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Supporting Experiential Learning Through Online/Onsite Interaction and Collaborative Use of Mobile Devices

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ABSTRACT
In this paper we discuss our work on supporting situated, experiential learning in social events, through online/onsite interaction and collaborative use of mobile devices such as PDAs and smartphones. We describe our empirical experiences in exploring these issues through an experiment at the Memoria Futura augmented conference and the design of the related i2tv system. We discuss the insights and lessons learned from this work - the specifics of different social situations, the typical roles and interaction styles inherent to such augmented contexts, and their implications for interaction design to support learning in such conditions. We show how the undertaken field trials point to the need for supporting active participation of the audience on-site and for enhancing co-located social interaction. In particular, we discuss how our findings informed the design of a mobile application concepts and the MoMAS system for personalised media annotations and visual awareness of shared community experience. Finally, we discuss how this concept supports experiential learning through unobtrusive creation of personal memories of shared events, augmented co-located P2P social exchanges and collaborative reflection on shared experience. In doing so, we present related interaction designs, early prototypes and outline future work.

Categories and Subject Descriptors
H.5.1 Multimedia Information Systems. H.5.2 User Interfaces. H.5.3 Group and Organization Interfaces K.3.1 Computer Uses in Education - Collaborative learning

Keywords
CSCL, Interaction Design, Mobile Applications, Mixed Reality, Situated Learning, Communities

1. INTRODUCTION
In this paper we discuss our work on investigating how to support situated, experiential learning from everyday social experiences through online/onsite interaction and mobile devices.

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1.1 Experiential Learning
The notion of experiential learning is a constructivist notion that refers to the idea of situated learning as a fundamentally social process grounded in experience and in encounters of the learner with different situations. While some authors use the term "experiential" [9] others have introduced notions such as "legitimate peripheral participation" [10] to describe learning through processes of social participation, or the concept of communities to describe the primary social contexts in which learning takes place [4], [21]. What all of these have in common is that the emphasis is not on learning in classrooms but on learning through participation in social practices.

With the widespread availability of personal mobile devices this leads to the question of how can such devices be used to support and augment situated social interactions as a fundamental source of experiential learning. In contrast, the majority of existing work on mobile support for learning has focused either on straightforward transfer of e-learning models to mobile devices (so-called m-learning) or on instructionist classroom-based settings [1] and meeting support [5], [6]. Only recently, more attention has been given to investigating possibilities for using mobile devices to support learning as a process happening in the everyday experience and social interaction of people [18], [19]. In addressing this issue we take a specific kind of social occasions, the conference, as an archetypical situation and a concrete context in which experiential learning takes place through situated social interaction. Since such learning is highly situated in a given social (and spatial) context, it is by its very nature always both a highly context-dependent and collaborative activity [20], [16].

1.2 Conferences as Archetypes of Situated Learning Experiences in Communities
Learning from experience at conferences is a mixture of three main elements: personal reflection and discussion of the content delivered in presentations of conference speakers, conversation about topics of common interest with other attendees and socialization in informal occasions (e.g. conference dinner). The speaker presentations and their discussion with other attendees are a form of learning through creating and exchanging explicit knowledge. Socialization and conversations not stricitly related to conference topics are a traditionally rich source of learning through sharing implicit knowledge. While learning from conference presentations is extensively supported (conference proceedings, powerpoints, videos etc.), the support for informal

social learning taking place through conversations between conference attendees is hardly considered. The knowledge flows and results of these conversations remain confined to the peer-to-peer communication between parties involved. At the same time, these interactions are often the most lively and most interesting parts of the event. They generate a multitude of different perspectives both on the content presented in the talks, as well as on the various topics of broader interest to the community. It is in the articulation and the exchange of these perspectives through social interaction that learning takes place – the ability to recognize and take on different perspectives in order to "see the world with different eyes" is a crucial prerequisite of learning.

Thus, while conference talks largely contribute to learning a limited part of explicit knowledge, it is through the social interactions that perspective making and perspective taking as mechanisms of learning take place [2]. It is also through these interactions that the sharing of tacit knowledge and maintenance of community awareness is enabled. In contrast, the standard conference proceedings and web archives reflect only a slight portion of the energy and knowledge created and shared in conferences in the flows of experiential learning through social interaction.

Against this background, following questions emerge: How can we find appropriate ways for making visible the multitude of different knowledge perspectives emerged as the result of shared conference experience? How can we support the emergence of shared artefacts that reflect a collective memory of personal impressions of a shared experience? How can this contribute to supporting and enhancing experiential learning situated in personal reflection and informal social interactions ?

1.3 Structure of the Paper

In this paper, we describe our experiences in addressing these issues through the use of mixed reality concepts and mobile devices. First we describe our experiments with augmented conferences formats which integrate on-line/on-site participation and show how this relates to experiential learning. We discuss the insights and lessons learned from the field trial at the Memoria Futura Symposium - the typical roles and interaction styles inherent to such augmented situations, and their implications for developing scenarios and applications to support social learning. We observe how these findings uncover the need for supporting co-located social interaction and describe the design of an application scenario based on using mobile devices for personalised media annotations and large projection screens for collaborative reflection on shared community experiences. We present early interaction designs and the MoMAS system for the realization of these concepts. We conclude how this supports experiential learning by augmenting co-located social interaction and outline future work.

2. INTEGRATING ON-LINE AND ON-SITE INTERACTION TO A LEARNING SPACE

Our first approach in addressing the described questions was based on the idea of extending the common conference format by integrating online participants into a conference discussion onsite. Most approaches view this as a problem of using technology to bridge geographical distance (e.g. videoconferencing, chat). In contrast, we were interested in using online/onsite integration as a means of creating new content and enriching the experience for all parties involved. We wanted to explore how the specifics of the "distant" vs. "onsite" situation can be used as intrinsic elements that *enable* the development of new forms of content and interaction – providing new, previously unavailable perspectives and leading to new forms of shared experience. This led us to the need of considering the characteristic differences of the remote and local situations (spatial, informational, social), the ways they are augmented by technology, the related roles and patterns of interaction and communication.

In order to empirically investigate these issues we conducted an experiment at the Memoria Futura Symposium at GMD. This trial departed with the common conference format as a point of departure in developing new models for connected on-line/on-site events [11]. The goal of the experiment was twofold: 1) to identify a minimal set of requirements needed to integrate on-line participants into the situation on-site and 2) to investigate how such integration could support the creation of new points of view, normally not available in standard conference formats. Its findings allow us to describe the context of the augmented conference situation and inform the development of new concepts and applications for supporting experiential learning. In particular, they illustrate how our original goal of exploring new forms of cultural experience can be related to supporting learning through emergence of new knowledge perspectives from the dynamics of online-onsite interaction.

2.1 The Memoria Futura Interaction Concept

To achieve this a group of invited experts was integrated into the discussion on-site as Internet participants through the i2TV system. Live audio and video from the symposium were streamed to remote participants as Internet streaming and as digital TV broadcast via satellite. On-line participants could intervene into the symposium by means of text which was made visible on-site in two ways. First, the complete view of online activity was displayed on a projection screen. Second, most important comments from online participants were selected by a moderator and displayed on the fly in large letters. These selections were also propagated to the web interface of on-line participants in order to provide a feedback of the moderator's actions (Fig. 1).

Figure 1: i2tv interface at Memoria Futura Symposium

In this way, online participants were considered neither as passive viewers, nor as individual remote speakers. They were integrated as sources of additional content, simultaneously with the speaker's presentation – providing new points of view on the presented content and acting as a kind of commentators. Furthermore, the time-based archive of their online discussion provided an alternative content which could be viewed later on in its entirety, as a kind of critical feedback on the content presented by the speaker. This concept aimed at actively supporting audience reflection on the presented material by providing some initial points of view for critical discussion – an aspect commonly missing in "normal" conference formats. Thus, supporting the ability to see the content from different perspectives as a crucial prerequisite of learning.

2.2 Technical Realization: the i2tv System

In order to realize this we developed the i2tv system [11], [13] for medial staging of online/onsite event. It combines technologies for multi-user interaction and awareness with broadcast such as Internet streaming and digital TV, and with mixed reality in shared physical space. It provides independent levels of implementation for broadcasting the on-site situation to on-line participants, for presence and interaction of on-line and on-site participants, for different input and display devices, and for medial staging on-site. It consists of the following modules:

- MOO server – platform for multi-user environments,
- RealServer – platform for streaming video over Internet,
- e-MUSE – system for multi-user interaction in a combination of shared physical and virtual space,
- 3DK Virtual Studio – distributed Virtual Studio system,
- eMOOSE – interface and module connection layer.
- Display and input devices – Web browser, handhelds.

Figure 2: Basic structure of the i2tv system

The MOO system [7] provides support for multi-user communication and awareness, event propagation, spatial structuring, behaviour scripting and shared virtual space. In i2tv system the text-based MOO system is extended into a framework for spatial structuring of hypermedia elements. The MOO is employed as an abstraction layer for generic representation of a shared virtual space, independently of the format of content representation (text, 2D, 3D). It serves as a universal layer for modelling interactions between on-site and on-line participants. For enabling appropriate forms of interaction for different roles of on-line and on-site participants, a range of interaction channels is supported such as moderated chat, streaming audio/video, text annotations to live video, 3D content creation in Virtual Studio, movement tracking and content creation in shared 3D space.

2.3 Evaluation: Roles and Interaction Styles

In evaluating the trial [11] we used the method of subjective analysis such as informal interviews with audience and participants, and written evaluations of professional observers. This was accompanied by objective analysis based on the video recording of the event and on the log files of online participants' contributions. The evaluation points to very specific characteristics of the four elements constituting an on-site/on-line event. They can be represented by the following roles:

- on-site speaker: the actor,
- on-site audience: the passively involved,
- on-line participants: the commentators,
- on-site moderator: the director,
- on-line viewers: the analysts.

The on-site speaker finds himself in the situation of both exposure and control. His goal is to lead the audience along his way. Hence the metaphor of an actor performing a piece. Being physically present and subject to the speaker's verbal action, the on-site audience is the only party really immersed into the situation. This implies a lack of distance for reflection. The only real possibilities of participation remain that of emphatic involvement, and immediate reactions rather than reflective considerations. The inherent nature of the situation of on-line participants is the feeling of not being exposed, since physically not "being there". This is reinforced by symbolic representation through photo-icons, rather than live video streams.

As a result, on-line participants turn out to be more prone to open discussion and critical remarks. Not being immersed into the situation created by the speaker on-site gives them the power to act reflectively. On the other hand, being able to make themselves noticed only through active production, results in the urge to act, which diminishes the objective part. The Internet viewers are the most uninvolved participants. They are invisible on-site, and consequently distant and cold. They can stop, rewind and replay at will, and do not feel obliged to follow the speakers flow. Hence the analysts metaphor.

Making the on-line discussion visible simultaneously with the talk delivered by the speaker on-site is a straightforward but ineffective way of visualising activity and contributions of on-line participants. The audience perceived it as a good indicator of on-line participants' activity, and hence of their presence, but not as means for conveying actual information. In contrast, having only selected on-line contributions projected in large letters by the on-line moderator, was appreciated as interesting side comments, providing a different point of view to what the speaker was saying. Propagating these selections to on-line participants was regarded by them as a very welcome feedback that enhanced their sense of involvement. Most speakers considered projecting these selections during their talk as an unwelcome distraction. Only a few tried to establishing some kind of communication with participants on-line.

2.3.1 The Presence Paradox

The on-site audience perceived on-line participants as being in the advantageous situation due to their active participation, in spite of their physical absence. This shows that available channels for active participation can be more important than physical presence. An equilibrium of participation channels for all parties involved is needed. The concept of personal media annotations as a model for non-disruptive audience participation throughout the event addresses this issue.

2.4 Visualizing the Learning Space: Is It Archive or Memories ?

The archive of an event commonly comprises only visible manifestations of participants' actions. What is missing is a dynamic account of the audience reception. What personal imprints did the event leave with them? Integrating asynchronous interaction into creation of content during a particular live situation becomes an important issue in this respect. To this end, subsequent development of the i2tv system extended the notion of a time-based hypermedia archive to an individualised memory space. The main idea is that the audience on-site and viewers on-line can make annotations to the video stream of the live situation, using their cell phones, palmtops or PCs. As a result, instead of a linear timeline the history of the event can be visualised according to the timepoints set by the viewers' actions.

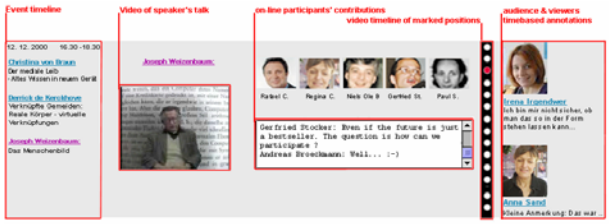

Figure 3: Visualising the event through personal impressions

These provide the structure onto which all the individual elements of the event can be mapped: the recorded video, the contributions of on-line participants, the comments of on-line viewers and of the on-site audience. Instead of an archive, a space of individual memories is built up. It can be visualised by the moderators, or looked up by the on-line viewers and participants, in real-time during the event not only at its end.

Rather than a collection of "objective" facts captured by the camera or text logs, the hypermedial archive of the event can nowbe visualised as a collection of personal impressions (Fig. 3). In effect, a space of individual memories creates a memory space of collective experience. This lays the ground for supporting and visualizing the commonly invisible social “learning space”. The next section describes mobile concepts and applications that expand on these insights to enhance co-located social learning.

3. FACILITATING CO-LOCATED SOCIAL LEARNING WITH MOBILE DEVICES

One of the results from the described trial has been the successful support for alternative viewpoints to be voiced and perceived as a way of supporting the learning experience beyond standard conference formats. Another critical finding has been the need to augment co-located social interaction as a principal source of different perspectives on the shared social experience. It is in the conversations and peer-to-peer social exchanges at conferences that a multitude of different perspectives both on the content presented in the talks, as well as on the various topics of broader interest to the community are articulated and exchanged. This is both a process of social learning and of reinforcement of shared community awareness.

As observed in the trial there are two significant participation contexts that determine the appropriate interaction styles. The first is the “impression modus” in which the audience finds itself during the speaker’s presentations. The audience is immersed in the talk which implies a lack of distance for reflection. The only real possibilities of participation remain that of emphatic involvement, and immediate reactions rather than reflective considerations. This modus requires simple, unobtrusive interaction support. The other is the “reflection modus” in which attendees find themselves during conversations with other attendees (e.g. in coffee breaks) when they explicitly discuss their impressions and opinions of the talks, and other themes of common interest. This is where they can be supported more actively in order to facilitate co-located collaborative reflection. Against this background we developed the following scenario and application concept for supporting the expression and visualization of personal impressions and for collaborative reflection on the shared experience.

3.1 Unobtrusive Support for Expressing and Capturing Personal Impressions

During the talks attendees can express their impressions and immediate feedback, by using their mobile phones or PDAs to mark the spots in the talk which spurred their interest, evoked an idea, met their agreement or dispute, or simply left them puzzling. They do this by clicking on a predefined shortcut button or tapping the appropriate button in a mobile application interface, which they previously downloaded to their device (e.g. from the wireless/Bluetooth conference server). This creates timestamped bookmarks which are both stored locally in a personal event bookmarks folder and transferred to a shared server. By default, the bookmarks contain only timestamps and session info, but can also be expanded by handwritten notes or voice memos, using standard applications provided by a given mobile device. In addition, if explicitly declared as “published” by the user, the owner information and his full notes can be included.

As a result, after each talk users have created a personal bookmark folder containing time-based media annotations that reflect their impressions. This is a basic kind of personal feedback and viewpoint on the perceived content. Since the modality of entering these annotations is very simple and straightforward it is non-distracting and unobtrusive with respect to the talk being followed. This respects the appropriate interaction style for the described “impression modus” characteristic for the audience role.

Users’ annotations are synchronized with the video recording of the event and with the slides displayed by the speakers. The distribution of users’ annotations is then visualized along the timeline of the event as a navigation interface which reflects a personal memory of the event. Clicking on the given annotation displays the context of that point in time: the snapshot of the speaker, the slide corresponding to that timeframe and the remarks made by the user (if any). In this way, a lightweight but powerful means for providing a basis of capturing and visualizing personal memories has been created.

Different forms of visualizing this “view in context” based on personal impressions can be called up, depending on the kind of mobile device, use context and display properties. The two main models include the described timeline navigation view and the cluster view which presents groups of related topics and similar users based on the analysis of user profiles represented by their bookmark folders. This grouping and visualization are realized by a combination of collaborative filtering techniques and kohonen maps that has been developed in the AWAKE project [14].

Using such views in context for navigating personal memories is a way of supporting learning through personal reflection, embedded in the social and spatial context of the conference. Accessing memory timelines of other users is a way of discovering different perspectives, as the talk content will be displayed in a different context, as seen by different users. This supports learning through discovering different perspectives. Both of these modalities support learning through processes of internalization and combination. But the visualizations can also be used to support social interaction. A straightforward way is to use the cluster view for finding attendees with similar interests or with interesting points of view. Having identified interesting people they can be approached for a conversation enabled by the informal conference. Thus we facilitate learning through social interaction.

3.2 Supporting Collaborative Reflection and Community Awareness

Once the personal impressions have been expressed in the described way by different users they can be used to support co-located social interaction in two ways. First, the overview of the talks with accompanying timeline views i.e. displaying groups of user annotations on various talks can be visualized and displayed on a large projection screen in different conference spaces (e.g. coffee break rooms). Providing such shared displays of the different viewpoints on the conference experience is a way of stirring discussions and comments between groups of attendees, during the informal socializing occasions. Since these are occasions in which participants are in the "reflective modus" such overviews are in line with appropriate interaction styles (see 2.3).

Second, the cluster view of related topics and similar users based on the analysis of annotation profiles of different users can also be projected. This is a way of visualizing patterns of shared experiences to larger groups of participants. In contrast to a single user using this view on his mobile devices to identify interesting conversation partners, here the group awareness of shared community topics and different viewpoints on them is stimulated.

The envisaged scenario is that people gather around such displays and comment on the emerged relationships between topics, talks and different viewpoints on them. We have tested similar scenarios in the AWAKE project and netzspannung.org workshops. There we used cluster views of extracted topic relationships from online community information pools and personal bookmarks as knowledge artifacts for stimulating discussion and collaborative sensemaking in workshops [8], [12].

In a similar way, experiments such as [3] have used dynamic wearable tags and projection screens to stimulate social exchanges of statements and opinons between members of a conference. They report good acceptance of this model which confirms the suitability of our approach. However, in their approach the "fun based" exchange of statements was not representative for typical conference interactions. In our approach, the user feedback is directly related either to the conference topics (personal impressions) or to the broader context of the community discourse (discussions between attendees).

We hypothesise that using the described model of expressing and capturing personal impressions through mobile devices and providing the visualizations of emerged community topics on shared projection screens, is a way of augmenting co-located social interaction to support experiential learning.

This also seems to be a possible way for visualizing and facilitating at least a portion of normally invisible knowledge flows that makes up the main tissue of conferences as community events – thus supporting broader community awareness.

3.3 Technical Realisation: the MoMAS – Mobile Media Annotation System

The described concepts and application scenarios have been prototypically tested with existing functionalities of the i2tv system (Chapter 2.2). In order to enable full realization and future field trials, we have designed the MoMAS multimedia mobile annotation system that is currently being implemented. This system aims at supporting participation of physically co-located participants, through creating rich-media notes using their personal mobile devices and reviewing them collaboratively on large projection screens.

The MoMAS architecture consists of the following elements: database server, streaming media server, annotation server, visualization server, interface / device applications (Fig. 4). Its modular design allows standard OpenSource or commercial modules to be freely used for individual parts. In the current partial realization we use the Postgres database and RealMedia Server installed on the netzspannung.org system combined with the the video notes test application and the MOO module from the old i2tv system as annotation server. The visualization server supports JavaWebStart Knowledge Explorer Client developed in the project AWAKE. The mobile interfaces are currently based on simple Web-Forms and JMDI interfaces are in development.

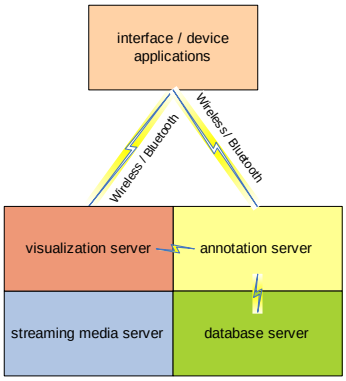

Figure 4: Basic structure of the MoMAS System

Such architecture supports the application concepts and scenarios described in the previous section in the following way. The conference participants can use mobile devices (PDA, smart phones, and mobile phones) to send their notes to the annotation server, without need to connect to the Internet. Due to its simplicity, local connection onsite is made using Bluetooth, enabling easy file transfer, without need for special provider services. The annotation server deals with communication with onsite mobile clients, receives the media notes and stores the time relation between the notes and video sections into the database. The streaming server archives and distributes video/audio streams of the Webcast. The relations between media annotations and stream's timestamps are delivered through the communication of the annotation and database server. The visualization server generates XML-based output. On the users' side, mobile interfaces and applications use the information from the visualization server, but also receive archived video materials

from the streaming media server in form of rich-media presentations or video-stills. For displaying visualizations on projection screens the corresponding PC needs to connect to the MoMAS server and download a suitable visualization client manually. In future, the automatic class-deployment framework for nomadic computing applications [17] shall be integrated, to allow automatic configuration of heterogeneous devices (PDAs, Smartphones, PC with projection screens) in the MoMAS system.

4. CONCLUSIONS AND FUTURE WORK

In this paper we discussed our work on supporting situated, experiential learning in social events, through online/onsite interaction and collaborative use of mobile devices such as PDAs and smartphones. We described our empirical experiences in exploring these issues through an experiment at the Memoria Futura augmented conference and the design of the related i2tv system. The lessons learned about the typical roles and interaction styles inherent to such augmented contexts, informed interaction designs for supporting experiential learning.

This trial demonstrated how the support for alternative viewpoints to be voiced and perceived is a way of enhancing the learning experience beyond standard conference formats. It also pointed to the need for supporting active participation of the audience on-site and for enhancing co-located social interaction. It is in the conversations and peer-to-peer social exchanges at conferences that a multitude of different perspectives both on the content presented in the talks, as well as on the various topics of broader interest to the community are articulated and exchanged. This is both a process of social learning and of community awareness.

Informed by these lessons, designed a mobile application concept and the MoMAS system for personalised media annotations and visual awareness of shared community experience. We described how views in contexts in form of memory timelines and cluster views can support learning through personal reflection, discovery of new perspectives and attendees with interesting points of view. Finally, we considered how this concept supports experiential learning through augmenting co-located peer-to-peer social exchanges and collaborative reflection on shared experience. By referring to empirical evidence from related work we argued how the presented model of combining mobile support for unobtrusive capturing of personal expressions and large projection displays for visualizing patterns of shared experiences to larger groups of participants is a promising way of supporting experiential learning in situated social interaction. Ongoing work includes further implementation of the MoMAS system for enabling full realization and field trials of described concepts and applications.

5. ACKNOWLEDGMENTS

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