A Collaboration Support Tool for Cartography Learning in the Open Air

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Abstract

SketchMap [2] is a system designed for use by primary school children in order to draw their 'personal environment maps' - a task habitually tackled when being introduced for the first time to the basic concepts of cartography. The system integrates face-to-face and distributed collaboration scenarios and offers the children a simple means to get accustomed to novel technology such as WLAN and GPS without being distracted from their learning goals. As a primitive use case, we have adapted the original SketchMap system and applied it for use in security map classes (that is the investigation of security issues on the children's way from and to school, creating map sketches to describe the school's surroundings). From participants' feedback of the case study conducted at a local primary school, we received valuable insights, both for the usage of applied technologies in such kinds of educational field activities as well as for SketchMap's further development.

1. Introduction

In the field of CSCL (Computer Supported Collaborative Learning) research, systems have naturally been inspired by ideas originating from pedagogy [16]. Often though, the systems were targeted towards young adults at university or similar educational facilities, and the focus was set upon supporting team work similar to the one found in industrial settings, where geographically wide spread teams, compound of several domain experts, have driven the necessity for and the requirements towards such systems. Looking at the pre-university level however, and the educational activities performed in this context, it becomes clear that here collaboration occurs mostly co-located, face-to-face, with occasional 'excursions' to distributed locations around school. The support of such combined kinds of collaboration is in our eyes still an important issue.

As an example, take one of the most widely spread approaches for introducing children to the world of cartography: Let them create a map of their 'personal' environment. For this task, the pupils of a class - divided into several groups of one or more students each - create map sketches of different sectors around their school. Using a set of drawing primitives, they pin down relevant points such as street crossings, traffic lights, deviations, or a scary dog. Once that all the sketches have been completed using paper and pencil, the different groups meet in one place and attempt to merge their results into a single, large sketch. It is at this point that the pupils encounter a variety of challenges:

Media: Paper-and-pencil drawings can only difficultly be corrected and adjusted towards one another.

Primitives: Each group in charge of one of the sectors to be drawn, might use a different set of drawing primitives for the various landmarks they encounter. At the time of merging maps, this requires efforts to explain these to their peers, but more importantly, it makes it more difficult to create an easily understandable large map.

Proportions: Reproducing the topology of an environment is a straightforward task. Relate topology to an environment's true proportions, however, is much more difficult, and requires some kind of a coordinate system and scale, which again will normally vary between groups. At the time of merging the maps therefore, reducing or enlarging them to same or similar scales is a difficult issue.

Overview: Relating each individual of a set of sketches to one another, requires the ability to match what is drawn by hand with the mental idea of the area by the person looking at the drawing - a process implying complex abstraction abilities. Even more so, if later the sketches need to be localized within a larger context of, say, a town map.

SketchMap is our intent to offer a system that, while supporting the children in the conceptual task of creating personal environment sketches, relieves them from the struggle with the above mentioned problems. In SketchMap, tablet PCs are used for the 'individual' drawing environment, while an average computer, possibly connected to a data projector, is used for the 'shared' merging task. While SketchMap can in principle be adapted to support a range of conceptually similar goals such as teaching children about civil protection measures in their living area, or even instruct them on traffic rules and behavior, the current version is made to support the above described sketching task.

To fulfill the previously mentioned range of functionalities, SketchMap must meet the following inherent or explicit requirements:

- Support of pen-based interaction.
- Provide a simple, extensible set of easily drawable primitives adapted to the children's motoric abilities.
- Provide a set of basic, easily extensible manipulation options such as rotations, translation or scaling.
- The individual child can amend (correct, extend) his or her drawing without being disrupted by what happens in the shared space.

SketchMap's was previously used in an initial user study to investigate whether the proposed concepts fulfill the user requirements. More recently, AnzenMap, an adapted SketchMap version for security mapping, was used in a half day educational practice. While there certainly remain many challenges to be met, the participants agreed to be easily able to complete the sketching task they were presented with and that their face-to-face collaboration efforts were supported well and unobtrusively.

2. Related Work

The range of systems that have found application in pedagogical settings is a sundry one. This said the focus of this section is set on systems that support *individualization* on the one hand, and *collaboration* on the other. While the first necessarily leads to the consideration of systems that allow using one appliance (computer) per student, the latter implies the use of networking and therefore distributed infrastructures.

The use of PDAs in educational environments to *individualize* tuition, has rapidly lead to the transfer of widely known effective pedagogical methods to this novel medium. Examples are the MapIt and PicoMap applications for concept mapping [7], or the Environmental Detectives [8] and Cooties [9] projects for science classes. School use of computers, also PDAs, tends however to stick to more common applications such as text editors, therefore merely replacing, not enhancing, previous 'paper and pencil' tasks with their electronic counterparts. While most of these early efforts originated in an attempt to enhance computer literacy of young and disadvantaged persons, newer studies returned to look at more advanced uses of PDAs for educational purposes (e.g. [5,6]).

The range of existing *collaborative* educational systems covers as varying topics as participatory simulations [10], classroom communication systems [11] or problem based learning [12]. Interestingly however, "Computer Based Collaborative Knowledge Building" [1], one of the oldest and least technology driven approaches, remains to date apparently the one to be didactically effective without failure. In this approach, by the mere use of an average text editor, pupils take note of their insights while acquiring knowledge on a novel topic and collaboratively compile a single 'information file' of all their results. A somewhat similar approach is these days supported by Wiki technologies.

If individualization and collaborative practices shall be integrated into a single system, there is virtually no limit anymore to the educational application domain: [6] compared the achievements of pupils using web based training systems in combination with PDAs in the 'integrated study' classroom, outdoors, and in a social education facility. [13] presented a system for use in the integrated study class, whose aim was to make pupils collaborate in the design of a town and experience the respective environmental implications. [14] again developed a system in which pairs of pupils collaborated to solve a knowledge quiz about the insights they gained from the science exhibition they were visiting each individually. The purpose of the Ad Hoc Classroom project [15] finally, was to develop a wireless platform so that teacher and students can establish a classroom dynamically irrespective of location and time bounds (that is anytime, anywhere).

3. SketchMap

SketchMap is a tool designed in the effort to come up with an electronic approach for the task described in Section 1 (Figure 1). While preserving and enhancing the team work practices that form part of the task, we intend hence to make away with the problems children encounter during task execution using paper and pencil.

The system, as a consequence:

1. offers the pupils a tool, that while familiarizing them with up-to-date supportive technologies such as GPS, WLAN and small-scale tablet computers, remains as simple to handle as paper

and pencil for the task they have at hand, and therefore, does not lead to deviation of their attention from the actual goal to be completed.
2. uses latest-generation technology in order to simplify, reduce or take cognitive demanding, but for the learning tasks irrelevant, activities away from the children, and let them concentrate on their goals instead.
3. provides teachers with a modern, computerized, basic appliance that helps them teach their students about the theory and practice of basic cartographical skills and concepts.

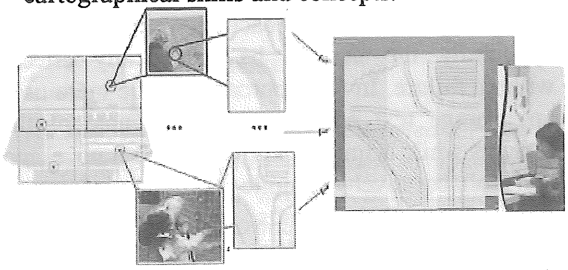

Fig.1: Creating a 'personal environment' sketch with SketchMap

3.1. Implementation Concepts and System Architecture

SketchMap is based on the two principles that have been pointed out in Section 2: *collaboration* and *individualization*.

The system is written in Java and the user-interface is designed to run on small-scale tablet PCs which allow for pen-based interaction. The system is implemented as distributed WLAN-based client-server MVC architecture, with the clients communicating with each other through a server which also embodies the role of the central sketch storage (Figure 2).

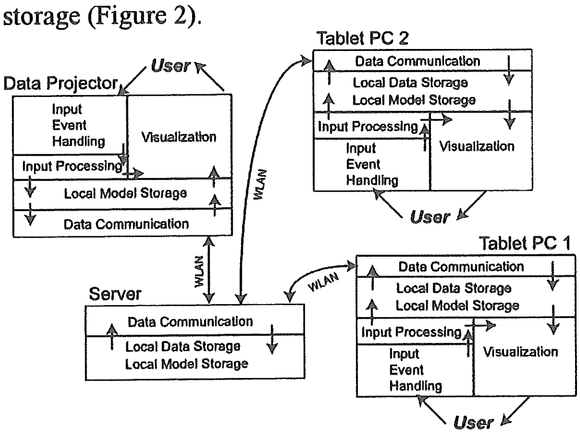

Fig.2 SketchMap's Architecture

3.2. Current State of Development

SketchMap is work still largely in progress and has therefore not reached its conclusive development state yet. The current state of development covers the possibilities also at hand when using paper-and-pencil procedures, and improves them by offering simple graphical operations such as e.g. scaling and rotating entire sketches in order to make them 'fit' together.

At the time of writing, SketchMap incorporates two different user interfaces for the task at hand:

- 'Personal' Drawing Interface: Gives access to both, the range of available sketching primitives as well as basic manipulation functionality such as deletion and translation of already drawn shapes.
- 'Shared' Merge Interface: Is targeted towards the activities of the moment when a set of sketches is merged and adjusted towards one another to form a single large sketch.

The drawing primitives used are a simplified (but extendible) version, for ease of use by primary school children, of those employed by international Boy Scout organizations for their field work [18].

4. A Field Study in Security Mapping

In Japan, a recent media frenzy to report on child abduction or murder cases has lead the public to call for stronger protection for pupils on their way to and from school. One fairly common method to achieve this is by means of "security map creation classes".

"Security Map Creation" is an educational approach in which pupils are asked to first gather information on locations on their way to and from school, that are either hardly visible from the street, or from where it is difficult to escape. Then, they sketch these on a map, and share and discuss the gathered information with their class mates in order to raise the level of their personal security consciousness. This approach is similar to the one SketchMap is based on, in that pupils, while drawing maps, analyze their personal environment with respect to a predefined educational goal.

Due to this fact, we were asked by a local primary school to create a SketchMap offspring for security mapping, called AnzenMap (Figure 3), and make it available for an educational practice. This simultaneously allowed us to test SketchMap's basic paradigms and mechanisms in the real-life setting of an educational environment, and investigate how pupils interact both with the system and the kind of hardware it is running on [4].

The remainder of this paper is hence dedicated to the experiences and insights gained during this half day's educational practice held in the context of a security mapping class for primary school 6th graders in Kashiwa, Chiba prefecture, Japan.

This field practice's structure was as follows:

1. Introduction (5min.): The leading primary school teacher introduced the experimenters as tutors to the pupils.
2. System Instruction (20min.): The pupils were instructed on how to use the system. Each group had at this point been jointed by a tutor who facilitated the pupils' "first steps" with AnzenMap.
3. Field Study (75min.): Accompanied by a teacher and a tutor, each group left then for the area assigned to them for documentation, in order sketch the area with AnzenMap, gather information on places they classified as dangerous and indicate them accordingly on the maps.
4. Study Summarization (30min.): The pupils returned to the class room, summarized their findings and prepared them for presentation to their peers.
5. Presentation (30min.): Each group presented their findings in class using AnzenMap to show the drawn maps of where relevant locations had been found. Pictures taken along the way were also presented, as were voice-recorded interviews.
6. Follow-up (15min.): Once the education practice had finished, pupils and teachers answered a written questionnaire on the usability and subjective effectiveness of the AnzenMap system.

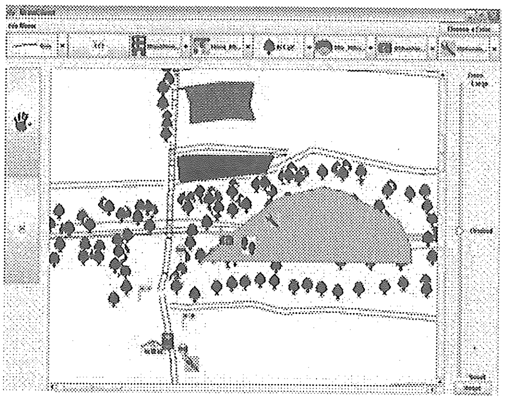

Fig.3: AnzenMap's sketching interface

Twenty-five pupils participated in the educational practice, divided into five groups of five pupils each. Each group was given one tablet PC and each group member was assigned one of the following tasks: interviewing, taking photos, and sketching maps.

Three video recorders as well as three digital cameras were used to capture the ongoings during the educational practice (Figure 4). Further, screen recorders and a database were used on each tablet PC in order to track the pupils' activities using the system for later evaluation.

4.1. Preliminary Results: Usability

Usability is commonly considered to consist of five parameters [3]: Learnability, efficiency, memorability, error avoidance and subjective satisfaction. We will hence summarize our insights in this section along these five criteria.

Learnability: While the system's functionalities were explained in "dry" only, with the occasional time slot for trials, the pupils seemed to instantly understand how to use AnzenMap in practice, as well as where they might encounter limitations.

Efficiency: Comparing the pupils' performance using AnzenMap in the beginning of their sketching task and towards its end, allows to draw some preliminary conclusion on how efficient the system might become for more experienced users. From this point of observation, it can be stated that in the beginning the pupils in charge of the sketching task tended to fall far behind their group peers and had to ask their peers repeatedly to wait for them. Towards the end however, they were able to catch up with their group peers and maintained a similar working speed as these. Over the time span of just about an hour hence, the sketching pupils' efficiency had increased considerably - let alone if they had had extensive previous practice with the system.

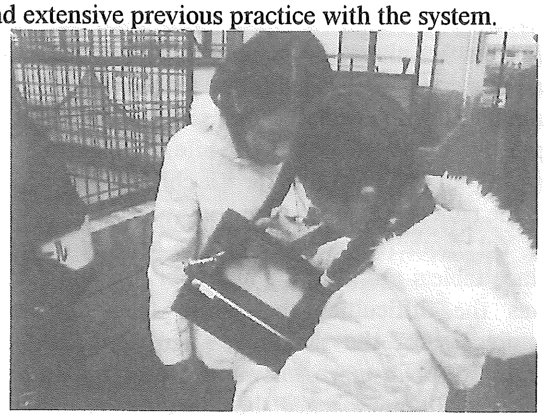

Fig.4: Field Study

Memorability: According to the teachers, the ability to get accustomed to new devices and technologies defers considerably from one child to the other. What as a supposed consequence of this fact became apparent was, that while some children remembered all they had been showed during the previous brief system introduction exercises well, and could start right away using AnzenMap, others had to be given further support by tutors and/or teachers in order to get under way. Further investigations are hence needed in order to make away with this "start up hurdle".

Error Avoidance: The prevention of (user and system) errors had largely been neglected during the development phase of AnzenMap. Among such problematic points are e.g. the manipulative smoothness of the color choosing and file handling functions. Furthermore, a driver incompatibility of the screen driver of this particular tablet PC type with Java Swing, easily lead to a system freeze as soon as the tablet's screen rotation button was pressed twice or more in a row while AnzenMap was running. While we knew about these issues beforehand, we did not expect at all that the children would use this functionality and therefore had not tackled the issue in advance.

Subjective Satisfaction: Pupils as well as teachers considered the security mapping class successful. The children said that the combination of using computers while learning on issues related to their personal safety made the class both useful and interesting. The comments also indicate that the system was unobtrusive enough not to deviate the children's attention from their main purpose, i.e. the identification of for them potentially dangerous places on their way to school.

4.2. Preliminary Results: Technology

The original SketchMap system had initially been designed and usability tested on small scale tablet PCs [2]. At the time, we found that a small screen is difficult to work with even for adult persons, let alone for primary school pupils. As a consequence, we decided to use for the present study tablet PCs with normally sized screens. The price we paid for it though was that while the drawing area turned out to be just fine for the children, the weight of the tablets was judged too heavy.

Yet another result, and one we had not expected since tablets are after all made for "mobile" work, was the difficulties that arose from the weak luminosity of the monitors when used outdoors. Figure 5 for instance, shows how near the children occasionally approached their face to the screen in order to properly see what they were drawing.

4.3. Miscellaneous Results

AnzenMap's focus, while being related to SketchMap's original goals, differs in one point distinctly from it: during its design it was always clear that it would be used in combination with documentary activities such as interviewing residents of a neighborhood. For the present field study hence, the teachers distributed - in addition to the tablet PCs for the use of AnzenMap - a digital camera and a voice recorder to each of the participating groups. The logic consequence of this was that AnzenMap was criticized by both pupils as well as teachers for its "lack" of multimedia support.

Another point that falls into roughly the same category is the fact that AnzenMap uses icons (e.g. for trees, traffic lights, supermarkets etc.) and a stamp-like input method, in addition to primitive-based drawing, as means of expression while SketchMap does not. Necessarily the question arises of where to draw the line between *too few* icons, *enough* icons or *too many* of them.

And finally, a question that arose: How, if at all, would it be possible to guide the pupils' focus of attention in a way favorable to the intended educational goals? For instance, during our study the children's attentions were heavily drawn towards small details well visible during day light such as hidden staircases. They did however rarely ever consider how an area would look like during twilight or at night and how that would affect their judgments of it.

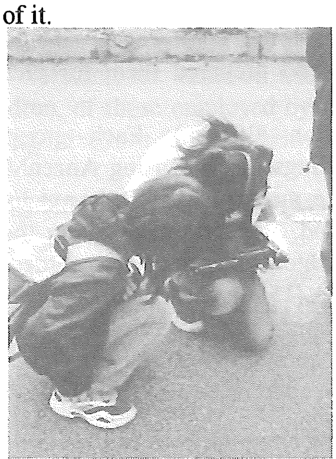

Fig.5:User's behavior

5. Conclusion and Outlook

In this paper we have presented the concepts as well as an initial implementation of SketchMap, a tool that aims at supporting primary school children in the creation of a 'personal environment' map. SketchMap combines face-to-face and distributed collaboration with technologies such as WLAN and GPS, while its interface relies on pen-based interaction. We have furthermore introduced AnzenMap, a SketchMap offspring intended for the support of security mapping activities in schools.

The presented user study gave us the opportunity to expose the system's concepts and ideas to its prospective users, and collect feedback related to both the system's usability as well as the hardware it is running on. As could be expected in such early a development stage, there naturally remain pitfalls and short comings to be addressed in the future. All in all it can be said though, that our approach was favorably welcomed by the pupils and proved beneficial to enhance their motivation and willingness to lively participate in an otherwise "only compulsory" activity.

Functions that are being developed at the time of writing include aspects such as awareness [17] among groups in an outdoor environment realized through WLAN as well as topology preserving transformations based on the GPS data points which can be introduced by the children into their sketches. We intend to facilitate further support to children during the act of merging sketches, such as a visualization of the differing coordinate systems and scales used by each group of children to draw their sketches, or an automatic merge function for the final stages of instruction as well as support to better locate drawn sketches in the larger context of e.g. a town map. These functionalities form the other half of SketchMap and will be evaluated and discussed in future user tests.

Acknowledgements

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