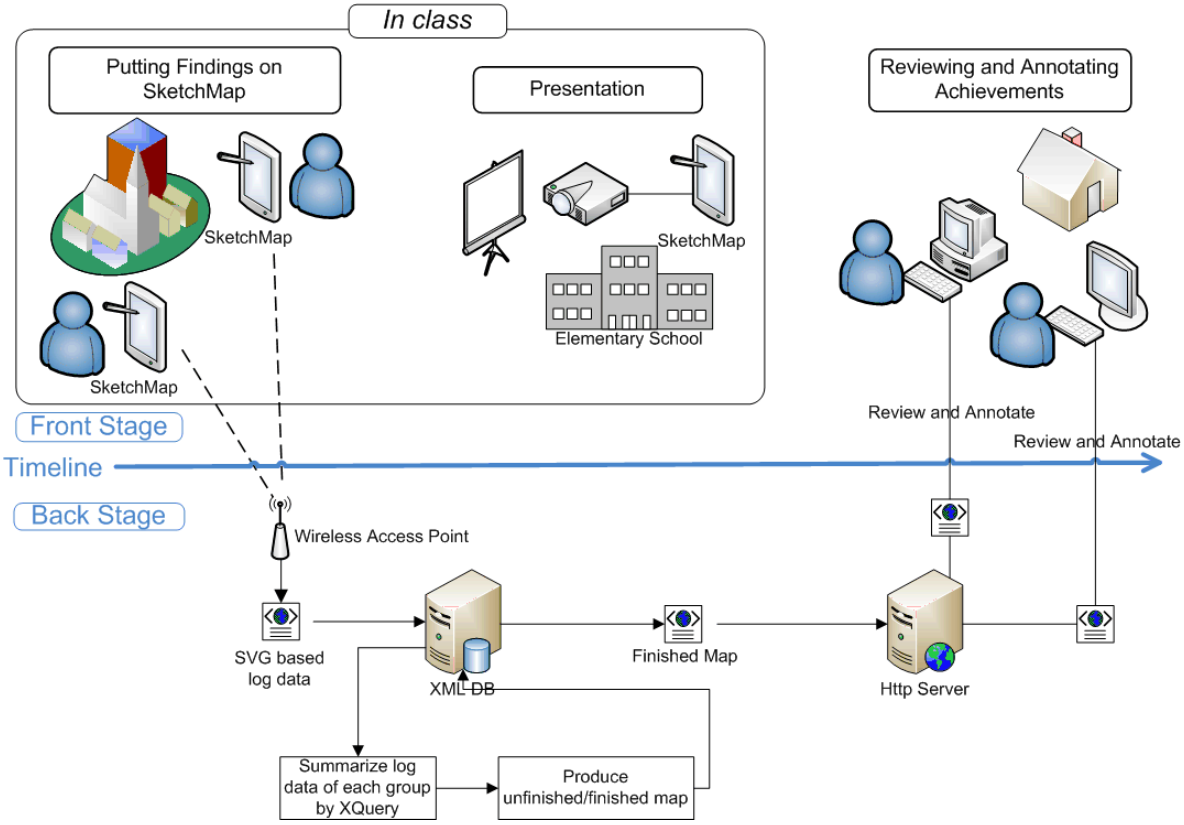


Figure 3.1 Components of the SketchMap system

In Fig.3.1 the class of field studies is located at the upper left. Software working on tablet PCs is brought into the class and intends to support capturing and drawing findings on maps during field studies and support to integrate tasks between outdoor and indoor environments. All manipulations for drawing are logged automatically behind the screen. The log data is transferred to a database after pupils go back to school. Then the log data is processed by the database in order to be published on a HTTP (Hypertext Transfer Protocol) server and pupils need not to rewrite what they have done in the field study while their maps are being translated. The all achievements during the field study can be browsed by anyone from anywhere they can connect to Internet. Stakeholders such as parents and neighbors can also browse the achievements and pupils participated in the field study can use the web contents when the pupils talk about what they did to their parents. In the following chapters these three components are introduced respectively.

3.1 Devices for field studies

In the field study pupils use a tablet PC instead of pencils and papers. Tablet PC was chosen by two reasons. One is to enable children to use their preexistent ability. It is assumed that most pupils have not used computers yet, but at least children have ever used pencils to take notes and to draw a picture. So it is essential to hire pen-based interaction to manipulate the support system. Another reason is the size of the screen. In

our early study [16] a prototype running on a small mobile PC having stylus[2] was examined by students in university. The system was easy for the students to draw maps and the PC was light enough to carry. However, one elementary school teacher gave us a suggestion that the small PC is not suitable for pupils to draw because of its smallness of the screen and the stylus. Hence, tablet PCs were chosen because of the size of the screen and the pen although tablet PCs seemed heavy to be carried by children for a long time.

Fig.3.2 a) indicates the tablet PC system used in the field studies. A tablet PC is connected with a web camera and GPS (Global Positioning System) with its antenna. The tablet PC is attached a bag like Fig.3.2 b) and is brought into field studies.

a) b)

Figure 3.2 Tablet PCs used in the field studies
a) Appearance of the tablet PC, b) a pupil having the tablet PC

User interface of the software was written in Java and was designed based on a metaphor of painting kits which pupils have ever used in the manual-art classes. Fig.3.3 indicates how the interface looks like. Our target users were pupils in Japanese elementary schools, so all information was written in Japanese; however, English annotations were added in this figure. The interface consists of one main window called SketchMap, and three subordinate windows called canvas, palette, and use camera. As well as painters put ink brush on palettes before draw something, users need to put a digital pen on the palette and then put the pen on the canvas. The digital pen has a specific ability after the user touches an icon on the palette. Hence, the digital pen works like stamps and users stamp as much as the number of they would like to make the icon. There are lots of icons in two tool boxes. When more icons are needed than on the palette, users pick up one of the icons in the tool box, the icon appears on the palette, and the icon becomes available newly. Some primitives for cartography such as various widths of streets and area are prepared in the tool boxes[3]. Users also can use multimedia expressions generated by the web camera. There is a window called use camera at the lower right of Fig.3.3. The screen reflects what the web camera is taking at that moment,

[2] Sony VAIO type U. See also http://www.vaio.sony.co.jp/Products/VGN-U50/
[3] Although primitives such as streets and area are made by Java 2D, most icons are borrowed from web sites providing icons freely for non-commercial uses. See detail in Appendix C.

and as users are looking at the screen, they press one of the buttons, take a photo, take a video, and record sounds. When users press one of the button, image, movie, or sound files is generated with Java Media Framework [18] on the palette window. These multimedia icons can be used as well as mere icons such as trees and traffic lights. On the canvas by using context menus users can enlarge, minify, play, and delete what they drawn. Users also can move what they drawn by dragging icons and primitives.

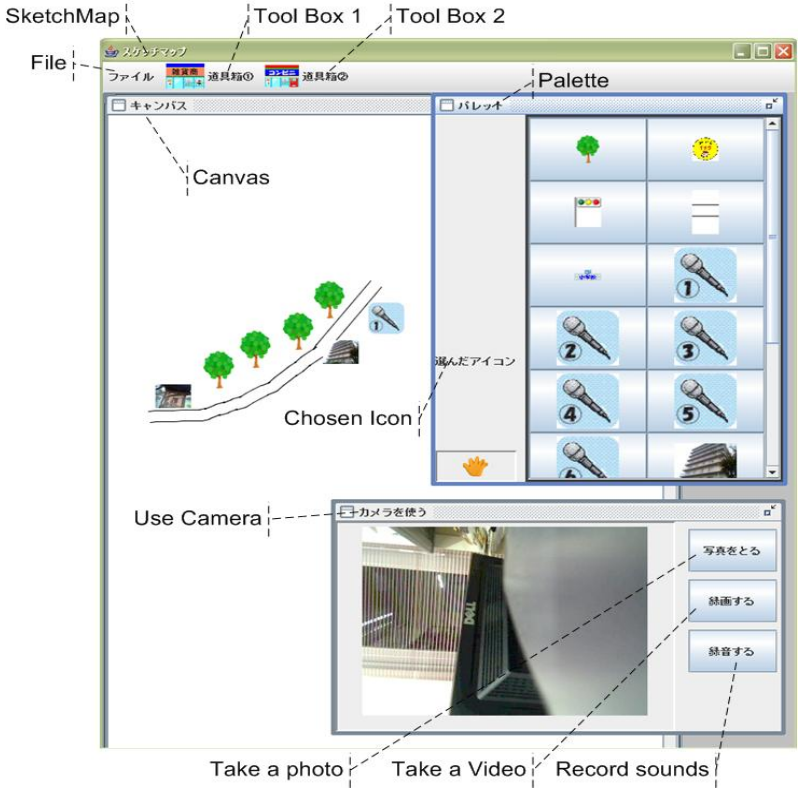


Figure 3.3 User interface of the tablet PC

Although maps drawn by this system can be saved by choosing file menus at the top of the main window as well as general software such as text editors, respective elements of drawings and sequences of manipulations are saved automatically with location information obtained by GPS. These logs are described in the SVG (Scalable Vector Graphics [17]) format in order to be computed later by the log system illustrated at the bottom of Fig.3.1.

3.2 Log data summarization

Overview of log data summarization is shown in Fig.3.4. In the class of the field study after pupils go back to school, log data is sent to the database server. Although dominant databases used in web applications usually hire relational data schema since the schema became mature through being used for long periods, our study hired open source native XML (Extensible Markup Language) database called eXist [19]. It is significant to keep data schema close to markup languages such as HTML and seems redundant to change XML into relational data schema and make it revert to XML since the achievements are going to be shared on web sites.

There are two kinds of XML data; one is to convert Java 2D based maps into SVG

based, and other is to save annotations for respective findings when pupils add comments on their findings later. The each SVG log combines drawing information with location information. First, the SVG based logs are processed by XQuery[4] [20], and SVG-based achievements are generated. All log data should have location information; however, some logs do not contain it because of flaws of GPS. Capability of GPS depends on physical environment in field studies, and lacks of location information are scattered among the log data. As a complementation, the parts without location information are complemented with adjacent two parts having location information. Lastly all processed log data are deployed on the HTTP server to be reviewed and to be shared by pupils and stakeholders. In practical scenarios, the HTTP server is managed by school teachers; therefore, the database server and the HTTP server are located separately. Elementary schools tend to have their own web sites. The achievements of the field studies are also managed as parts of their web sites. School teachers do not have technical skills, and the database server may be out of their skills. Hence, it is essential to separate the server of processing data and the server of storing and managing the achievements.

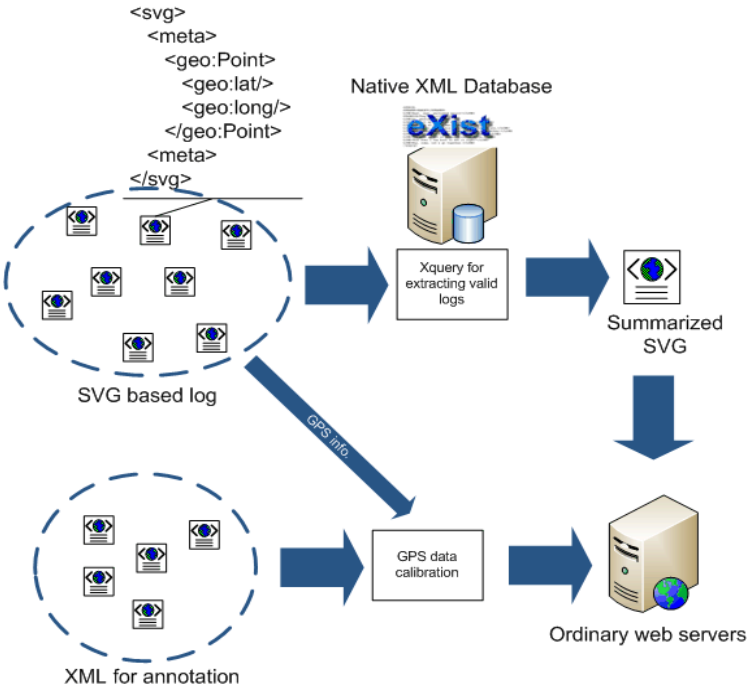


Figure 3.4 Processing log data

3.3 Web sites for sharing achievements

At the step of the upper right of Fig.3.1 the achievements have already converted into formats familiar with the web, and appear on web browsers like Fig.3.5. These web sites are designed only for Internet Explorer, which may be recognized as the most commonly used browser by Internet novices such as pupils[5]. Users can review maps as achievements in field studies on the left side of Fig.3.5 a). These maps are displayed with Adobe SVG Viewer [22] which enable users pan and zoom SVG based maps on

[4] a query language for XML that can process not only files in XML format, but also other data including databases whose structure -- nested, named trees with attributes -- is similar to XML. [21]

[5] Global usage share of Internet Explorer is 85.81% in January, 2007 according to [29].

the browsers. If one of the multimedia files on the maps is clicked, the file is appeared on the right of Fig.3.5 a). In order to realize smooth interaction to view the maps Ajax (Asynchronous JavaScript and XML)[6] is implemented on the sites. It is assumed that if the sites are constructed only by HTML, new pages are reloaded whenever they click and users would lose attentions because they would lose where they were seeing. After one of the multimedia file is displayed, users can add annotation by writing comments in text fields which appears when a button below the media file is pressed. The annotation is stored with the multimedia file and used in Fig.3.5 b). The representation in Fig.3.5 a) is only for users who participated in the field studies since the expression of maps is difficult for anyone except the participants to be understood correctly. Hence, another representation of the achievements is designed for stakeholders such as pupils who have not participated in the field study, parents whose children have participated in the field study, and neighbors living in the environment surveyed in the field study. Findings during the field study, mainly multimedia files, are displayed on Google Maps [23] in Fig.3.5 b). If one of the red flags on the Google Maps is clicked, the media file with the annotation is appeared. Practically, Fig.3.6 b) can be an interpretation of the hand-written achievements, which connects what pupils learned during the field study with stakeholders, and gives the pupils another way of viewpoints of their field study.

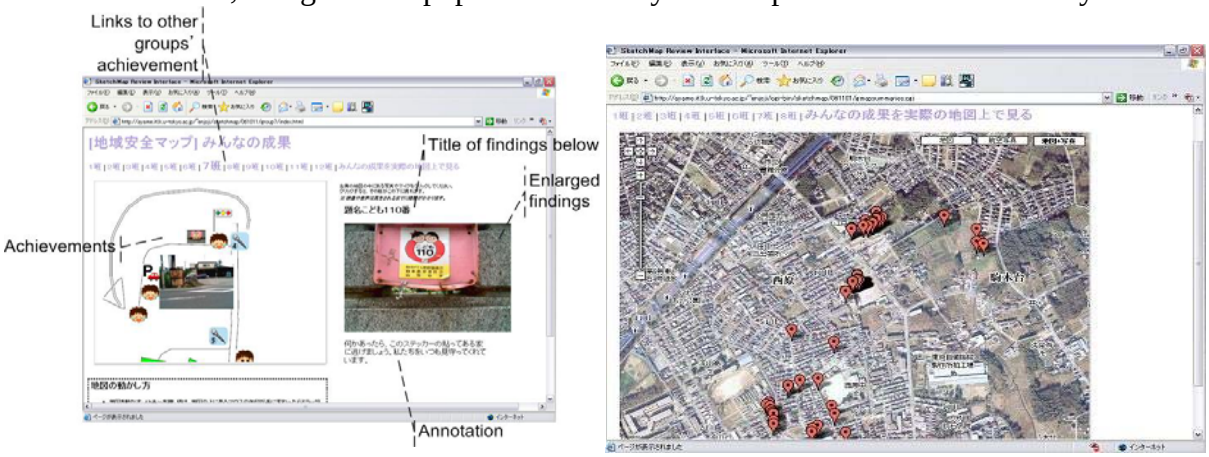


Figure 3.5 Screenshots of web sites for reviewing achievements
a) web sites for the pupils having done the class, b) web sites for the stakeholders

3.4 Envisioned sequences of field studies

Based on the SketchMap system discussed above, sequences of the ordinary field study in primary education can be changed as shown in Fig.3.6. Hatched processes indicate that they are changed because of technologies applied newly in order to fulfill the requirements discussed in chapter 2.3. Compared Fig.3.6 with Fig.2.1 there are no changes before the field study; pupils learn what they should study in class, organize groups to survey the assigned fields, and confirm what each pupil do during the field study. There are no new roles assigned to respective pupils, but only equipments are changed. Using the tablet PC, pupils can draw maps on site instead of just only memorizing what they find with pencils and papers. The pupils also do not need erasers,

[6] A technique to provide richer user experience, which exchanges data of parts of the currently displayed pages behind the scenes instead of data of the whole pages

digital cameras, and microphone to interview since all functions the pupils need during the field study are provided by the tablet PC system. Moreover, expressions by multimedia such as photos and interviews can be attached on the maps immediately after the pupils take a picture or interview neighbors living around the target fields. It is assumed that pupils can do almost every task to draw a map. Although there are some small tasks so as to complete the map and prepare how the pupils present their own achievements in front of their classmates. Consequently, the amount of time from the field study to the presentation is shortened and it may become easy to keep the pupils attention on the same topic.

The field study shown in Fig.2.1 ends with one presentation session, but the field study using the SketchMap system never ends since the pupils participated in the field study can review their achievements in the web whenever they want. So it is assumed that the pupils who enjoyed the study using the SketchMap system and became interested in the content of the field study will occasionally return to the web sites and may improve understanding regarding their local environments. The availability of the successive reviewing may provide the pupils better learning experiences since pupils who get interested in the class can keep devoting their curiosity to the target. Moreover, the availability contributes to hold conversations within families. Parents can know how children recognize their local environment and children may improve their understanding regarding their local environments by listening their parents' comments and idea.

Adopting the way of field studies envisioned by SketchMap does not change contents and purpose of the class, but only change its equipments. Hence, teachers in primary schools do not require changing their ways of teaching, but require adding a session to teach pupils how to use the SketchMap system. If the system can fulfill the requirements the system should fulfill, it seem not to be demanding to add the instruction session newly and it is assumed that the way of field studies in Fig.3.6 is easy to be applied in practical education in public elementary schools.

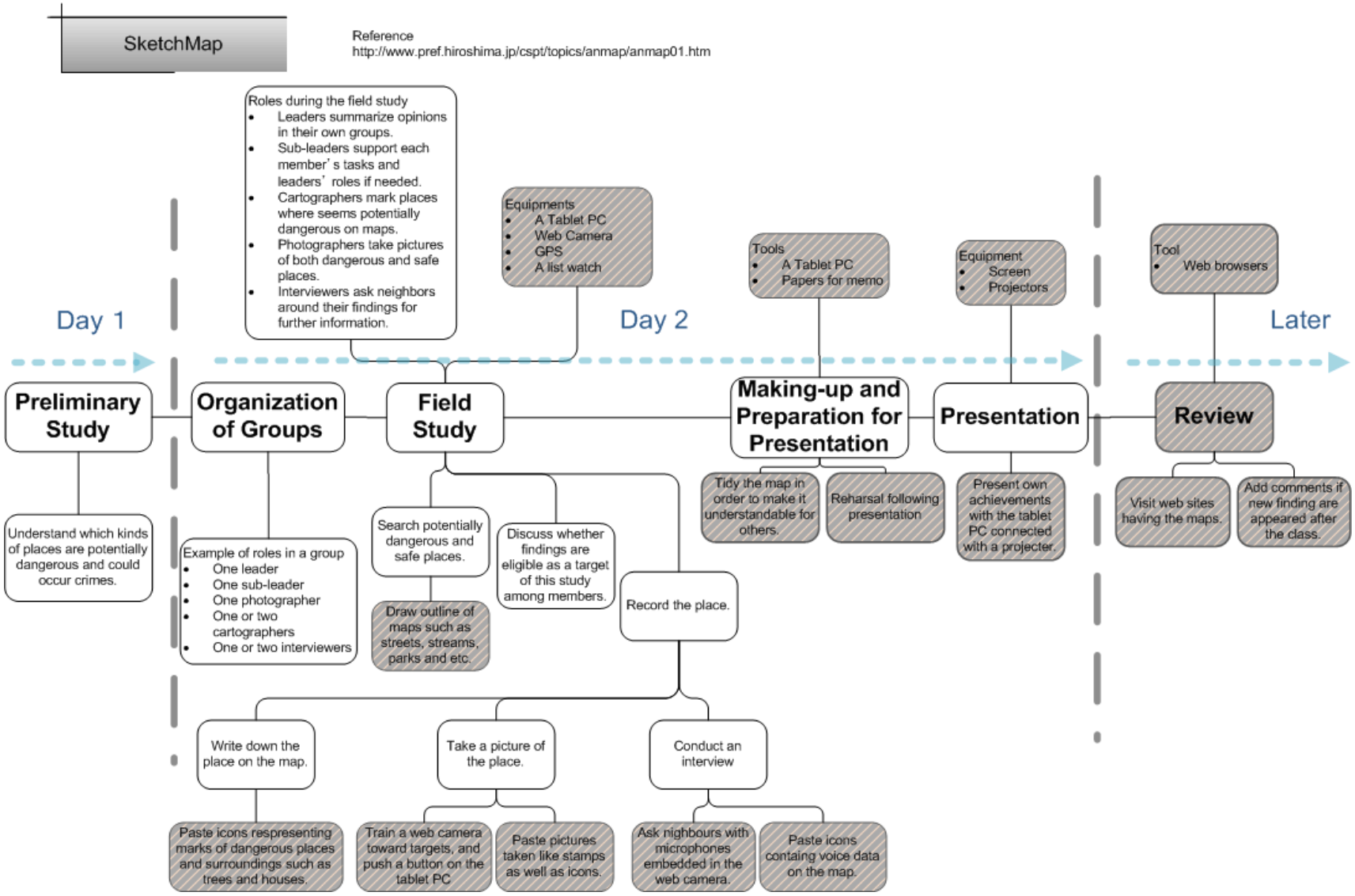


Fig.3.6 Sequence realized by the SketchMap system

4 User Tests

The SketchMap system should be used practically in primary education if the system actually can provide richer learning experience. In order to examine the validity of the concept of SketchMap our study held two user tests in classes including field studies in a public elementary school. One user test was held in the Security Map Creation class and another user test was held in classes called nature observation. Nature observation is a class to learn how creatures around schools such as birds, insects, and plants are spending in each season through observing their appearances.

4.1 Security Map Creation

Sixty seven sixth graders, from eleven to twelve years olds, in a public elementary school in Chiba prefecture, Japan participated in the class as a user test. The number of pupils means that two fourth classes of the grade attended the class. The pupils organized six groups having five or six pupils in each class. There was no selection of pupils based on their abilities; however, the school teacher told us that relatively calm and decent classes were selected among four classes. Each pupil had a specific role in his/her group such as a leader, a photographer, and a cartographer and each group had one tablet PC based system. Because of experimental aspects of this user study, at least one teacher of the elementary school or one guardian accompanied respective groups. And one or two student volunteers also accompanied them in order to support when the pupils face technical troubles regarding the tablet PC and to record the pupils' conversations and behaviors during the field study.

Table 4.1 indicates how the class in a day was divided. The day before the user test the pupils took guidance regarding the purpose of the class and how the class goes along by the school teacher in the elementary school. On the day the user test was started from introductory orientation. Instruction of usages of the tablet PC consisted of approximately ten minute demonstration and ten minute trial use in doors. Then, the pupils went out to assigned area to find out potentially dangerous places. During the field study the student volunteers do not tend to intervene in the pupils' activity. It means that if the pupils spoke to the student volunteers, the volunteers tended to have a conversation, but not to divert pupils' attentions from the learning purpose of the class. Although in the rigorous experiment of, for instance, experimental psychology and usability study it is improper that persons related examiners get engaged in the experiment if the intervene is unnatural compared to ordinary situations. However, the student volunteers were allowed to interact with the pupils since this user test was held in a public elementary school and what is the most important is pupils' study, not experiments in this context. Basically, pupils should not be treated like "guinea pigs" in the context of public elementary schools. However, results of this study in a public elementary school are expected as generalized responses from pupils since public elementary schools are much more than private elementary schools. After the pupils went back to school, they had lunch break. In the afternoon they started to complete their maps for the following presentation. At the same time the pupils also discussed how to present their maps and the order of presenters. A sheet to review the class was provided by the school teachers and the pupils were filling in the sheet, so the pupils did not spend all forty minutes only to manipulate the tablet PC system. Then, the presentation was held in the respective classes. Each group presented their achievements

for approximately five minutes. During the presentation the pupils did not manipulate the PC to change focus of the canvas so as to shorten the presentation, and the student volunteers supported the presentation by manipulating the PC along their presentation. Finally, the school teacher summed up the Security Map Creation class and a questionnaire to get feedbacks was filled by the pupils.

Table 4.1 Timetable of the Security Map Creation class

Time	Task
Preceding Day	Preliminary guidance
10 min.	Orientation
20 min.	Instruction of how to operate the tablet PC
70 min.	Field study
	Lunch Break
40 min.	Finish of drawing maps and preparation for presentation
45 min.	Presentation
10 min.	Closing

For this class we prepared:

- 12 sets of the tablet PC system including web cameras and GPS devices for the field study
- one laptop PC for database and HTTP servers
- 4 tablet PCs prepared as spare
- a wireless LAN station to construct temporal Internet connection
- equipments for evaluation such as digital camcorders and voice recorders

4.2 Nature Observation

General studies in the nature observation class do not draw any maps. Pupils in the nature observation class find out creatures around school, sketch or take a picture how they live in the season, and compare their findings later with looks of the creatures in other seasons. However, some similarities with the security map creation class are seen in the nature observation class. Both of them include field studies and save findings to compare with other achievements and to be shared among the class. Hence, we decided to have user tests in the nature observation class in order to examine the flexibility and the general versatility of the SketchMap system.

The class was held in the same elementary school as the security map creation class. Two classes participated and the user test in one day was held for each class. In total seventy pupils in the fourth grade, from nine to ten years old, participated. There was no selection of pupils based on abilities. Table 4.2 indicates the schedule of the class. This class could have substantial guidance how to use the tablet PC before the day of the field study since the school teachers worried about computer literacy of pupils who were younger than the pupils in the security map creation. The guidance could include not only demonstration in doors for 30 minutes but also trial use outdoors inside the school compound for 15 minutes. The class including field studies held in the morning and its procedures basically follow ways of SketchMap illustrated in Fig.3.6. The class

was started only with short introduction for 10 minutes. By that time the pupils organized eight groups per class, and each group has four or five pupils who engage respective roles such as a leader, a photographer, and a cartographer. As well as the security map creation class each group was provided the tablet PC and accompanied by at least one school teacher or one guardian among the pupils' parents and a few student volunteers. The pupils drew maps in order to illustrate where and what they found on the screen of the tablet PC. After the pupils went back to school, they had a short break and started to summarize what they found in order to present them to their classmates. In the presentation session approximately five minutes were provided to respective groups. Although the student volunteers helped to manipulate the PC during the presentation, their presentation tended to be longer than assigned time. Since the closing session became shorter than the plan because of the long presentations, the pupils filled the questionnaire as feedbacks after lunch break. The equipments we prepared were almost same as the security map creation class.

Table 4.2 Timetable of the Nature Observation class

Time	Task
Preceding Day	Preliminary Study
Preceding Day (45min.)	Instruction of how to operate the Tablet PC
10min.	Orientation
70min.	Field study
10min.	Short break
20min.	Preparation for presentation
50min.	Presentation
5min.	Closing

4.3 Evaluation method

4.3.1 Lessons learned in a preliminary study

In order to evaluate the validity of the system it would be reasonable to do a comparative study which probes efficacy of the system based on differences between one user group with the system and another group without the system. However, our study chose a public elementary school, and the school teachers do not prefer to be treated their pupils like guinea pigs. The school teachers have commitment to treat pupils equally and not to make pupils annoyed beyond educational activities. It is unacceptable ethically to treat specific pupils specially. So, our study evaluated the user studies without any comparative studies.

In the case without comparative studies, it seems reasonable to ask participants some questions regarding learning purposes before, right after, and later the user tests. In fact our study had a preliminary study in order to examine the transition of pupils' understanding with the questionnaires in three times. The preliminary user test was held in the nature observation as well as the test explained in Chapter 4.2 and used only the tablet PC system. These questionnaires were designed based on toolkits by Read [24,

25], which studied to evaluate children's fun with expectation, engagement, and durability[7]when children used systems. Fun consisted of these three factors can be important for learning; imagine that you can remember easily what was fun. Interesting learning experience for children can be remembered well and children will also remember what was important in the class together with the interesting learning experience. Both in the questionnaires before and right after the preliminary user test, one same question asked appearance of the environment. Pupils answered the question by describing how the nature is; e.g. "trees bristle in a park" and "birds are singing cheerfully". It was assumed that pupils answer the question before the user test only using knowledge they already had and right after the user test using their knowledge and additional information they get during the field study. That is, sentences written by pupils can be like "The leaves of trees in the park are green but eaten partly perhaps by worms" and "Birds were bathing themselves in water." The difference between respective children's answers to these questions may reflect what they learned during the field study and learning efficacy. The third questionnaire carried out approximately five days later was designed to inquire what the pupils remember in the field study class. The pupils asked to write freely their experiences in the user test. It was presumed that the class fostered the pupils' learning experience if they could write down a lot what they learned during the field study. In an undesirable sample of the answers, descriptions regarding the system and students volunteers might be appeared a lot. Such descriptions which are not related to the purpose of the class should not be in the descriptions from the viewpoints of learning support systems.

The preliminary study was held successfully; however, the feedbacks in the questionnaires were disappointed our anticipation. Regarding the question which asked the appearance of the nature in the questionnaires before and right after the user test, explicit differences between them were not appeared. In the third questionnaire there were no descriptions at all regarding the system and the student volunteers. This extreme bias in the description is totally unnatural since the pupils at least knew there were outsiders such as the student volunteers and felt the difference from their ordinary classes. It is considered some reasons why the three questionnaires did not behave as we hoped.

- Qualitative purpose of the class

The purpose in the nature observation class is to give the pupils rise to interests and concerns in nature. The sense of care about nature cannot be constructed within one day. Hence, changes of their mind sets cannot be seen in the pupils' descriptions.

- Difficulty to intervene in primary schools

The first questionnaire delivered before the user test and the third one delivered in approximately one week were conducted only by the school teachers. Although the intentions of those questionnaires were noticed to the school teachers in advance, the

[7] Expectation represents difference between expectation to an event and satisfaction perceived by the event. Engagement is measured by children's behaviors; for instance, similes and concentration signs as positive instantiations, and frowns and shrugs as negative instantiations. Endurability is based on a desire to do again an activity that has been fun. [25]

teachers mistook and did not follow our intentions precisely. It is considerable that we present the moment to deliver the questionnaires; however, a burden imposed by visiting us would be enormous for the teachers and it is difficult for us to request the teachers to make us be there at the moment of filling questionnaires.

- Undeveloped writing skill of pupils

Writing to explain impressions and memories seemed a huge task for the pupils. Of course, they can write sentences, but it cannot conclude that the sentences precisely reflect what the children wanted to mention. Although the questionnaires had other questions which require writing sentences to answer why they thought so, some sentences were not understandable because of improper answers to the questions.

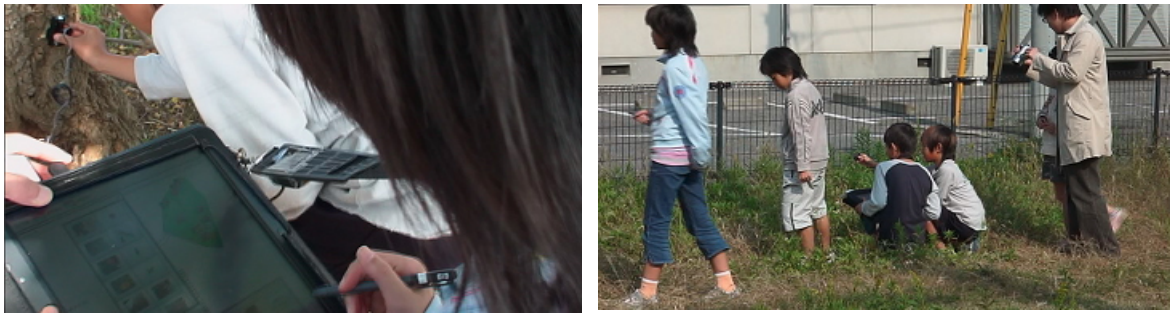
4.3.2 Evaluation strategy

It was revealed so far that in practical educational settings Comparative studies were not acceptable ethically and multiple questionnaires along the user test's schedule could not produce reliable evidences. Hence, our studied hired multifaceted resources in order to evaluate the validity of SketchMap.

- Sectional footages

In order to analyze the pupils' behaviors and transcribe their conversation, our study prepared eight video cameras for observations of experiences in the user tests. Two focus groups were chosen by the school teachers as groups which may be interesting and easy to be observed, and two video cameras were assigned to each focus group. One video camera was for details of interaction around the tablet PC system (Fig.4.1 a)), and the other one was for recording how all members were interacting among the group (Fig.4.1 b)). The other four video cameras were assigned other four groups. The footages of the groups which were assigned a video camera were mainly to keep the viewpoints of evaluation broad and general. The rest of groups accompanied no video cameras. However, eight voice recorders were worn around the neck of the leaders in respective groups just for supplementary recorders of conversations.

Our outdoor user tests had difficulties compared to indoor user tests. The remarkable differences between footages indoors and outdoors are impossibilities to place the video cameras on specific sites and to expect precisely routes of the pupils' activities. In the field studies the pupils walk around broad area for one hour. So the student volunteers took along the video camera; however, the pupils kept moving and there were always feasibility to miss to record something important. In case the footages missed some scenes which seemed important, the voice recorders were used so as to pick up the missing events.



a) b)

Figure 4.1 Main focuses of respective video cameras
a) a view recording details of operation of the tablet PC, b) a view of the whole activities in a group.

- One questionnaire right after the user tests

Based on lessons learned in the preliminary user test, only one questionnaire was conducted right after the user tests described in Chapter 4.1 and 4.2. The questionnaire avoided relying strongly on the pupils' writing skill and designed based on suggestions of Read [25]. It seems difficult for children to judge how past events were only from words like Fig.4.2 a). In order to make children answer our questionnaires easily the questionnaire hired choices expressed by smiley marks like Fig.4.2.b) through a discussion with the school teachers. The questionnaire (See its detail in Appendix A) was conducted by the school teachers in the day of the user test.

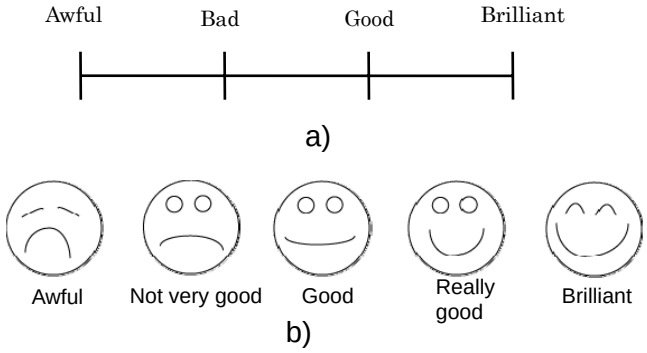


Figure 4.2 Formats for multiple choice questions
a) An ordinary style of multiple choices, b) a style for children of multiple choices

- Feedbacks from the school teachers

In order to complement a transitional evaluation of pupils behaviors compared to usual classes, our study held meetings with the school teachers. Ideally speaking, we should observe how the pupils' behaviors have changed in the user tests compared to the usual classes; however, it is time-consuming not only for us but also for the school teachers to do so. Hence, our study gathered the school teachers' opinions instead of direct observation of the pupils in the meeting right after the user test. Discussion during the meeting included from impressions regarding our system from the viewpoints of the school teachers to the class structures using the system. It took approximately one hour to discuss these issues.

- Access log analysis

One backup system to save annotations and Google Analytics [26] for check visitors were employed to investigate how often the web sites for reviews were utilized by the pupils and stakeholders such as pupils' parents for educational objectives. The backup system was used for what annotations were added and how the annotations were grown by visitors such as pupils participated in the user tests. Using Google Analytics frequency of visitors on each page was counted. These indications can be reflectors how often reviewing processes that foster pupils' learning occurred in the web sites. If continual visiting by pupils to the web site are recognized with the reflectors, it means that the site can contribute effectively to the pupils' learning.

5 Result and Discussion

Both user tests described in Chapter 4 held without critical technical troubles. Although the SketchMap system in the user tests filled its responsibility to conduct the class successfully, lots of merits and flaws were revealed. This chapter shown those topics based on requirements the SketchMap system has.

5.1 Usefulness for pupils

Easiness of use of the SketchMap system for pupils is important indeed in order to apply the system to the practical situations. Here we discuss aspects affected to the usefulness provided mainly by the tablet PC. Although easiness to learn, expressiveness, hardware, and interaction methods are discussed respectively, in summary lots of improvements were appeared not only in the software but also in the hardware.

5.1.1 Easiness to learn how to use SketchMap

First of all, the system should be easy enough for pupils to be learned in practical educational settings. There were 20 minutes instruction in the security map creation class and 45 minutes in the nature observation class. According to answers to questionnaire asked easiness of use (Fig.5.1), the system was not easy enough for all pupils participated in the user tests. In Fig.5.1 items answered Ok indicate middle-ground opinions and occupy the charts to some extent. However, the reasons attached answers Ok include irrelevant comments to the question such as the pupils had not used the system because he or she was not a cartographer. And some other reasons mention negative aspects of the system such as “I couldn’t understand some functions” and “It was difficult though this was the first time for me to use the system” (See details in Appendix B). It is natural to think that positive answers that mean the system was easy to use are only “Very easy” and “Easy”. In fact reasons of answers “Very easy” and “Easy” filled with positive comments. Consequently, it seems that the system was not easy for pupils. It is interesting that fewer pupils in Fig.5.1 a) answered easy than the pupils in Fig.5.1 b). In fact, pupils participated in the security map creation was sixth graders, and pupils in the nature observation class was fourth graders. Older children tend to have better comprehension than younger children, but these charts do not reflect the tendency. It is presumed that this difference is generated from the amount of instruction time. The fourth graders could have enough time to learn how to use the tablet PC system in preceding day, but the sixth graders learned the system right before the field study within 20 minutes. The sixth graders are oldest in public elementary schools, so it can be said that 20 minutes was too short for pupils to learn how to use the tablet system.

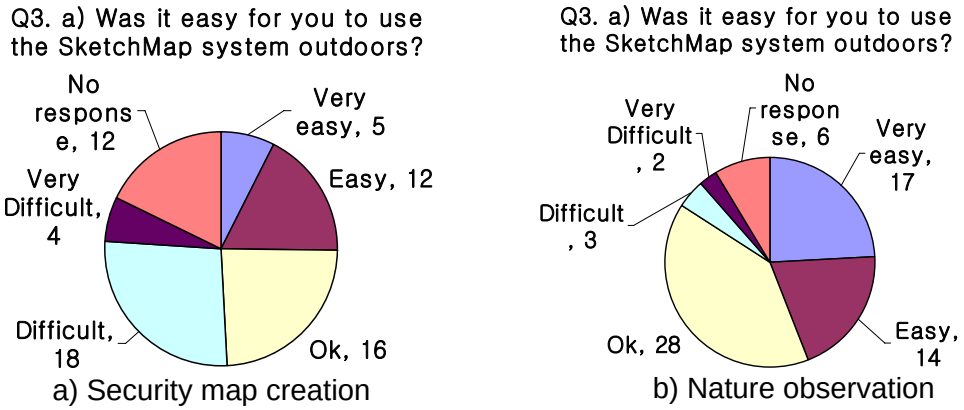
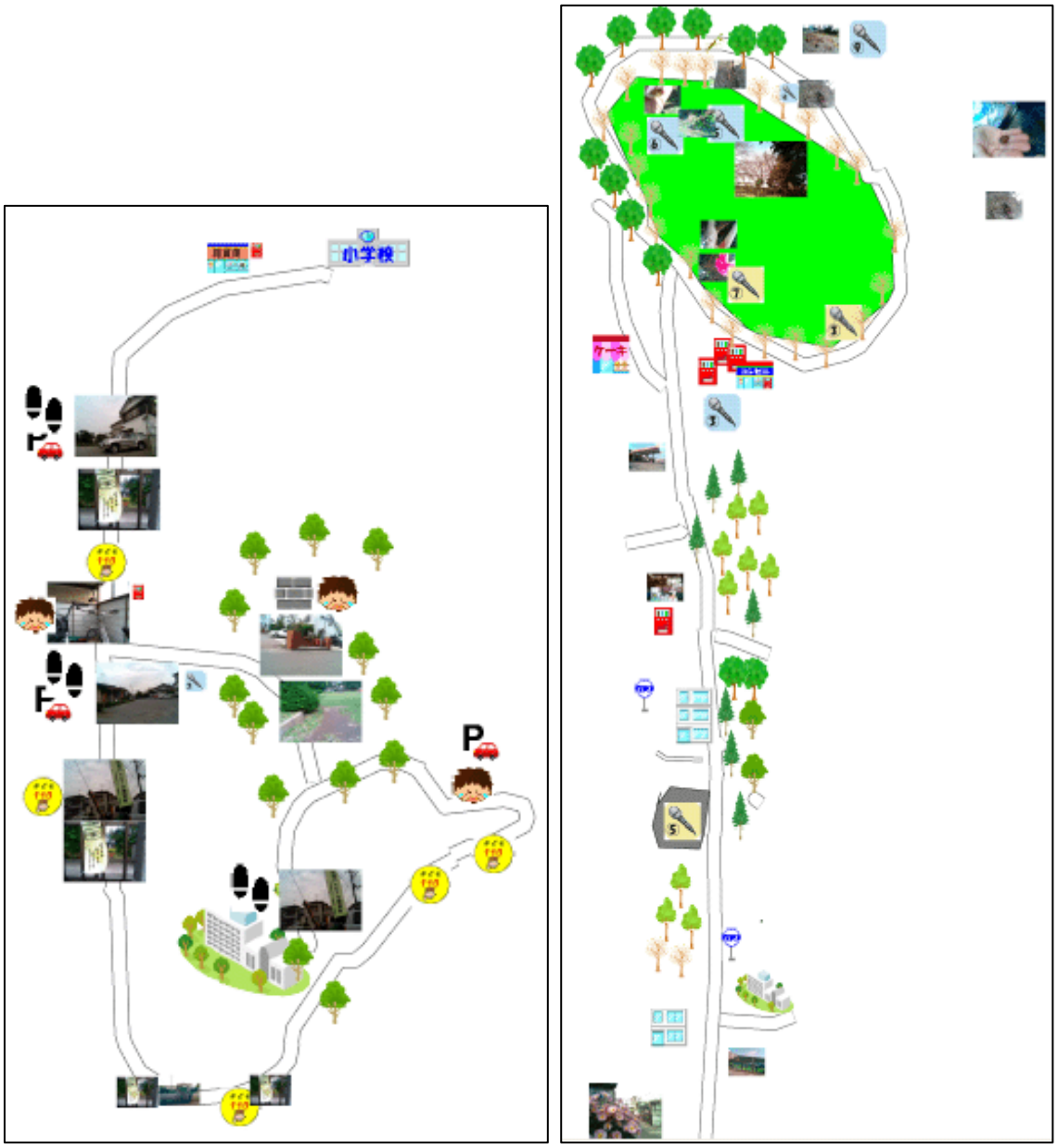


Figure 5.1 Answers to question asked ease of use

The difference of instruction time affected maps they achieved. Fig.5.2 indicates two maps; one was drawn by a group of the sixth graders and the other was drawn by a group of the fourth graders. The streets in the map of the sixth graders are more structured than of the fourth graders, but the scale and the detail of the maps are similar. Although it was anticipated that there would be obvious differences between maps by the sixth graders and maps by the fourth graders, the differences might be averaged by the amount of instruction time.



a) A map made by sixth graders

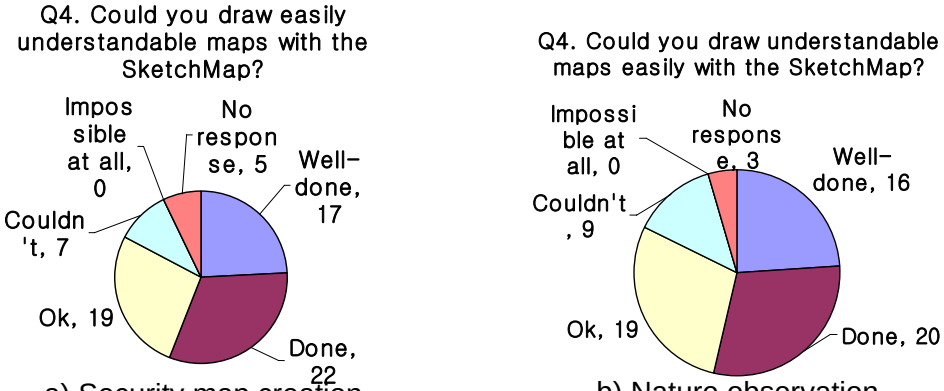
b) A map made by fourth graders

Figure 5.2 Comparison of maps

What made it difficult to learn the system was mainly that the system had too many functions (9 in the sixth grade and 8 in the fourth grade suggested related reasons). It is simply considered that shortage of learning time made pupils impressed that the system had too many functions. Hence, it is better to have longer instruction for the sixth graders before the field study. It is guessed that 45 minutes are maximum amounts for instruction because minimum time span in class schedule in elementary school is 45 minutes. Our study used 45 minutes for instruction to the fourth graders, but the fourth graders could not understand all functions the tablet PC system has. It is needed not only to increase instruction time but also to change the system design from the viewpoints of ease of learning.

5.1.2 Expressiveness

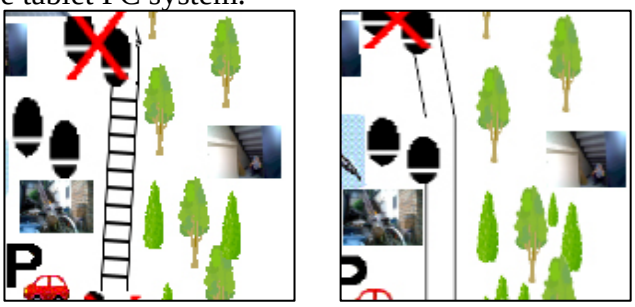
The pupils participated in the user tests only used the tablet PC instead of pencils and papers in order to draw maps, so it is important how rich the expressiveness offered by the system is. As Fig.3.3 showed, the system provides different expressions to pupils instead of mere handwriting. Entirely, it can be said that the pupils were satisfied with the expressiveness provided by the system since majority of the pupils answered that they could draw understandable maps using the SketchMap system (Fig.5.3). According to question 4, 15 out of 67 in the security map creation and 12 out of 70 in the nature observation mentioned goodness of the expressiveness as reasons of their answers. These positive comments mentioned that the stamp-like input of icons and availability of photos and sounds made drawing maps easy and understandable.



a) Security map creation b) Nature observation

Figure 5.3 Answers to question asked satisfaction to expressiveness provided by the system

On the other side of the positive answers, some pupils mentioned flaws of the expressiveness. Outstanding points of flaws were rendering of streets and too dense icons. Fig.5.4 indicates a low quality sample of street rendering in the tablet PC system and in the review web sites. These two drawings indicate same part of a map; left one was drawn by the tablet PC, and other was translated the left one to the SVG format in the web sites. The jaggy street in Fig.5.4 a) did not affect accomplishing the assigned task, drawing a map, at all. But this flaw was not acceptable for the pupils. The web sites developed later than the table PC system hired different kinds of rendering algorithm and occur no jaggy streets. It is necessary to transplant the rendering used in the web sites to the tablet PC system.



a) Tablet PC b) Web site

Figure 5.4 Two rendering of street primitives

One of the groups in the security map creation class drew a map shown in Fig.5.5. This group tried to draw a map finely, and they put many photos in a small area. Bounds of photos are too close, and some are difficult to be identified. It was considered in the design phase of SketchMap whether boundaries of photos should be depicted or not. Since the same photos could be linked together in order to draw something like areas of bush and a bunch of flowers, our group chose photos without lined boundaries; however, there was only one group that did such expressions, linked photos so as to express an area of something. As a practical next step, the boundaries should be ornamented discreetly.

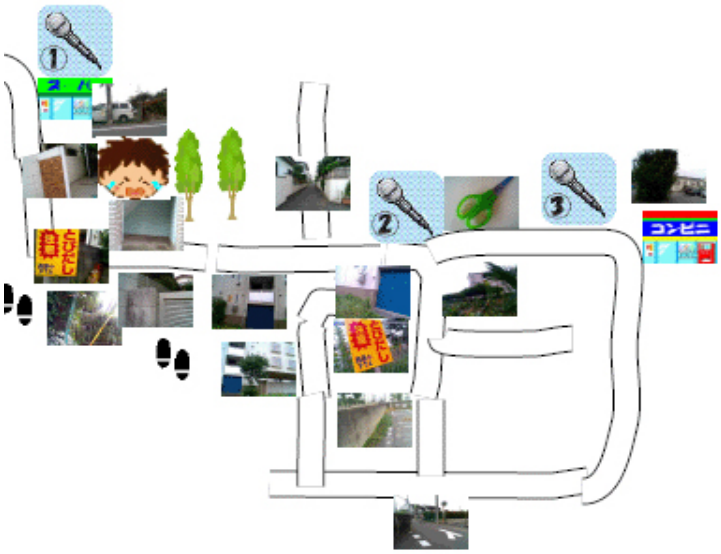


Figure 5.5 A part of a map having crowded pictures

These two flaws are tiny in the maps. However, they highly affected impression of expressiveness provided by the SketchMap system. In real life, the pupils do not need to use this digital technologies, and use pencils and papers. It is necessary for the system to provide pupils richer expressiveness to draw finely than pencils and papers.

5.1.3 Usability of hardware

One of the unpredictable things in the user tests was how the pupils use tablet PCs and cameras connected to the PC in the outdoor environments since PCs are ordinary designed for use indoors and for business and research works. According to the answers of the questionnaire and feedbacks from the school teachers, mismatches of used environments appeared. Comments that the PC was too heavy appeared across sundry questions, and the school teachers also suggested that the PC was heavy even for sixth graders. Consequently, the pupils tended to sit to draw maps (Fig.5.6 a)). During the field studies some pupils said that it was too bright to see the screen. So they tried to shade the screen with his body (Fig.5.6 b)). Moreover, members surrounded the pupil having the PC in order to look on the drawing map (Fig.5.6 c)). Sometimes the surrounding was made to shade the screen. These behaviors stem from technological attributes of the tablet PC. If the tablet PC is lighter and the screen has wider view angles, the field studies using the tablet PC will be comfortable; however, our group cannot do anything to improve these technological attributes.

a) Drawing maps while sitting

b) A pupil shading the screen

c) Pupils surrounding the tablet PC

Figure 5.6 Behaviors of pupils in the field studies

Although a web camera attached the tablet PC enabled pupils to use multimedia as their expression, the camera caused other problems. When they took a photo, a cartographer had the tablet PC and a photographer held the web camera like Fig.5.7. So the photographer cannot see what the camera is capturing, and tried to communicate the cartographer how the camera should be tilted. It took time to take one photo because of this communication. Additionally, the photographer sometimes tends to walk as he or she likes without concern for what the cartographer having the tablet PC was doing. Fig.5.8 shows one of such situations. A photographer holding the web camera in the left of Fig.5.8 moves as she likes while cartographers are checking their maps. And the school teacher on the right of the figure is trying to avoid making the camera disconnected. If the web camera is disconnected from the tablet PC, they need supports of student volunteers since the function of making photo icons is suspended even if the pupils connect the web camera with the tablet PC again.

Figure 5.7 Pupils taking a photo

Figure 5.8 Stretched code of the web camera

As Fig.5.7 and 5.8 indicate, it was not convenient for pupils to separate roles of taking photos. Our study has ever considered to separate the web camera from the tablet PC and to connect them with wireless connections. However, it was expected that the manipulation of making photo, movie, and sound icons became difficult for the pupils since there would be a function of transmitting photo data and a function of converting photos into icons. It was also considered that the wireless communication might not be stable in the outdoor environment. Based on these concerns, our study decided to hire a wired web camera. However, ideally wireless camera is preferred in the outdoor environment.

5.1.4 Validity of interaction methods

The software design used a metaphor of painting kits worked well partly. According to the school teacher, the pupils started immediately to draw their map at the beginning of the field study. It can be said that the single input method, drawing after users touch one of the primitives on the palette, was accepted successfully by the pupils. However, modifying and reviewing the maps had some difficulties for the pupils. In comments to the question 3 b) asked easiness after they came back to school, 7 in the security map creation and 5 in the nature observation mentioned difficulties of modification and reviewing; for instance, the canvas became white when the pupils moved scroll bars of the canvas a little and lost canvas orientation, and the system made the pupils tired to modify what they drew. In particular the difficulties of the interaction were appeared as Fig.5.9 shows. Boy 1 pointed out Boy 2’s mistake, and Boy 2 struggled to modify the mistake. While they concentrated on the modification, a car suddenly appeared and Teacher 1 prompted the boys to make space. This dialogue is highly undesirable for the pupils. The system is used in the outdoor environment. The outdoor environment

changes more drastically than the indoor environment as changes happened in Fig.5.9. So, the system should not keep the pupils' attentions long except for essential works.

Boy 1: Hey, you did mess again.

Boy 2: Oops, I did it again.

Boy 2: Add a color, it's Ok.

Boy 2: Hmm, ok, I delete it.

Boy 2: Is it ok to just connect them? ... Oops,

Teacher 1: Can you open your space? A car is going through there.

Figure 5.9 inactive interaction of drawing map

Although in chapter 5.1.2 expressiveness of streets was discussed, another difficulty of drawing streets was found in footages. Adding icons were easy for the pupils while walking since it was needed to do like stamping. So, the pupils naturally tried to draw streets while walking as Fig.5.10 shows. There is no flat surface beneath the tablet PC, so it must be difficult to draw clear lines. In answers to the questionnaire asked advices to their friends who may have the same class (Q.10), some pupils answered that stop walking when you draw icons and streets. It may be implied that they were in a hurry since their time for the field study was being consumed by some reasons. The reasons may contain taking photos or extent of assigned area; however, what the system can do for them is only reducing their tasks to draw a map. It would be necessary to improve the design of interaction the SketchMap system provided based on the consuming time.

Figure 5.10 Drawing maps while walking

5.2 Seamless Learning Integration

Second requirement to the SketchMap system is to integrate seamlessly learning occurred between outdoors and indoors. The system could realize to shorten the class but it might also generate adverse effects. The effect generated by dispensing with rewriting a big map as ordinary security map creation classes do is discussed in this chapter. If the shortened class did not affect learning of the pupils, it can be said that the system could realized to integrate seamlessly two kinds of learning. In summary, it can be mentioned that our system did not disturb learning of the pupils by shortening the class schedules. In the following chapters, reasons why the system did not disturb learning are argued respectively.

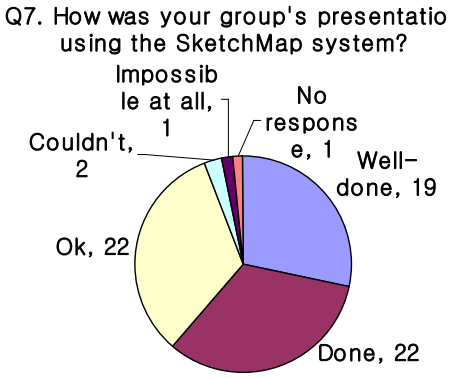
5.2.1 Presenting achievements

The presentation session of achievements is important for the pupils in order to reflect on what they learned during the field study and to share the knowledge among the classmates. As the system shortened the interspaces from the field study to the presentation, it is concerned the quality of the presentation.

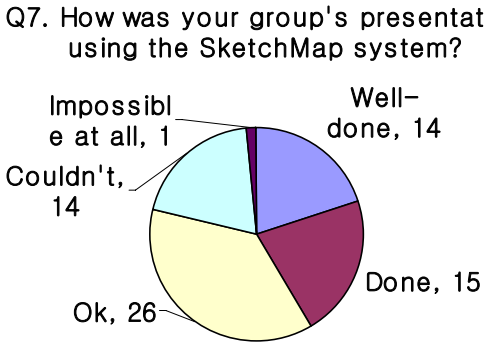
Fig.5.11 indicates answers to the question asked satisfactions to their own presentations. Although it is not feasible to verify objectively whether the presentations succeeded or not, the pupils in the security map creation could do better presentation as long as seeing Fig.5.11. Hence, here is discussed what factors made the difference between these two user tests.

In fact, 40 minutes for the security map creation and 20 minutes for the nature observation were assigned to prepare for the presentation. Moreover, the security map creation class had lunch break before the preparation. Some groups were working spontaneously during the lunch break. So, the pupils in the security map creation could have substantially more than 40 minutes for the preparation. But among the comments to the question 7, the number of comments that mentioned lacks of preparation was almost same; 4 sixth graders in the security map creation and 6 fourth graders in the nature observation. Their skills of presentation were also different. It is supposed that elder pupils tend to have better presentation skills than younger pupils. Outstanding common reasons in the both classes were about their skills of presentation, such as their voices were low and they couldn't say fluently. These dissatisfactions stem from immatureness of their presentation skills. Both the sixth graders and the fourth graders felt lacks of presentation skills likewise. Unique difference between them was the number of answers "Couldn't". The fourth graders who answered "Couldn't" pointed out that they could not divide tasks of presentation successfully and they failed their presentation. From these comments it can be mentioned that the fourth graders did not have enough experience to prepare for presentations. In fact, facial expressions of the fourth graders seemed more nervous than the sixth graders. It is supposed that the nervousness stemmed from lacks of time for preparation. Due to the lacks of their experiences for preparing presentations, it is estimated that at least 40 minutes are needed for preparation of presentations.

There were no comments on the system in the presentation session. It can be said that the system could shorten the class successfully without disturbing their learning especially in the security map creation class. However, there is one concern that the pupils did not manipulate PCs during the presentation. As Fig.5.12 shows, all members of a group stood on stage and a student volunteer was manipulating the PC in the lower middle of the figure. If pupils also manipulated the PC, it would take more time, need instructions how to present their maps with the PC, and make the pupils less satisfied with qualities of their own presentation, considering low computer literacy of the pupils.



a) Security map creation



b) Nature observation

Figure 5.11 Subjective satisfaction to their own presentation

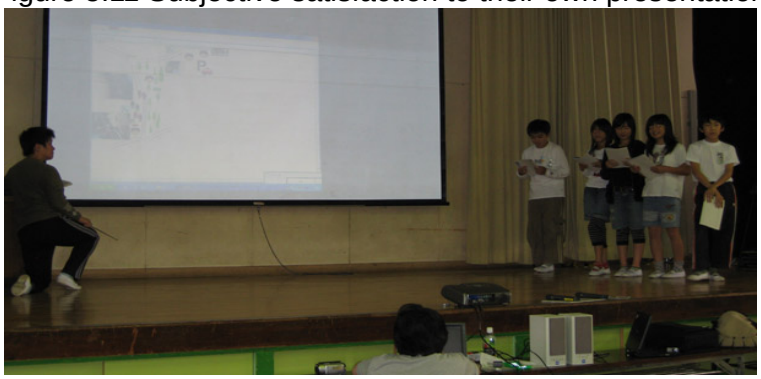
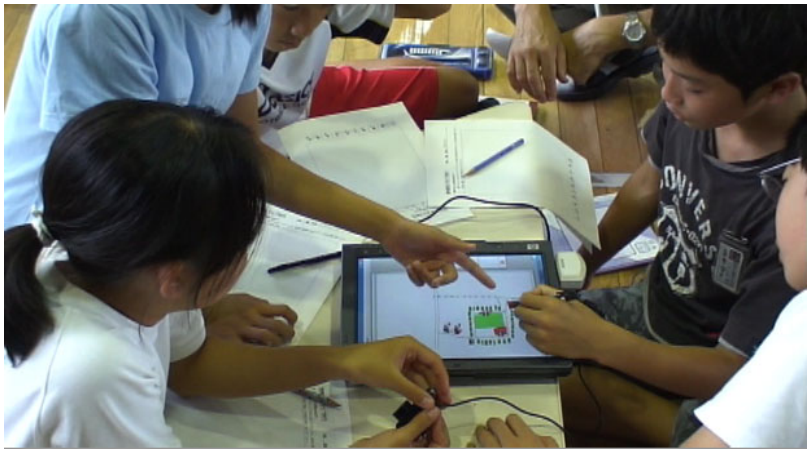


Figure 5.12 Presentation of a group in the Security Map Creation

5.2.2 Commitment to discussion

The SketchMap system provided completely different kinds of representations to draw their maps. It is concerned that the difference affects the quality of discussion about what they did during the field study after they go back to school. Here are two transcripts of discussions by the pupils. In Fig.5.13 pupils were preparing for the presentation. Boy 2 was playing with the digital pen but the teacher urged the pupils to discuss their field study. Then, the pupils started to discuss specific places. The system got the pupils' attention and hindered discussion. However, after the boy 2 stopped playing with the system, the group immediately started discussion. During the discussion the pupils used demonstrative pronouns a lot. It means that their discussion was based on the map generated by the system, and the map successfully could be a medium to share contextual information. If the map did not convey any contextual information, the pupils would have to explain places around their findings and demonstrative pronouns such as this and that would not be used during the discussion.



Boy 1: Hey!

Boy 2: (He enlarges a photo icon.)

Teacher 1: Hey, memorize rapidly what you have been discussed otherwise...

Girl 1: Let me do that. (She asked to Boy 2)

Boy 2: (He ignored Girl 1 and kept using the pen.)

Boy 2: Interesting!

Boy 1: Don't act up!! (said to Boy 2)

Boy 2: Here, whatsit, whatsit, so…. It was an agricultural cooperative around here. Then after we turned this corner, you started saying it's dangerous around there though I couldn't understand, didn't you?

Boy 3: There was a Mercedes around there, Mercedes!

Boy 2: The Mercedes was around here. It' s little bit further from here. Did you remember why there was dangerous?

Girl 1: The place was difficult to be seen from outsides, and...

Figure 5.13 One discussion and its situation

In another conversation as Fig.5.14 indicates, pupils sometimes forgot how the place was. During the field study the system was only one tool for memorizing. The frustration stemmed from forgetting might cause the short friction between them (Boy 1 and Girl 1). In order to memorize how the place was, our study assumed that voice recording and photos could be instead of text memos. However, the groups used multimedia functions for just memorizing were few. If ways of memos taken by the multimedia functions are introduced in the instruction session before the field study, they might not forget how the places were. In summary, the map generated by the system could fill a role as a medium during the discussion, but sometimes the system attracts pupils' attention and hinders their discussion, and the contents having the map were sometimes not enough to hold deep discussions.

Boy 1: Lots of illegal parking! Lots of parking fields!

Boy 2: What dangerous was this?

Boy 1: What was it? You, two, found this, didn't you? (pointing at Girl 1)

Girl 1: Huh, uh··· Draw our map cleaner and more visible if you say so.

Boy 1: What the hell is that!?

Girl 1: Do more...

Boy 1: This house is Nakamura's.

Girl 1: Is this car park, isn't it?

Girl 2: Oh! It may be there, next to the second park, near that gravel road...

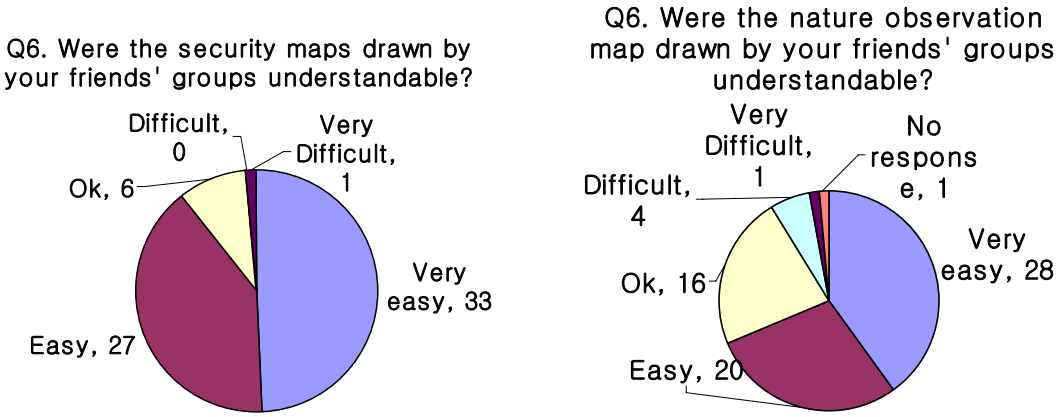
Figure 5.14 Another Discussion

However, from our points of views it is impossible to judge whether these discussions were valuable compared to their usual discussions in their ordinary class schedule. According to one school teacher, the system could support pupils' understanding and summarization of findings through making the pupils combining findings with places on site. This comment reflects that the system could successfully provide a means of summarizing data on site, and could support to start discussion smoothly after the pupils came back to school.

5.2.3 Multimedia for sharing information

Another aspect of integration between outdoor study and indoor study is to make it easy to understand what other groups had done during the field studies. Aforementioned chapters focused on efficacy of sharing knowledge within one group. Here the relationship between achievements made by one group and comprehension of the other groups is discussed. According to the answers to the question asked comprehension of others' presentation (Fig.5.15), majority of the pupils answered that others' presentations were easy to understand. Main comments why they answered so mentioned multimedia representations such as photos and icons helped their understanding of others' maps. A merit of the multimedia was referred also in feedbacks from the school teachers. One teacher commented in the security map creation class that one of the groups interviewed a local, and the local told that he would help the pupils when they faced any accident around his house because windows of his house were kept open and he could be aware of emergent signs outside. The comment by the local sounded reliable for the teacher because the class focused mainly on dangerous places, but the interview noticed them that there was a safe place supervised by locals in their community. The school teacher also added that if the pupils rephrased the local's comment, the comment would lose the reliability. Consequently, in comments to the question asked their favorites during the class, 8 pupils in the security map creation answered that the class was valuable because they could also know more about other places in other groups' presentations. Based on these facts, it can be mentioned that the multimedia representations assisted to share viewpoints of respective groups within the

class, and the presentation as an opportunity of sharing achievements was successful as reflections of the field studies.



a) Security map creation b) Nature observation

Figure 5.15 Easiness of comprehension of others' presentation

5.3 Sharing Achievements

This chapter mainly focuses on sharing achievements via web sites introduced in Chapter 3.3. Although the sharing knowledge within the class was discussed in Chapter 5.2, sharing in this chapter occurred after either in the class or at their homes. Frankly speaking, through the user tests, the web sites for reviewing their achievements did not work as we expected; however, the school teachers were pleased with the feasibility and the design of the web sites. Mainly two concerns were considered as the reasons from practical and technical points.

5.3.1 Reviewing in the practical situation

In our scenario of introducing the web sites, our study assumed that if the pupils were noticed that they can see their maps on WWW, they would visit the sites spontaneously since it was revealed in our preliminary study that 87% of pupils in the fourth grade have a computer at their home and some of them commented that they liked to use it. Hence, our study has tried to notice only the URL to the pupils. However, the school teacher inspired from the web sites that the web sites could be used as a tool for the reviewing class of the security map creation, and held one school hour for reviewing the class in a room equipped desktop computers at the school.

In order to use the web site a plug-in of Internet Explorer called Adobe SVG Viewer was essential. But the school facility of the room equipped desktop computers hindered to use the web sites since the facility basically prohibited installing new software to the computers so as to keep its security. In fact, pupils can install any new software to the computer and change the setting, but the new software is deleted and the changes restored when the computer is rebooted. The school teacher told us disappointedly that it was cumbersome to reinstall the plug-in every time when they saw the maps in the school facility. The school teacher tried to use the web sites beyond the cumbersome installation, but she faced another problem. The web sites were using Ajax in order to produce interactivity, but the Ajax did not work well in the school facility.

Asynchronous loading data of Ajax cannot be detected by ordinary web browser settings since web browsers tend to cache data of web sites users have visited and when users visit the web site again, the web browser loads the data from its cache, not from the server containing the data. In case of the web sites for reviewing the maps, user cannot see changes or addition as long as the web browser loads data from its cache. Although our study grasped this problem in advance and made a troubleshooting page to support to change settings of the web browser and to see the changes of comments successfully, our treatment was poor to the practical educational setting. To change the settings of web browsers was also cumbersome for the school teacher and was impossible for the pupils. Therefore, the web sites did not work well in the class for reviewing. However, the school teacher collected annotations like how places were from the pupils participated in the review class, and added them later from a computer which belongs to the teacher and can manipulate the web sites correctly.

Consequently, only a few pupils who noticed the URL of the web sites visited there according to our access log analysis and any indicators of discussion between pupils and their parents were not acknowledged. However, the tendency that the school teacher used the system aggressively can imply that the design of the reviewing web sites could reflect their requirements well and can be improved further.

5.3.2 Technical problems in the field studies

It is crucial for sharing achievement how precise the logs such as location information obtained by GPS were. The log system regarding drawings was stable enough against the pupils' uses of the tablet PC, but GPS was not. In the preliminary study it was ascertained that some signals from the PC interfere the operation of GPS. In order to avoid these matters our system hired GPS antenna and the body of GPS was adhered with a piece of vinyl tape. In the introduction of our system in Fig.3.2 the GPS antenna was stored in a small bag, but the antenna was attached son the shoulder cushion of the tablet PC bag so as to make carrying the system simpler (Fig.5.16).

Fig.5.16 Position of GPS antenna

In the user tests the SketchMap system was used by 28 groups, but only 5 of 12 groups in the security map creation and 9 of 17 groups in the nature observation could obtain some location information by GPS. The field did not contain any tall buildings and most blockers of signals for GPS were two-storied buildings as Fig.5.17 shows. This environment seemed tolerable to the signals of GPS. However, only half of groups could obtain some location information. Sensitivity of GPS was worse than we expected since GPS got the first information in around five minutes and kept obtaining it when our system was tested the GPS sensitivity near the field by us. One reason of hindering GPS operations was blocking signals by buildings, and another was unplugged bodies of GPS from the tablet PC. This situation was recognized in a few groups in the security map creation class, and the body of GPS was held to the tablet PC tightly with Scotch

tape in the nature observation classes so as to avoid being withdrawn the body of GPS from the tablet PC. The GPS data was obtained when the pupils drew and modified something on their map. Compared to Table 5.2, ratios of taking location information in Table 5.1 was higher, and the start-up time, which is interval from the first attempt to the first acquisition of GPS data, was much earlier on an average. The difference may originate from difference of assigned tasks. The pupils in the security map creation tended to walk along streets, but the pupils in the nature observation went to narrow spaces and edges of parks and might covered the GPS antenna by their body. In fact, the pupils seemed not to care of the GPS antenna, and concentrated on assigned studies in both classes. In order to make GPS works better, it may be effective to ask them to keep caring of GPS during the field study, but to do so is out of their activities, and is not suitable for practical educational settings. The results of the sensitivity of GPS were not good from technical points of view. However, these numerals reflect real performance of GPS used by the pupils. In order to improve the performance more sensors may be needed as well as automotive navigation systems have assistant sensors such as accelerometers to obtain stable and accurate location information.

Figure 5.17 A look of the field

Table 5.1 Sensitivity of GPS in the Security Map Creation class

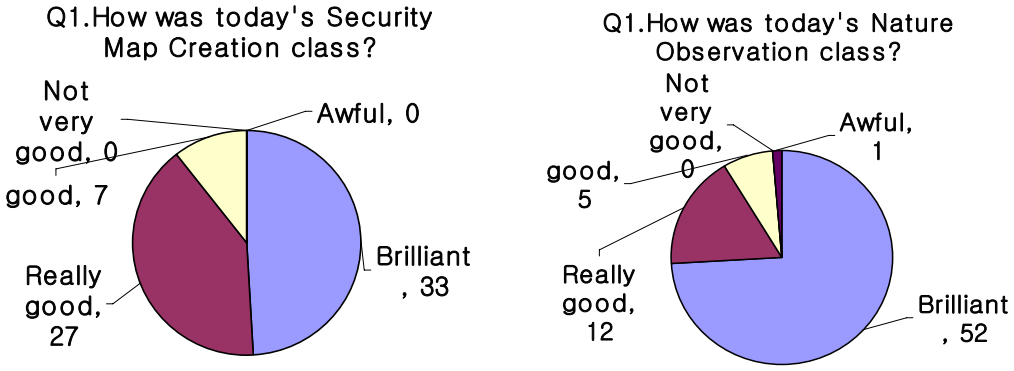
Group	Attempt	Obtained	Missed	Ratio	Start-up time
1	126	43	83	0.341	0:18:13
2	134	117	17	0.873	0:04:45
3	70	54	16	0.771	0:02:07
4	144	112	32	0.778	0:04:13
5	101	84	17	0.832	0:03:09
Average				0.719	0:06:29

Table 5.2 Sensitivity of GPS in the nature observation class

Group Num.	Attempt	Obtained	Missed	Ratio	Start-up time
1	91	45	46	0.495	0:43:27
2	200	69	131	0.345	0:34:15
3	94	62	32	0.660	0:24:18
4	361	131	230	0.363	0:20:47
5	63	47	16	0.746	0:07:02
6	113	84	29	0.743	0:13:36
7	130	32	98	0.246	0:28:55
8	123	68	55	0.553	0:18:48
9	90	21	69	0.233	0:26:37
Average				0.487	0:24:12

5.4 Learning Experience

Although the merits and the flaws of the SketchMap systems were discussed in aforementioned chapters, holistic views to these classes used the systems are meaningful for the system in order to evaluate its validity in the practical educational settings. According to the answers to the questions asked impression about the class, more than three fourths of the pupils mentioned something positive in the class (Fig.5.18). The pupils commented such as they could learn well the study target and they could cooperate with their group members. These comments reveal that learning experiences provided by the field studies were rewarding for the pupils.



a) Security map creation b) Nature observation

Figure 5.18 Impressions to the classes

Answers in Fig.5.18 contains various aspects of the field studies because of ambiguous focus of the question, but in the question asked contributions of the SketchMap system to the field studies, it was revealed that the system could contribute the learning experience of the field studies. Fig.5.19 indicates that more than three fourths of the pupils enjoyed using the system though specific parts of the system made the pupils difficult to use the system as we discussed in Chapter 5.1. It was indicated that the pupils simply enjoyed the various functions the system provided.

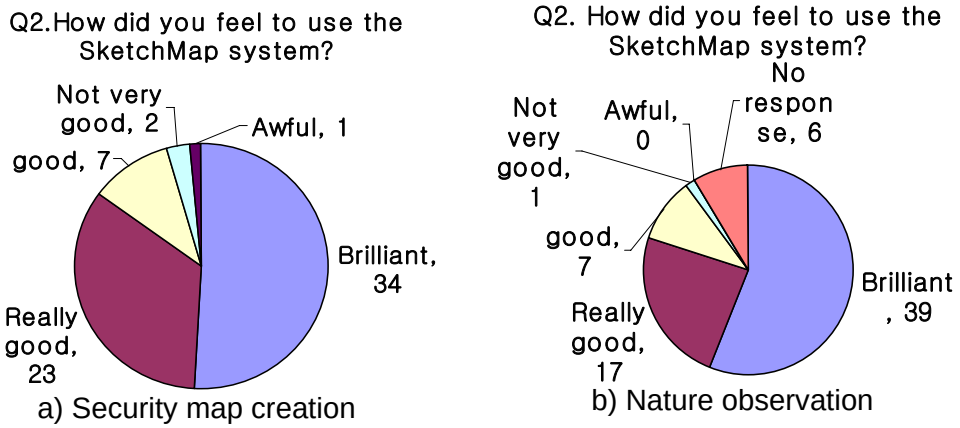


Figure 5.19 Impressions to the SketchMap system

One of the situations they enjoyed the functions was shown in Fig.5.20. They were trying to take a photo of a place where strangers might hide. The pupils investigated the place by themselves and seem to enjoy the investigation. Aggressive participations of the pupils to the field study were revealed in this situation. It is conceivable that the expression of maps used photos enhanced their engagement to the activities since the photos were transformed immediately after they took them and it was easy to understand interesting photos made their map more interesting.

(They were taking a photo that a pupil hided behind a fence of a bicycle shed.)

Boy 2: Well, take below my face.

Boy 1: Let's take a picture from below your face.

Boy 2: That's right, OK? Yeah, from below my face...

Girl 1: But, do this seem a suspicious person? This looks usual, isn't it?

Girl 2: Hahaha (Girl 2 is laughing.)

Boy 2: Take a picture, soon!

Boy 1: (Taking a picture of the scene with Boy 2)

Boy 1: Be a model when we take pictures.

Figure 5.20 A scene the pupils were taking a photo

It is also conceivable that the pupils always study aggressively in other classes as well as the field studies. However, according to the school teachers, the field studies could be a nice opportunity to plant consciousness of safeness and observing nature. Additionally, the class teacher said that some pupils who usually do not say his/her opinion and are reluctant to participate in discussions in class could present their achievements well and the class seemed beneficial for the pupils. Learning which might contribute to foster their consciousness was appeared in discussion during the field study. Fig.5.21 shows one discussion in the security map creation class during the field study. Girl 1 and Boy 2 indicated that the area was dangerous, but Boy 1 inquired the reason of their opinions and explained why the place was not dangerous. Through this discussion, Girl 1 and Boy 2 could learn thought of Boy 1 and improve their understanding to the potentially dangerous places. Although the system did not contribute to the discussion, it is conceivable that the pupils could discuss well even if the system was there. To say this is to be expected, but it is important that the discussion was occurred successfully since the discussion indicated that the SketchMap system was unobtrusive for their learning.

Girl 1: Draw, it is dangerous area here.

Boy 1: Why?

Boy 2: Because, in here...

Girl 1: I just thought so.

Boy 1: Don't decide without grounds.

Girl 1: No, because, something... (She cannot give a reason soon.)

Boy 2: We can enter here. (holding up a blue sheet covering some garbages.)

Boy 1: No, because here is easy to be seen by someone and difficult to enter there. The sheet separates the space strictly and everyone can walk around here.

Boy 2: Well, all right.

Figure 5.21 A discussion in the field study

Consequently, the SketchMap system could provide novel and worthy learning experiences in the field study and the worth of learning could satisfy demands of the school teachers to some extent. Although the system has small flaws, the pupils and the school teachers showed positive impressions to learning experiences provided by the SketchMap system.

6 Conclusion

Through the SketchMap project, we designed a system, which consists of three components, a tablet PC, a backend data summarization system, and web sites for reviewing, based on requirements from the practical situations in primary education. Through the user tests in two kinds of classes having field study, the SketchMap system could fulfill parts of requirements. The user tests revealed lots of flaws regarding both hardware and software of the system. Considering the use of the novel technologies in the outdoor environment, lots of improvements should be incorporated in the system.

- Easiness of learning how to use the tablet PC system, expressiveness of the digital pen, and validity of interaction were treated distinctly in Chapter 5.1, however, these three factors are interrelated. If the system becomes easy to learn, the expressiveness may be poor because of limited manipulations to reduce things to learn. These factors should be improved since whether the pupils keep using the system spontaneously afterward or not depends on comfortableness and fun of using the system. These impressions may affect whether the reviewing system can be used frequently by the pupils or not. Hence, through more practical user studies the tablet PC system should be improved since pupils' expectations to a kind of the drawing system vary greatly [27] and the outdoor environment has various factors that affect pupils' behaviors.

- Problems stemmed from hardware are difficult to be fundamentally solved. There are other candidates such as PDA and cell phone instead of the tablet PCs, but others can not become constructive solutions since mobile technologies have limited interface to input and small screens are not suitable for pupils to draw something. It is desirable to devise somehow to reduce feelings of heaviness and to avoid making the cable of web camera disconnected.

- Stability of data acquired by GPS sustains quality of reviewing achievements. The ratio of the obtaining location information in the user tests was not acceptable for purpose of practical education. It is conceivable to add new devices to specify locations of the pupils. However, the remedial measures must be unobtrusive to the activities of the pupils in the outdoor environment. It is another remedy to enable pupils to rearrange location information on the web sites for reviewing. But the manipulation of arrangement should be intuitive and need another system.

- The essential activities to reflect what the pupils did during the field studies such as discussion and presentation were succeeded. One of the reasons that sustained discussion among the pupils and their presentation was multimedia expression provided by the tablet PC system. Multimedia supported to share context of respective findings of each group and satisfied appetite for understanding achievements of other groups. And supports by the system did not disturb their radical capability of discussion and presentation.

- It is considered that the rewarding discussion and presentation and pleasure of using the system made learning experience provided by the SketchMap system

attractive not only for pupils but also for school teachers. Satisfaction to the system was revealed briefly on questions asked impression to the system in Fig.5.18 and 5.19.

Through the practical evaluation of SketchMap, our study realized to attract and motivate pupils and school teachers to utilize the SketchMap system practically in their classes. It means that only the first part of envisioned scenario of SketchMap was realized. So far, what the system succeeded essentially is replacement of means of field studies in practical educational settings. The benefit of transforming physical data written by pens into digital expression was to assist discussion of the pupils, but another benefit is located beyond the replacement. The web sites for reviewing achievements are one of the benefits although the web sites did not work practically because of technical and practical problems as mentioned in Chapter 5.3. Digital data easily goes across physical distances. After the achievements are transformed into digital expression, stakeholders such as parents can join the worth field studies for the first time. Therefore, one of the challenges given as future recommendations is to redesign the web sites to make them available in the practical educational settings. It can be considered to make interaction of the web sites static only using HTML. The static web sites would have capability to share achievements even in the facility of the elementary school, but it would not be attractive for pupils. As Norman suggested [30], emotional aspects of products are important to make the product a success. Interactivity of the web sites can contribute to attract pupils. Therefore, the existing web sites should keep hiring Ajax and improve the technical flaws or use other techniques to produce interactivity such as Adobe Flex [31].

While the SketchMap system were not matured enough and still had lots of improvements, it can be considered that at least one direction how to provide richer learning experience with novel technologies to primary education and a candidate of additional values produced by transforming achievements into digital expression were revealed through this study. In order to realize the entire scenario envisioned by the SketchMap system and to sort out unrevealed problems around the sharing achievements, it is necessary to hold practical user tests iteratively and conduct another sort of study involving stakeholders.

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Appendix A: Questionnaires delivered in the user tests

Here is a sample of questionnaire used in the user tests so as to obtain feedbacks from pupils. Although original questionnaires are written in Japanese, the following questionnaire is translated in English. In fact, we prepared same formats of questionnaire for the user tests. The difference of the questionnaires between for the Security Map Creation class and the Nature Observation class is only the part of the class name used in the questionnaire.

Questionnaire for right after the class

Group Num.( ) Class Num.( ) Personal Num.( )

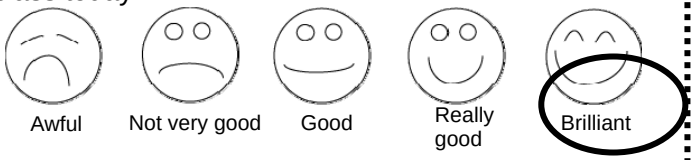
Name:( )(Boy ・ Girl)

Role in your group ( )

How was the class of the Security Map Creation class today? Please tell us how you felt about today's sduty.

This is not a paper test, so write your honest comments as you like. Fill reasons wherever you can write. Questions are 13 in all.

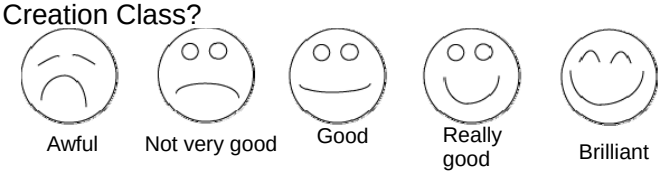
Example. How was the gymnastics class today?



Why?

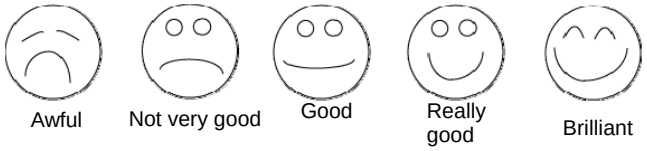
Could play football, and got a goal!!

1. How was today's Security Map Creation Class?



Why?

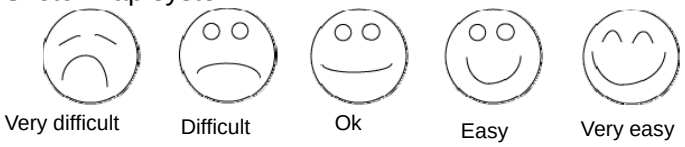
2. How did you feel to use the SketchMap system?



Why?

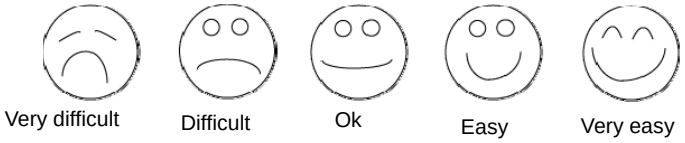
3. Was it easy for you to use the SketchMap system?

Outdoors:



Why?

In school:



Why?

4. Could you draw easily understandable maps with the SketchMap?

Why?

5. Could you draw the potentially dangerous places on your map in an understandable way?

Why?

6. Were the security maps drawn by your friends' groups understandable?

Why?

7. How was your group's presentation using the SketchMap system?

Why?

8. Tell us your favorite up to 3 items in today's study.

9. Tell us what you would like to do if you have a same study again?

10. Give advices to your friends who may have the same class as well as today's security map creation class later.

11. Tell us what functions are preferable newly and unnecessary among the functions of the SketchMap system.

Preferable functions

Unnecessary functions

12. Suggest tools which you didn't use today, but are necessary in order to draw better the security map.

13. Any feedbacks are welcome if you have more!!

That's all. Thank you for your cooperation.

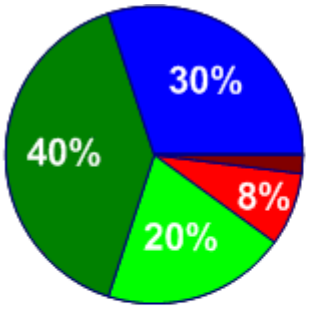
Cut here

Visit the web site below. You can review your today's achievements from your home. Your achievements are going to be available from DD/MM/YYYY.

http://www.itl.t.u-tokyo.ac.jp/~enjoji/sketchmap/yymmdd/

Appendix B: Detail of questionnaire answers

Here are details of the pupils' answers to our questionnaires in each use test. The charts consist simply of the number of answers on the grades, but the reasons were grouped by with similar topics. The grouping was done based on contents and implication of the description, and locations of each square are based on similarity of topics among them. Original descriptions in Japanese were translated in English for convenience's sake. Although the reasons displayed in the following pages are not structured well, it is considered that the more we summarize them the less readers get context of the user tests. The pupils gave us their candid opinions. We kept them as much as possible.



Each chart indicates the number of each grade of multiple choice questions

Brilliant

Titles grouping which grade the reason belong

The number of pupils answered reasons related topic below

[5] Lines like drawn by pencils

Reasons pupils have answered

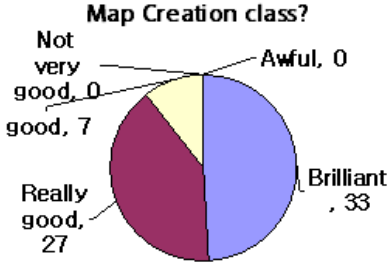
Irrelevant answers

Areas colored gray indicate a group of answers mentioned in the body of this thesis

Security Map Creation

Answers to Question 1

Q1.How was today's Security Map Creation class?



Brilliant

- [11] Could understand safe and dangerous places
- [4] Could cooperate with my group members
- [1] Could use a brilliant computer
- [2] Could do together with student volunteers
- [3] Successful presentation of interviews to locals
- [2] Fun to walk around with group members
- [2] Could get coupons at local pharmacy
- [2] Could draw a map by myself
- [1] Could enjoyed studying
- [2] Could understand differences between our viewpoints and others after the presentation.
- [1] It was the first time

Really good

- [9] Could walk around and see various dangerous places
- [4] Could cooperate with my group members
- [5] Could use computer having various functions
- [3] Could learn various things
- [2] Fun to walk around with members and take photos.
- [2] Could draw a map by ourselves

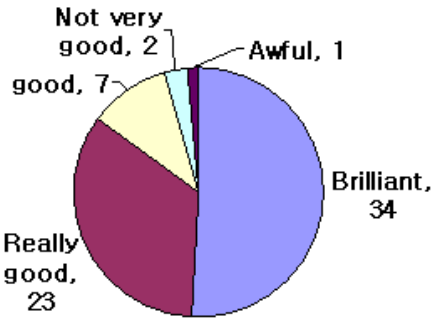
Good

- [4] Squabbled
- [1] Could interview
- [1] The class was similar with ordinary field trip classes
- [1] The computer was heavy and my hands hurt

Security Map Creation

Answers to question 2

Q2.How did you feel to use the SketchMap system?



Brilliant

[5] Nice and easy to use

[2] Could touch with the digital pen

[3] It was the first experience to use the machine

[1] Could draw a nice map

[3] Interesting to use various functions

[1] Could take photos

[1] Could draw kinds of streets

[1] Could draw a map by myself

[8] First struggled to use because I didn't't know the usage, but finally I could manage

[3] Student volunteers taught us hot to use functions we cannot understand.

[1] It was delightful to walk around to find out various dangerous and safe places together with my group

[1] It was good experience because I understood dangerous places aflesh

Really good

[3] Very easy to use the system

[3] Could do various things easily

[1] It was pen instead of mouse

[1] Could enjoyed with colors and icons

[3] Easy to make buildings and streets with stamp-like operations

[1] Enjoyed to do field study while checking maps

[2] It was the first experience

[1] I thought it was great.

[3] Could use a PC and understood its usage.

[3] Glad to have made our maps

[1] Could finished though we mistook a little

[2] I haven't use it.

[1] Difficult to use the computer.

Good

[3] It was tough because the PC was heavy and difficult to use.

[1] Understood where are dangerous

Not very good

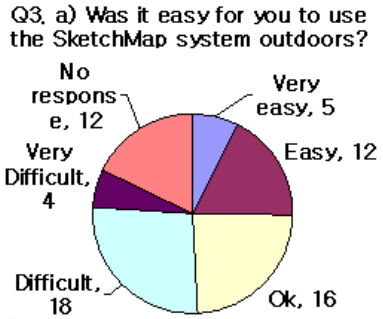
[2] Heavy and couldn't understand its usage

Awful

[1] I haven't use it.

Security Map Creation

Answers to questions 3 a)



Very easy

[1] It was easy because I was taught how to use it first.

[1] I'm good at manipulate machines.

[2] Easy to use even when I was walking

[1] Could sling strings of the PC bag

Easy

[5] Easy because what we do is only touching.

[1] Enjoyed because our work went smoothly

[2] Could get used to manipulate it finally

[1] It was difficult to insert trees and buildings.

[1] Looked delightful to use it.

[1] Demanding to draw lines

Ok

[1] Could draw streets by ourselves

[1] It became easy because we used it a lot.

Irrelevant answers

[5] I haven't manipulated it.

[1] Could see kinds of places

[1] It was too heavy to sit so as to manipulate the pen well.

[5] Difficult though it was the first time.

[2] It was difficult to use the pen while walking and standing.

Difficult to draw streets

[4] Difficult to draw streets and lines.

Too many functions

Difficult

[2] Sometimes marks did not disappear when we pressed "Delete".

[2] It was tough because strange screens were suddenly appeared.

[1] Because it was the first time.

[1] There were too many functions to understand

[1] The map looked messy.

[1] Couldn't understand what the camera was capturing.

[1] It was invisible because of light reflections.

[1] I couldn't infer manipulations more than what I was taught.

[1] Couldn't understand its manipulation

[2] Heavy and made my arms tired.

Very difficult

[1] It was hard to start it up.

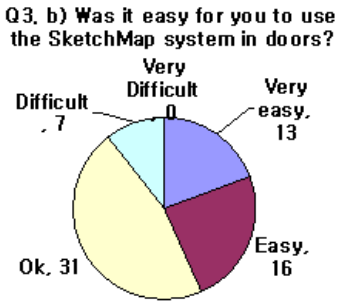
[1] I haven't manipulated it.

[1] Drawing a map while walking made the map messy, and I couldn't manipulate as I like.

[1] It was difficult to draw and couldn't understand how to use.

Security Map Creation

Answers to Question 3 b)



Very easy

- [3] Convenient because what needed was only touching
- [1] Easy to drag contents
- [2] Easy because we could put the PC on a table
- [4] Learned how to use when we were using it outdoors
- [1] Easy because stamp-like inputs
- [1] Could draw a clean and understandable map shortly
- [1] Easy to modify

Easy

- [2] Tough some manipulations were difficult, it became easy because we could put the PC on a table.
- [3] Easy to add more drawings later
- [1] Easy to enlarge photos
- [1] Difficult to use the digital pen
- [1] Student volunteers taught us how to use it
- [1] Convenient because what needed was only touching
- [1] Could draw various streets
- [1] Our group was a little late on the time to come back to school
- [1] Gradually got used to manipulate it
- [1] There was no changes

Ok

- [6] Got more used to manipulate it than when used outdoors
- [5] I haven't used it a lot.
- [1] Difficult to stamp icons
- [1] Understood
- [3] The ways of manipulations were difficult.

Difficult

- [1] System errors have occurred frequently
- [1] East to use in doors, but it became messy when we used it outdoors
- [1] I was tired.
- [1] Got used to manipulate it because I used it a little
- [1] Difficult to modify
- [1] Difficult to use the area primitive
- [1] The canvas became white when we moved scroll bars a little and lost canvas orientation.
- [1] Difficult to check contents of interviews
- Difficult to review maps
- [1] Some streets were vanished suddenly

Very difficult

Security Map Creation

Answers to Question 4

Q4. Could you draw understandable maps easily with the SketchMap?

Well-done

- [4] Could cooperate with my group members
- [1] Could insert photos and interviews on our map
- [1] Could draw finely corners, traffic signals, and so on
- [1] Surprised at I could find many dangerous places
- [1] Easy to manipulate the PC
- [2] Made our map understandable with many stamp-like icons.
- [1] Enjoyable to draw a map
- [1] Could enjoy

Expressiveness was nice

Done

- [1] Could cooperate with my group members
- [7] Could paste photos, interviews, and icons a lot
- [1] SketchMap was easy
- [1] Our map seemed to be understandable in my opinion.
- [1] Streets were vanished once, but we could recover the map by the presentation.
- [1] Our members summarized our map well.
- [4] Could use various kinds of icons
- [1] Enjoyed to draw the map with colors
- [1] Some parts of our map were not understandable easily.

Ok

Expression of streets was messy

- [1] Added trees and symbols
- [5] Lines of streets became jaggy.
- [2] It became difficult to see if we drew the map finely.
- [1] We did not record movies while we were interviewing.
- [1] I thought that handwriting was faster than the system because of difficulty of modification.
- [1] Quality of our map was less than others
- [1] Couldn't understand which places were drawn on our map
- [1] Boys have done most manipulations.
- [4] I haven't used the system a lot.
- [1] Could a little

Couldn't

- [2] Our map became messy because of lots of photos.
- [1] Could use photos, but couldn't use icons well
- [2] Difficult to understand
- [1] Difficult

Maps became messy

Impossible at all

Security Map Creation

Answers to Question 5

Q5. Could you draw the potentially dangerous places on your map in an understandable way?

Well-done

- [10] Could insert them with icons
- [1] Could make streets thin and thick
- [1] I haven't used it.
- [1] I could understand where were dangerous, so I also could do so.
- [1] Could cooperate with our group members.
- [1] Our map indicates lots of dangerous places and readers will understand dangerousness.

Done

- [5] Could paste photos of dangerous places
- [2] Could draw dangerous places with colors
- [2] Because the system was easy to use.
- [1] Could draw them cleanly
- [1] We surveyed the places by entering there actually.
- [1] Convenient for presentations
- [3] Could do it a little though we could find them more
- [3] Could use icons which simply indicate dangerous places
- [1] Could also add them later
- [1] Could achieve them
- [1] Could achieve with a primitive named area
- [1] Haven't used it

Ok

- [2] Could paste photos
- [2] We forgot to put them
- [2] Could do only a little
- [1] Didn't go well to express them with icons.
- [1] I sometimes forgot how the place was.
- [1] The expressions have already been prepared in the PC.
- [1] We strained only to draw streets.
- [3] We missed some dangerous places.
- [1] We haven't draw them on our map.

Couldn't

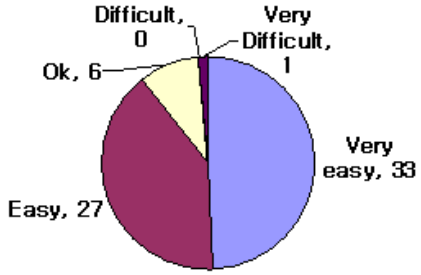
- [1] Forgot to do so
- [1] Didn't't know the marks exist in the toolbox

Impossible at all

Security Map Creation

Answers to Question 6

Q6. Were the security maps drawn by your friends' groups understandable?



Very easy

- [3] Easy to understand with photos
- [2] Their maps were drawn well.
- [2] Their maps were drawn from different viewpoints from ours.
- [1] My friends' groups also found dangerous places.
- [5] Easy to understand using photos and icons wisely
- [2] They used voices of interviews obtained well.
- [6] They drew maps in detail.
- [1] I wished I could refer others' presentations.
- [5] Because there were lots of marks on their maps.
- [3] Their maps were better than ours.
- [1] Only one group has done well.

Easy

- [5] Easy to understand with lots of icons.
- [2] Easy to understand using photos and icons wisely.
- [2] Everyone summarized their maps well.
- [3] Could understand fairly
- [7] Their maps were drawn cleanly.
- [1] The photos were concrete.
- [1] They surveyed lots of things.
- [4] They tried hard and talked loudly.

Ok

- [2] They were showing places and how the places were at once.
- [1] Their maps were messy.
- [1] Their streets were also jaggy as suspected.

Difficult

- [1] I couldn't understand their maps.

Very difficult

Security Map Creation

Answers to Question 7

Q7. How was your group's presentation using the SketchMap system?

Well-done

- [1] Using trees, photos, and buildings wisely
- [1] Could find dangerous places
- [4] Could do well without reharsals
- [3] We did well though did mistakes a little.
- [2] We cooperated each other.
- [1] Our cartographers made a clean map.
- [3] Could present our maps loudly
- [1] Could present the map respectively and circumstantially.
- [1] Our presentation was nice because the members tried hard.
- [1] I enjoyed the presentation.

Done

- [4] Could present our map clearly with photos, icons, and interviews.
- [3] Did mistakes a little but present loudly
- [3] Not too bad in my opnion
- [3] My speaking was sometimes short and low.
- [2] I could summarize what I speak by myself.
- [2] It was a very nice presentation as my group was cooperative.
- [1] It took time to present our map.
- [1] Could know various things
- [1] I could understand other groups' achievements.
- [1] Student volunteers supported us.
- [1] My speaking was bumbleheaded.

Ok

- [6] My voice was low.
- [3] It was too short to prepare for presentation.
- [2] Could be better.
- [5] Couldn't say fluently.
- [1] The progress of preparation for presentation was not good.
- [1] I couldn't write sentences a lot.
- [1] Presentation has started without reharsal.

Time constraints

Couldn't

- [1人] Haven't done closing greetings.

Impossible at all

- [1] My voice was not loud.

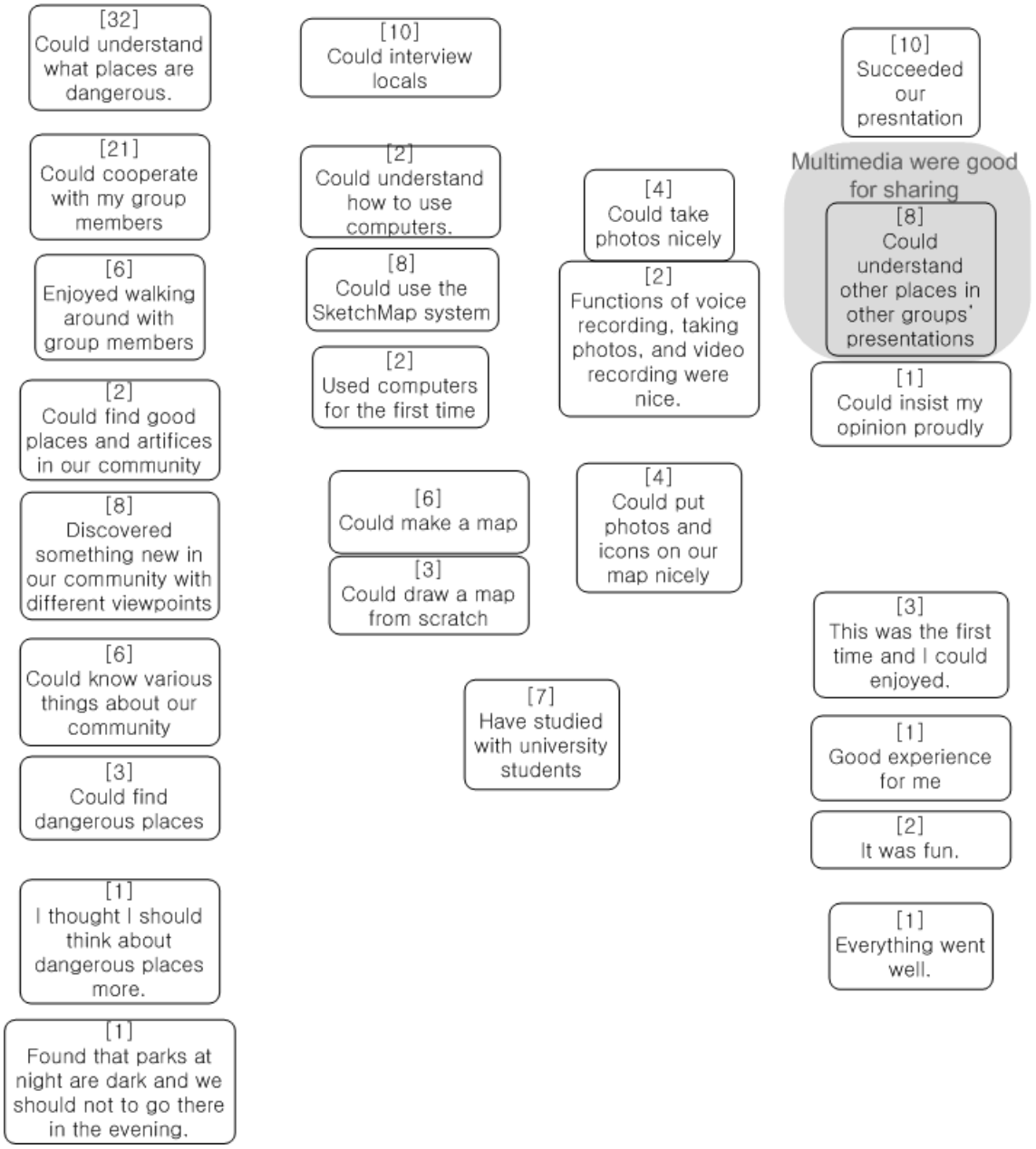
Comments without answers

- [1] Our speaking was loud and clear enough to understand our presentation.

Security Map Creation

Answers to Question 8

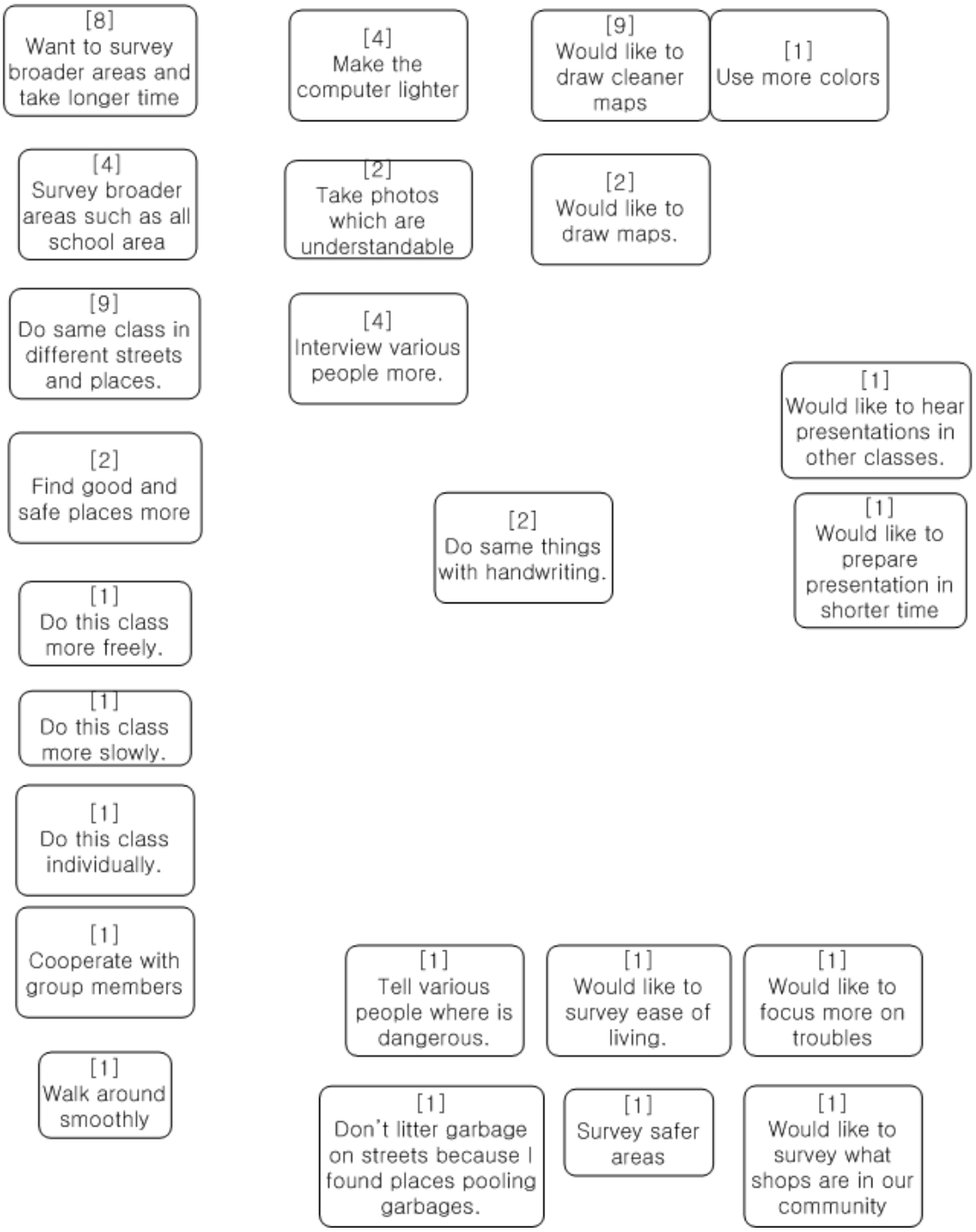
Q.8 Tell us your favorites in today's study up to 3.



Security Map Creation

Answers to Question 9

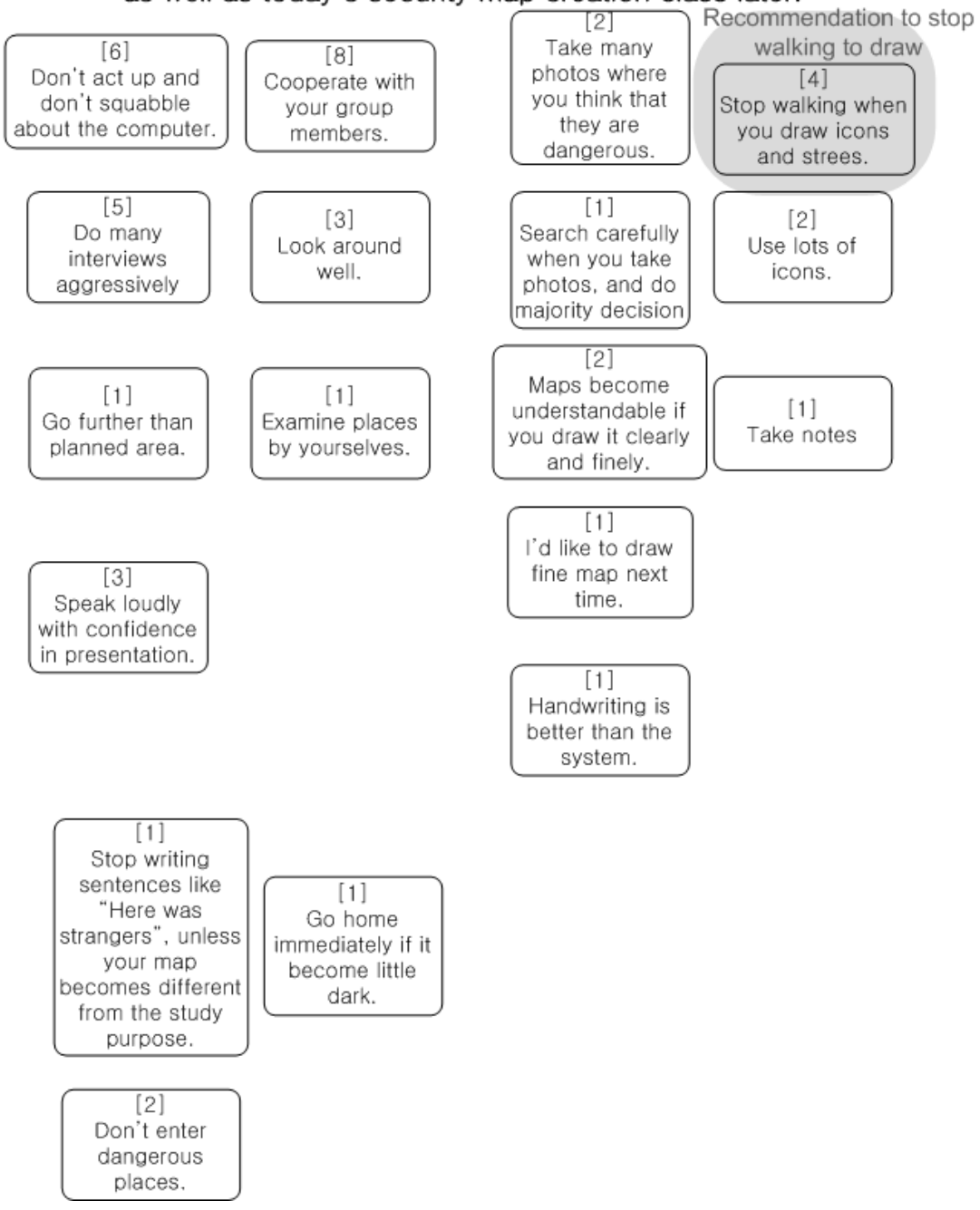
Q.9 Tell us what you would like to do if you have a same study again?



Security Map Creation

Answers to Question 10

Q.10 Give advices to your friends who may have the same class as well as today's security map creation class later.

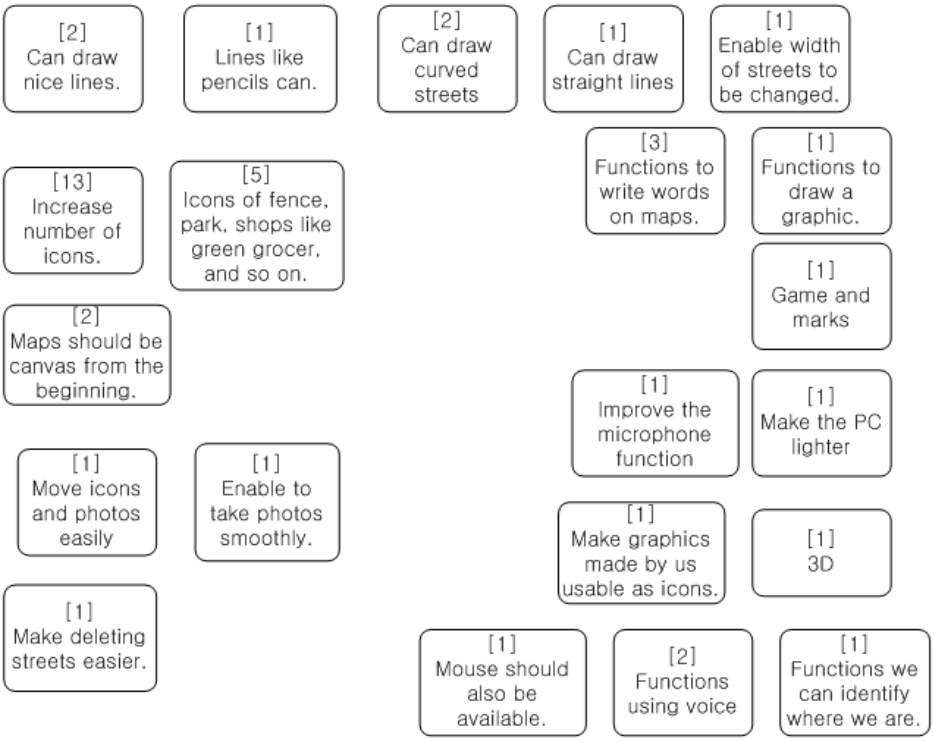


Security Map Creation

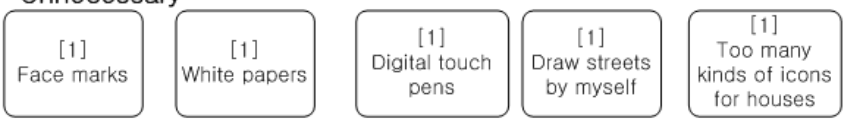
Answers to Question 11 and 12

Q.11 Tell us what functions are preferable newly and unnecessary among the functions of the SketchMap system.

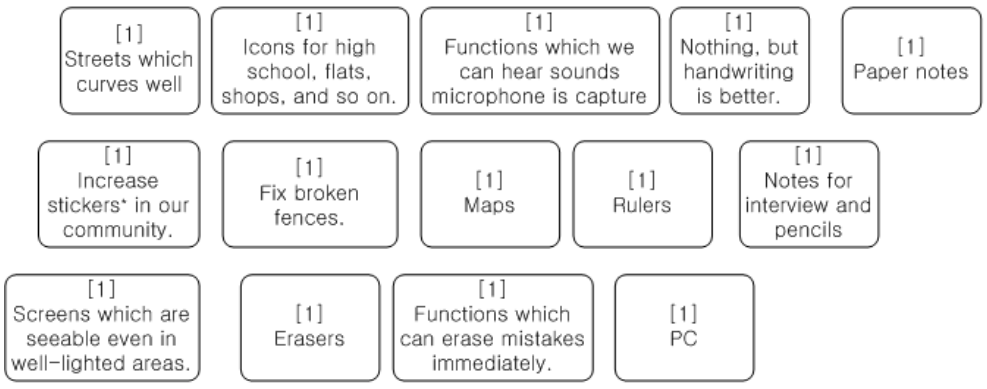
Preferable functions



Unnecessary



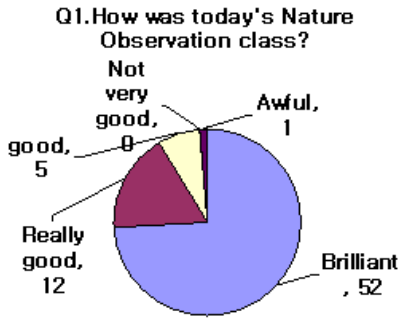
Q.12 Suggest tools which you didn't use today, but are necessary in order to draw better security maps.



* stickers pasted on some houses indicate that the house contribute to help in case of emergency of children.

Nature Observation

Answers to Question 1



Brilliant

[17] Could find various kinds of insects and plants

[4] Could understand well how creatures are in automn

[1] Experienced various things

[2] Found insects by myself

[2] Could use PC

[2] Successfully made our nature observation map

[4] Explored outside school

[2] Took lots of photos

[1] It was fun.

[4] Could become friendly students

[10] Could cooperate with our group members

[1] Went to a park with friends and present our achievement

Really good

[7] Could observe various creatures

[1] It was very fun.

[1] I can't think of right words to say.

[1] We mistook assiged streets.

[1] Could interview locals and understand difference from summer.

Good

[1] It was neither fun nor boring.

[1] Squabble with my members

[1] Could see various insects

[1] Could interview locals

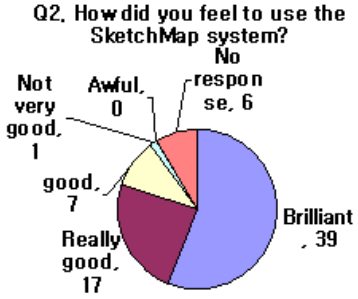
Not really good

Awful

[1] I was afraid of spiders in the park.

Nature Observation

Answers to Question 2



Brilliant

[7] Could do various things

[7] It was fun and interesting.

[4] Convenient because of various functions

[2] Fun to draw streets and put trees

[1] Could draw a nice map.

[1] Students taught us unknown functions.

[1] Could cooperate with friends

[1] Fun to draw streets on the screen of PC

[2] I've never done this

[4] Could use a digital pen

[1] Could survey what and where things are.

[4] Fun to take photos and to record

[1] Easy and useful

[1] Tried hard though the PC was heavy.

Really good

[3] Drew streets by ourselves.

[2] Could perform various things conveniently

[1] Fun and convenient to use

[1] Could draw a nice map

[1] Fun also to just see others were using it

[1] It was the first time for me.

[1] The manipulation was interesting

[2] Could use a digital touch pen.

[2] Could paste photos taken in the field study

[1] The PC was very heavy.

Good

[3] I have used it only a few times.

[1] I was not interseted in it, but fun to take photos.

[1] Very heaby

Not really good

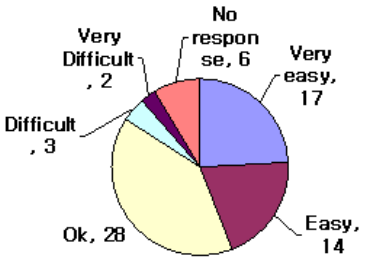
[1] Seemed to be difficult to draw streets

Awful

Nature Observation

Answers to Question 3 a)

Q3. a) Was it easy for you to use the SketchMap system outdoors?



Very easy

[3] Could draw with a touch pen

[4] Could draw easily and readily

[1] Draw the map with members

[2] Interesting and fun

[1] Convenient to move streets and to paste icons

[2] Students taught us how to use it

[1] Could use icons when we missed to take photos

[1] Nice because it was compact

Easy

[3] Can draw only with a touch pen

[1] Difficult to delete

[1] Maps suddenly have disappeared.

[1] Rememberd what I was taught

[1] It was fun.

[3] It was little difficult but easy.

[2] Students taught us how to use it.

[1] I felt anxiety but could achieve better than I expected

Ok

Too many functions

Difficulty of interaction methods

Irrelevant answer

[1] Seemed to be easy

[1] Easy because photos were available

[3] Some functions were still incomprehensible for me

[1] Sometimes I could but sometimes I couldn't

[3] Little difficult to manipulate it

[1] It made me tired to rewrite maps after our map suddenly disappeared.

[1] I haven't used it

[2] Made me tired because it was heavy

[2] Students taught us how to use it

[1] I was surprised at popped up strange screens.

[3] The plug of camera was frequently come out.

[1] It was fun.

Difficult

[1] Difficult to take photos

[1] There was a small accident.

[1] Too many functions to use

[3] Difficult to draw streets

[1] It was the first time for me to use it.

Difficulty of drawing streets

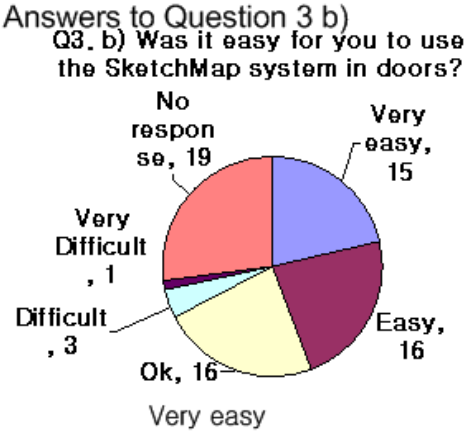
Very difficult

[1] Very difficult to draw maps

[1] I was walking during drwing.

Nature Observation

Answers to Question 3 b)



Very easy

[3] It was fun.

[1] It was very convenient.

[1] It was easy to modify.

[1] Our map looked nicely

[1] What I did was only making a area

[3] I didn't use a lot after came back to school.

[1] Students taught us how to use.

[1] Nice for reviewing achievements

Easy

[1] Cooperated with group members

[2] Got used to use it when I was outdoors

[2] I became to be able to use it after taught by students.

[2] It was easy when we modify our map.

[1] Interesting when I used it a little.

[1] Could put it on a table

[3] Used only a few after we came back to school.

[1] I don't know

Ok

[3] Made me tired to modify what we drew.

[1] Some parts were difference from actual maps, but others were OK.

[1] There were no accidents.

[1] Teacher scolded me

Difficulty of reviewing maps

[1] It was not easy to review

[1] Our map was suddenly disappeared.

[1] I don't know because I haven't used it.

Difficult

[1] Difficult to rearrange the map.

Very difficult

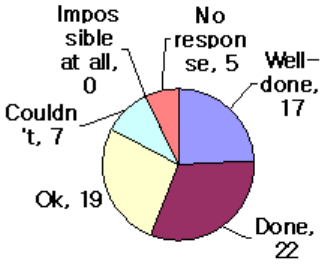
[1] Very difficult to clean up the map.

[1] I don't know.

Nature Observation

Answers to Question 4

Q4. Could you draw easily understandable maps with the SketchMap?



Well-done

- [6] Put icons, photos, and sounds carefully on respective places.
- [1] Understandable because of buildings surrounded photos
- [1] Cooperated with group member
- [3] Could make our map understandable easily
- [1] Recorded our own comments before going back.
- [1] Would like to do this again because we could observe nature well
- [2] The PC was easy to use.
- [1] Students taught us what I don't know.

Expressiveness was nice

Done

- [5] Put nice photos a lot on our map
- [1] I could use it after I listened instructions.
- [1] Some photos lapped over each other.
- [1] Could draw creatures
- [2] Well-done
- [1] Everyone taught me
- [2] Drew streets we passed precisely
- [1] Couldn't draw streets nicely
- [2] I did some mistakes
- [1] I don't know
- [1] The PC was easier than I expected.
- [1] Made pictures as small as possible

Icons became messy

Ok

- [1] Not so bad, not so good
- [1] Difficult to see where microphone is.
- [2] Difficult a little to understand
- [1] Took various pictures

Couldn't

- [7] Couldn't draw streets nicely
- [1] Couldn't record voices well
- [1] I haven't used the SketchMap

Expression of streets was messy

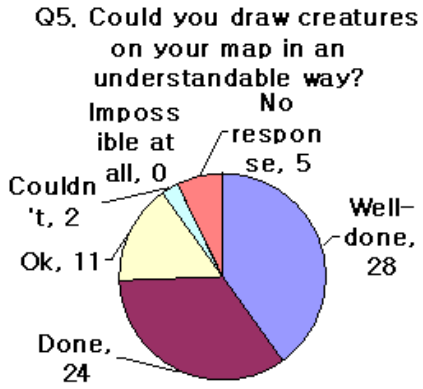
Icons became messy

Impossible at all

- [2] Streets became messy
- [1] Placed streets on an edge of the screen.
- [1] Too many trees on screen to understand
- [1] Our maps had no buildings and trees
- [1] I guess we missed some places

Nature Observation

Answers to Question 5



Well-done

- [6] Could draw lots of insects and plants
- [3] Could record chirps
- [2] Used camera well
- [2] Put icons of buildings and creatures in a balanced manner
- [1] Could put many things on our map
- [5] Easy to only touch the screen.
- [2] Can draw with the pen and express also with recording
- [1] Saw many places carefully
- [1] Made our map like a real one.

Done

- [5] Drew our map with lots of photos
- [1] Easy to paste icons on the canvas, but difficult to take photos.
- [1] I think we did well but may miss some insects.
- [1] It was easy.
- [1] I observed carefully.
- [3] Some pictures were out of alignment
- [3] Could make understandable maps
- [1] Many things on our map
- [1] I cannot find words to say

Ok

- [1] Could see and touch various things.
- [3] We didn't do well.
- [1] A little bit difficult to use
- [1] Couldn't realize where the findings were in the real environment.
- [1] Almost everything was done by my friends.
- [1] There were something we couldn't take photos.

Couldn't

- [1] Couldn't hear crying of birds with recorded icons.
- [1] We haven't taken many photos

Impossible at all

Nature Observation

Answers to Question 6

Q6. Were the nature observation map drawn by your friends' groups understandable?

Very easy

- [6] Their presentations were skillful and clear.
- [4] They used photos and movies nicely.
- [2] Many things about autumn were on their maps.
- [2] They successfully drew streets.
- [7] There are devices to understand for audiences on their maps.
- [2] Understood situations with many things such as houses and trees.
- [1] They divided presentation on each member carefully.

Easy

- [1] Various icons were on their maps.
- [3] Their maps were easy to follow.
- [1] Streets were drawn in comprehensible ways
- [1] Some parts that icons lapped over each other were difficult to see.
- [1] They drew in detail
- [1] Some parts were easy to follow but other were difficult.
- [1] There were some incomprehensible photos.
- [1] Could follow with enlarged pictures
- [2] There were various devices for audiences
- [3] There were many trees.
- [1] They used photos as their expression.

Ok

- [1] Couldn't hear recorded voices
- [1] Couldn't understand what the movie contained.
- [3] Couldn't hear their low voices
- [1] They used difficult words.
- [4] Some parts were incomprehensible
- [1] There were too big pictures.
- [1] Couldn't understand because of cluttered picuters.
- [1] Their presentations were amazing.

Difficult

- [2] Couldn't hear their low voices
- [1] It was not understandable.

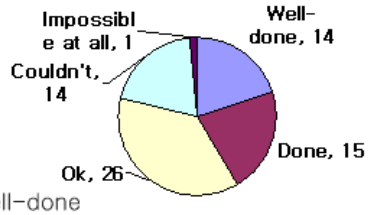
Very difficult

- [1] Others' presentations made no sense to me.

Nature Observation

Answers to Question 7

Q7. How was your group's presentation using the SketchMap system?



Well-done

- [4] We did great presentation.
- [2] We divided tasks for presentations successfully.
- [2] Could put photos and records well
- [1] Could speak lots of things
- [1] Cooperated with our group members
- [1] Could see plants which I cannot see frequently
- [1] Could see physical materials that we brought
- [1] Just presented what I've done.

Done

- [2] Cooperated with our group members
- [3] We divided tasks for presentations successfully.
- [1] Could show real thing (acorns)
- [1] Could do well though the order of presentation was accidentally changed.
- [1] Good presentation with recorded sounds in my opinion
- [2] Spoke loudly
- [1] Found various things
- [1] I became bashful a little.
- [1] Our presentation didn't go well.
- [1] Hurried because amount of time was not enough

Ok

- [7] My voice was low.
- [2] Couldn't use recorded sounds.
- [1] There were no special to what and who present.
- [2] Not so good, not so bad.
- [1] We divided tasks for presentations successfully.
- [1] Couldn't't speak smoothly
- [1] I became bashful a little.
- [1] I became nervous.
- [1] It was not successful.
- [1] Couldn't present in detail
- [1] Spoke same things as previous presenter said.

Time constraints

- [1] Difficult to present without reharsals
- [1] Did practices a little
- [1] Our presentation was bit messy.

Couldn't

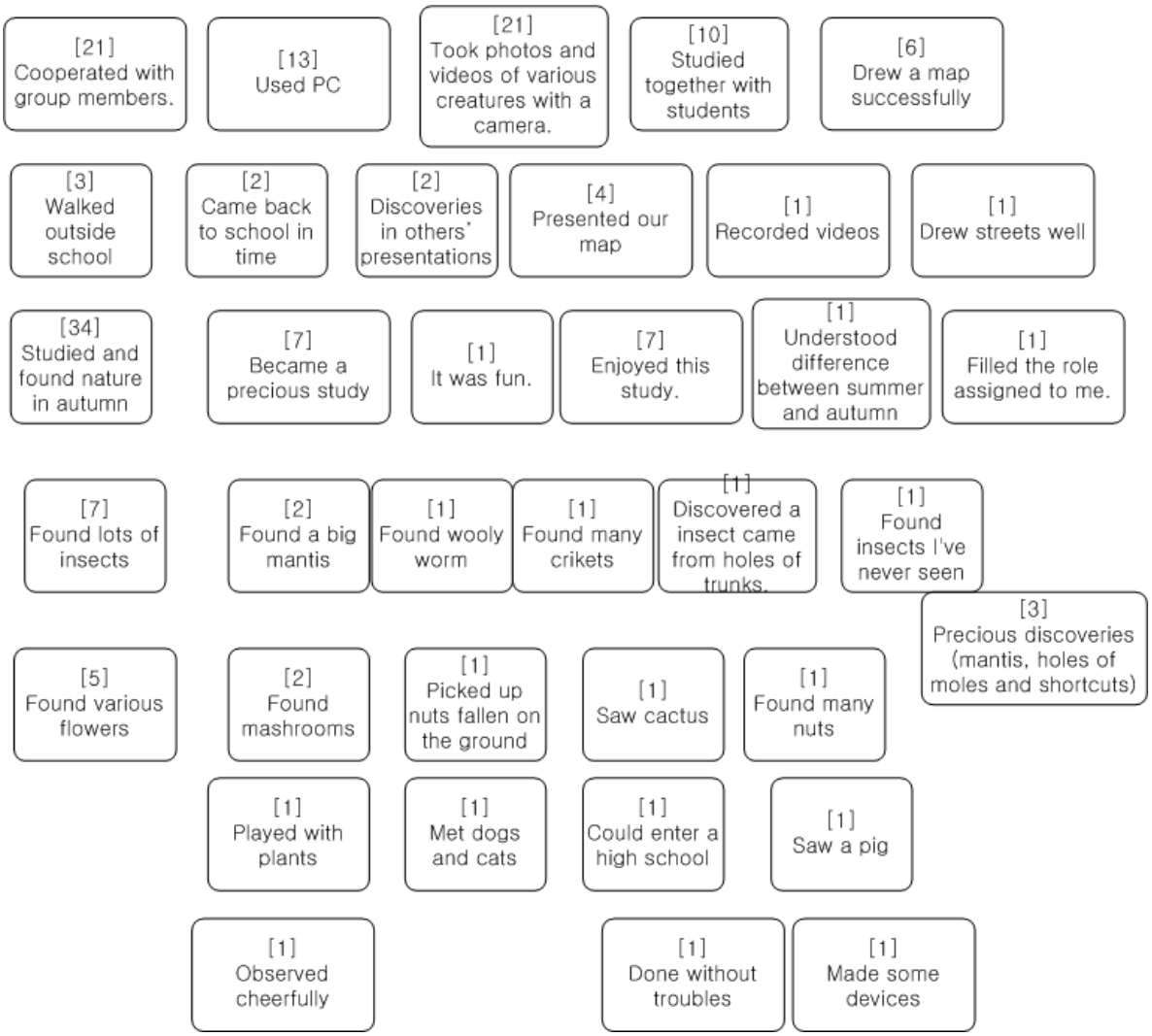
- [3] Couldn't divide tasks of presentation successfully.
- [1] My voice was low.
- [1] Some parts were OK, but some parts missed to put photos.
- [3] We failed our presentation.
- [1] Stopped our presentation
- [1] We haven't had a discussion much about the presentation.

Impossible at all

Nature Observation

Answers to Question 8

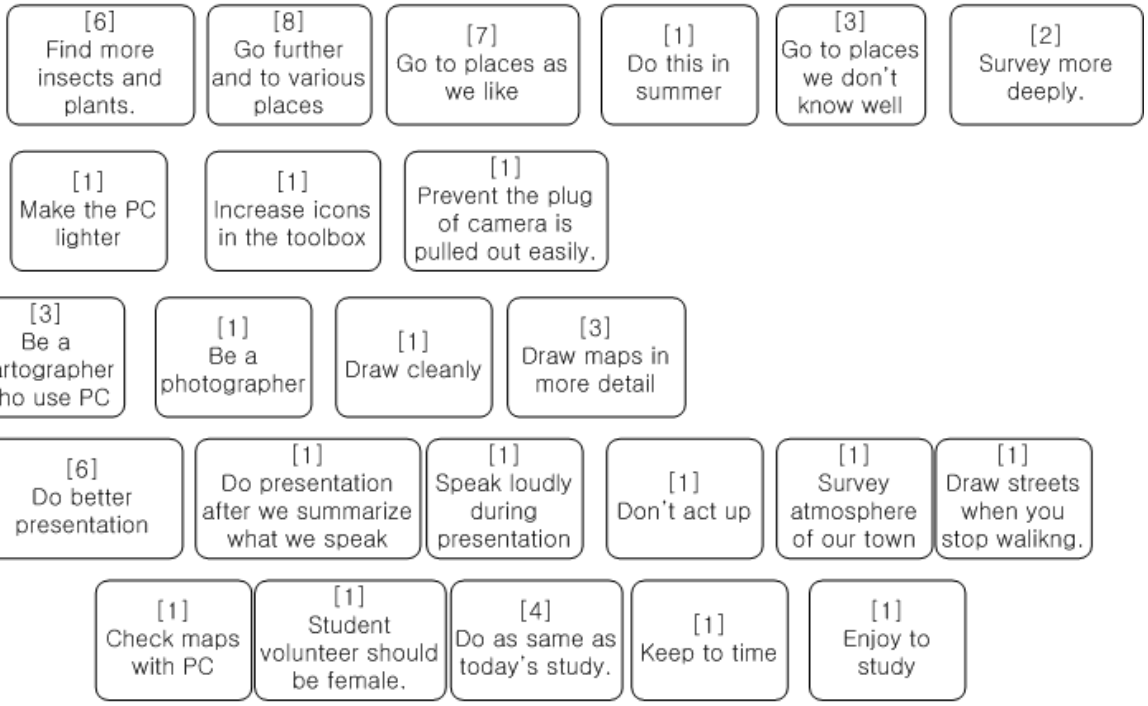
Q.8 Tell us your favorites in today's study up to 3 items.



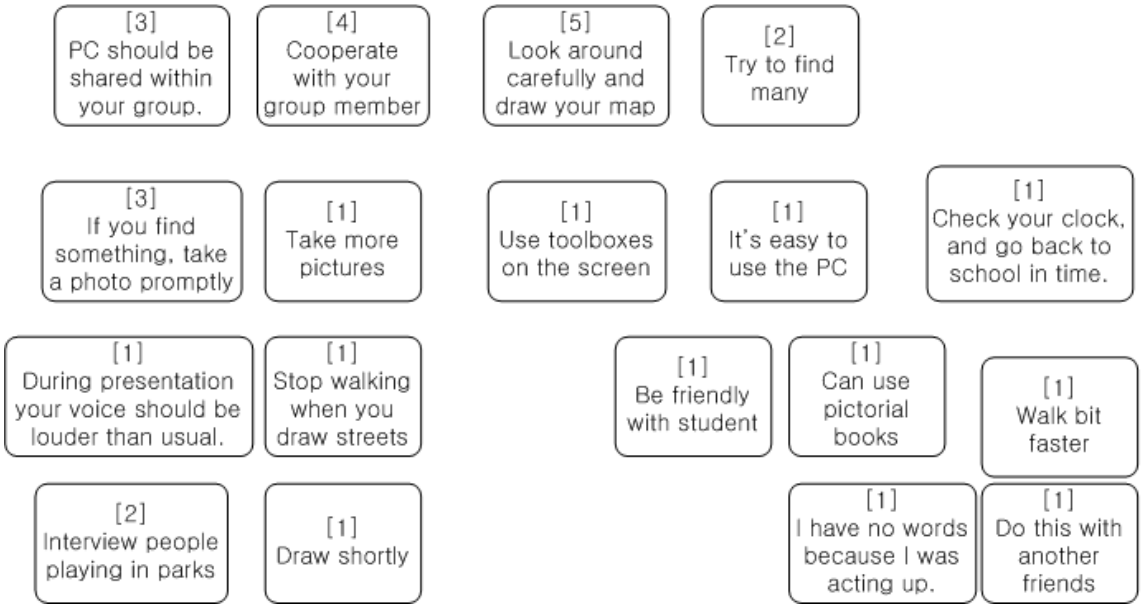
Nature Observation

Answers to Question 9 and 10

Q.9 Tell us what you would like to do if you have a same study again?



Q.10 Give advices to your friends who may have the same class as well as today's nature observation class later.



Nature Observation

Answers to Question 11 and 12

Q.11 Tell us what functions are preferable newly and unnecessary among the functions of the SketchMap system.

Preferable functions

[6] The camera should be unplugged.

[2] Functions to recording movie and voice in one file

[2] PC should be smaller.

[2] Functions that show names of insects

[1] Viewers photographer also can check what the camera is aiming as digital cameras can

[1] Can observe far targets

[3] Insert letters on maps

[7] Increase sorts of icons in the toolbox

[1] Icons in toolbox are easy to follow if they also have name.

[1] Functions of pictorial books

[1] Functions that show name of findings taken by the camera

[2] Make carrying PC comfortable

[1] Functions filling grids with parts like games

[3] Automatic cartography

[1] Maps having only streets are needed

[1] Draw a picture and paste it like icons

[1] Navigation system

[1] Functions that teach us why this happened

[1] Come out money

[1] Functions that find something

[1] Use mouse instead of pens

[3] Manipulation with voice

[1] Make a map on PC and color the map

[1] Pencils appear when a button is pushed.

[1] Student volunteers should be more

[1] It is fun enough as well as today's study

Unnecessary functions

[2] Weight of PC

[2] Touch pen

[1] Marks for trees and insects

[1] Automatic PC

Q.12 Suggest tools which you didn't use today, but are necessary in order to draw better maps.

[4] Digital cameras

[3] More icons

[3] Pictorial books

[1] Survey sorts of insects

[1] Jiggling proof camera

[2] Magnifying glass

[2] Map

[1] Add comment on SketchMap

[3] Telescope

[1] Functions to avoid sunshine.

[1] Colorful paintings

[1人] Touch pen

Appendix C: Detail information of equipments

Physical Devices

- Tablet PC: HP Compaq tc4200
- GPS: I-O Data CFGPS2
- GPS antenna: I-O Data GPS-ANT/CF2
- Web Camera: Logicool Qcam® for Notebooks Pro
- Access Point: HP ProCurve Networking Wireless Access Point 420

Software:

- Java Development Kit 5
- Java Media Framework API 2.1.1e
- Java Communication API 1.2
- eXist - Open Source Native XML Database ver.1.0
- Apache HTTP Server 2.0.52

Equipments for evaluation

- 8 video cameras: Sony DCR-PC100 and Sony DCR-SR100
- 8 voice recorders: Sony ICD-SX66
- 3 digital cameras: Canon IXY Digital 700

Icons borrowed in the tablet PC system

- http://www.schoolicons.com/
- http://www.t-animal.gn.to/main.html
- http://egkaz.sakura.ne.jp/iconanime.html
- http://music.geocities.jp/rusticana06/konchu.html
- http://music.geocities.jp/rusticana06/tori.html
- http://park18.wakwak.com/~osyare/
- http://sozaidas.com/