Design of an Interface for Technology Supported Collaborative Learning – the RAFT Approach

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Abstract. In the emerging scenarios of distributed education, design plays a key role in shaping new ways of collaboration and knowledge management. In the Remote Accessible Field Trips (RAFT[1]) project described in this paper, we aim to support high school students' field trips with mobile technology and to enable real-time remote collaboration with the classroom. In this paper we look at the pedagogical issues and consequences for the interface design. We propose a role-centred interface design approach, aiming at the development of dedicated tools and interfaces.

1 Introduction

The ongoing development of information communication technology, especially in the direction of wireless technology, puts the basis for new distributed scenarios and new forms of situated learning and knowledge management.

These issues imply new challenges in terms of interaction design, suggesting the need of new forms of interaction patterns between users and environments, and between users and users.

In this paper we describe the design approach adopted in the ongoing European funded project RAFT (Remote Accessible Field Trips). In order to accomplish the aim to deliver an enjoyable and engaging learning experience, we support the idea that consistent effort must be invested in acquiring knowledge of the domain, understanding the educational dynamics and identifying collaborative learning patterns to support the appliance design activity, both in terms of software design and interface design.

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2. The RAFT Concept and its Pedagogical Ground

The main objectives of the RAFT project are to demonstrate the educational benefits and technical feasibility of remote field trips for high school students.

It has become more and more difficult in many countries to organize field trips due to various reasons, including finance, staffing levels, health and safety. RAFT envisions facilitating field trips for schools and enabling remote collaboration of schools. Web based video conferencing and wireless networking is used to enable an integrated, interactive system to link field trips and classrooms in real time, so as to establish extensions on current learning material standards and to exchange formats for contextualization of learning material.

Several fields related to experiential learning, education and training, rely on the idea that people can learn very effectively through direct, hands-on experience, as long as these experiences are well designed and facilitated (Dewey 1938) [1]. According to Dewey, educators are responsible for providing students with experiences that are immediately valuable and which enable the students to contribute to society in a better way. The value of the experience is to be judged by the effect that experience has on the individual's present, their future, and the extent to which the individual is able to contribute to society.

John Dewey's educational philosophy has inspired most of the experiential educational theories that are used in many outdoor educational programs. Experiential Learning Cycles [5] (ELC) are educational principles based on the idea that by breaking the fuzzy processes of learning into distinct stages we can better understand how the process of learning works. Several ELC have been identified and organized in terms of the numbers of stages they propose: the most popular is probably the Kolbian 4-stage model [6], consisting of *concrete experience*, *reflective observation*, *active experimentation* and *abstract conceptualization.*

3. Recognizing and Applying Patterns, the RAFT Scenario

Design patterns move on the same need to structure an activity by identifying an underlying framework based on recurring events, in order to draw generalizations and suggest solutions.

In order to recognize patterns and build a pattern language, domain knowledge is a main issue. In Computer Supported Collaborative Learning (CSCL) it is essential to gain an understanding of the learning activity in order to leverage new engaging learning experiences enabled by wireless technology.

In the first year of the RAFT project the different phases and functional requirements for supporting live collaboration and information access during field trips were worked out. The approach we adopted is in line with existing methodologies of scenario based design, contextual inquiry, evaluation of technology and participatory design.

In the initial stages of RAFT, various workshops for teachers were held in the partner countries so as to draw scenarios. In the workshops teachers were familiarised

with the RAFT concept, so as to gather ideas and issues for RAFT field trips. A general RAFT scenario sees a teacher preparing a field trip as part of a course, structuring several modules including various tasks to be distributed among students in the field and in the classroom. The learners in the field and in the classroom work in teams in order to accomplish the assigned tasks. The groups going to the field are equipped with data-gathering devices (photographic, video, audio, measuring), wireless communication devices and a video conferencing system for direct interaction between the field and the classroom. Learners at school can ask questions, influence the behaviour of their peers in the field, and help them by providing information they request, analyze the collected data and eventually archive it.

4. Roles within the RAFT Experience

By analysing learning scenarios, encountering main issues repeatedly occurring, we recognized and applied collaborative and pedagogical patterns. Because of the nature of the activities that make up a distributed field trip, including gathering of information in the field, answering questions, analyzing data from the field in order to provide immediate feedback, and communication taking place between the field and classroom, a wide spectrum of interaction between the participants needs to be enabled.

Referring to the work of DiGiano concerning collaborative learning patterns [2] we recognized in RAFT design issues consistent with the *Pipeline Workflow* activity pattern. This suggests a solution for the problem of "a teacher who needs to organize student activities in a complex task in a way that allows each student to play a meaningful role that requires cooperation with other students". The solution proposes that "Students work individually on a shared and accumulating data form. As each student completes his/her portion of the data calculations, he/she sends the revised form along to the next student in the sequence. The teacher initiates the activity by describing data collection procedure and rationale, forming students into groups, and distributing a base blank form to the first group member assigned to the first task in each group. Next, the teacher instructs students on how to operate within the sequence and how to save and send the form along, including to the final database."

This led us to draw a setting in which different users play different roles and perform different tasks to accomplish a shared goal. This approach finds consistent support in the Role Play Pedagogical pattern described by Jutta Eckstein [3]. This addresses the problem that "the complexity of some concepts makes them hard to understand with only abstract explanations. …You not only would like to provide a positive learning environment, so even learning complex topics might be fun, but you also want to take into account that different people learn things best using different sensory modalities." The suggested solution is to "invite your students to behave as a part of the concept involved in a role play. Every student plays one part of the concept to get a deeper knowledge for its underlying structure. Because role play is almost always implemented by a team of players, it also builds human interaction and social skills."

The inquiry activities undertaken so far have been essential application design tools to recognize and apply patterns, identify workflows, specify roles and users' needs, evaluate technology and suggest interface design solutions.

CSCL research has approached Activity Theory (Nardi, 1996) as inspiring theoretical ground for interaction design methodologies (e.g., Gifford & Enyedy, 1999) [4]. According to Nardi [7], activity occurs within the framework of an objective and a community of users, in which rules and roles affect peers' behaviors, and in which the outcome can become another activity or artifact. When taking the distributed scenario into account, this generative nesting - coupling the output of one activity to the next sequential activity or within a hierarchical framework of activities - suggests the potential for new pedagogical sessions. Furthermore, the division of work becomes a main category of coupling roles and rules, as work can be divided in multiple representations among multiple devices, to provide a larger overall screen space in the classroom.

5. The Design Approach

Each role can perform specific functionalities and needs therefore a specific interface and device, rather than the "Swiss Knife" multi-functional interaction tool.

Given the dynamic set of devices that characterizes the RAFT Field Trips, the challenge is to provide a single GUI that runs on all the devices and yet accommodates the input, output and processing capabilities of each device. Our approach in this matter proposes a widget-based scalable and modular interface, which adapts to the role and to the device.

To clarify this approach and illustrate how some patterns identified can be realized on the basis of a flexible role-based architecture, we present the role of a Scout as example. We illustrate here the case of a Scout getting involved in a task to detect a certain tree in the field. According to the related use cases, the Scout searches for interesting points in the field and needs to be informed about tasks; to be able to send information about interesting locations (hotspots); to communicate with other users in the class and in the field. A device suiting these requirements is a GPS, GPRS enabled handheld device, providing features of portability and trackability: the user interface for a Scout on a Gotive handheld device is shown in Figure 1.

Fig. 1. the Scout's User interface on a Gotive device

The Scout mainly cooperates with the Task Manager in the classroom and the Data Gathering teams in the field. Therefore, the entities a Scout manipulates go into a consistent field trip object repository and can be seen and manipulated by other team members in the field and in the classroom.

The Scout starts to search for points of interest and scans the environment; as soon as he/she finds something interesting, he/she locks the position and a notification with the Point Of Interest (POI) record is stored in the shared field trip repository (see interaction flow in Figure 2).

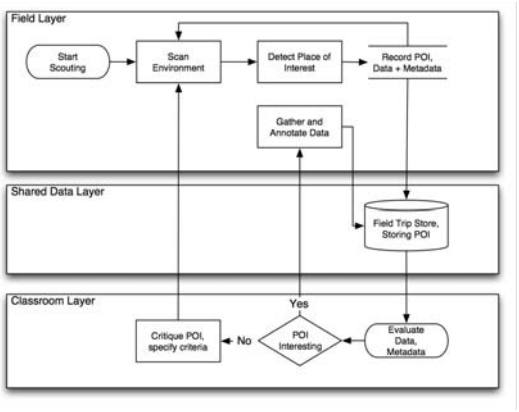

Fig. 2. Schema of the Interaction flow

The repository automatically sends a notification to the team members and also to the Task Manager. Awareness about changes in the state of tasks and data collections for tasks plays an important role for the collaborative work and the design of the interface. The Task Manager evaluates the data and the metadata of the Scout and decides whether more scouting is needed or the data gathering and annotation can start (Fig. 3 shows the Task Manager's view on POIs based on the status of the different tasks he/she is managing).

Fig. 3. The Task Manager's view on a desktop PC

The Data Gatherer then works together with the Annotator in the field to collect samples and material that can be forwarded to the Task Manager and further elaborated by the students in the classroom. In this case the team players are distributed over different places and can use different devices due to the necessary mobility. Nevertheless different GUIs for the manipulation of POIs go back to a shared field trip repository.

6. Conclusions and Future Work

From the pedagogical point of view, the use of roles provides a clear methodology to start application design from educational and pedagogical functions the learners take in a realistic learning situation. The roles taken by learners can be described and mapped on to curricular goals.

From a software engineering point of view this allows a clear mapping of functionalities and user requirements to interaction widgets. As – for example in UML – the use cases are often neglected when designing the user interface and interaction, this methodology provides an approach to design complex application with a clear relation to the use cases elicited.

The developing technology promises the possibility to design new engaging learning experiences and the design methodology to support CSCL needs to raise on the understanding of the users. Context awareness in collaborative settings is going to enhance this process: by tagging the users' experience with values for a wide range of parameters, there is the chance to augment the Reusable Learning Objects with new features and dimensions, resulting from different perspectives.

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