Don't Annoy the Informal Teacher:
Context-Aware Mediation of Communication for Workplace Learning

Simone Braun
(FZI Research Center for Information Technologies
Simone.Braun@fzi.de)

Andreas Schmidt
(FZI Research Center for Information Technologies
Andreas.Schmidt@fzi.de)

Abstract: Verbal inter-human exchange forms an important part of informal learning, especially for workplace learning. But informal learning of an employee within inter-human communication implies informal teaching of another employee on the other side. And in the same way we try to integrate the learning process into the surrounding work processes, we also need to integrate the teaching process into the work processes on the teacher side. As a method for matching interests on both sides, we present in this paper the *context-aware mediation* of communication between the learner and the informal teacher.

Keywords: workplace learning, informal learning, informal teaching, communication, interruption, context-aware mediation
Categories: K.3, H.1.2, H.5.3

1 Introduction

Informal learning has gained a lot of attention in the last years. It is increasingly recognized that informal learning makes up a much bigger share of learning activities than formal learning [Livingstone 00]. A new paradigm of e-learning (or technology-enhanced learning) is currently emerging which does not translate the classroom model into the virtual world, but rather originates from observations of everyday activities, especially at the workplace. This paradigm is characterized by learning on demand where employees learn just when it is actually needed. So far, this paradigm has been realized in approaches like [Farmer, Lindstaedt 04] and [Schmidt 05] with process- or context-aware delivery of learning objects or less didactically designed documents (e.g. from organizational memories). The inter-human communication dimension of informal learning that plays a decisive role for knowledge transfer in particular in workplace learning [cf. Grebow 02] has been neglected so far. In the knowledge management domain, support for communication is basically restricted to locating experts. But as for learning on demand with learning objects, a search engine is simply not enough.

Informal learning of an employee within inter-human communication implies informal teaching of another employee on the other side. And in the same way we try

to integrate the learning process into the surrounding work processes, we also need to integrate the teaching process into the work processes of the teacher side. Informal teaching is always a compromise between getting disturbed and benefiting from the teaching activity by gaining a deeper level of understanding through explaining or gaining social esteem. If we do not balance costs and benefits, the informal teacher will get annoyed, which has been an ongoing problem in expert finder applications [cf. Rosenberg 06].

In this paper, we want to tackle this problem by mediating the communication between the potential learner and the potential teacher, and we want to focus on knowledge-intensive work environments where work can still be structured into repeatable processes (where competency requirements can be attached to). The major assumption here is that annoyance of "teaching requests" can be avoided or reduced if we also consider the context of the informal teacher. More specifically, in order to understand the causes of annoyance, we especially have to take into account the following factors:

- **Timing.** Sometimes communication is simply poorly timed and thus disruptive. Right before a meeting or in the middle of a highly creative process is probably the worst situation in which to disturb.
- **Subject.** More subtle is the dependence on the subject. But it should be clear that any "context switch" is cognitively challenging and should thus be avoided. But if you are just working on something similar to what the learner wants to ask about, the teacher will be much more benevolent.
- **Communication partner relationship.** Regardless of timing and subject similarity, it should also be clear that the quality of social relationship between the learner and the teacher is very important. There are always colleagues to whom you will answer even though you are in a hurry, while there are others you will never allow for disturbing you.

In the remaining part of the paper, we first want to analyze the problem of annoying in more depth by considering research in the context of human-computer interaction and will then present an approach of context-aware mediation of communication. As a first demonstrator, an instant messaging application scenario will be presented.

2   Analyzing the Problem of Annoying

In today's mobile information society people are reachable at almost any place at any time. A learner can easily approach various contact persons (all of them potential informal teachers) and is not restricted to persons at the face anymore. If problems or questions occur, the learner just can ask e.g. by calling a person she knows or writing a message in a discussion forum. However, the various possibilities for communication also implicate challenges. They require time- and cost-consuming coordination and management. For instance, when sending an email it is unclear for the sender when to expect a response; and calling someone by phone will fail if the person is not reachable. So that in the worst case the learner cannot continue and is constrained to wait for the needed information. Moreover the communication initiations can annoy the teacher if they are poorly timed and disruptive, e.g. if the

person is in a meeting or if they distract her from regular activities. In face-to-face communication subtle cues like eye contact or body language, and social conventions of human-to-human interaction indicate the appropriateness for one person to interrupt another. This information lacks in communication among remote parties.

2.1 The Impact of Interruptions

Numerous studies have been exploring interruptive and disruptive communication as well as interruptions in general. Studies by Bailey et al. [Bailey et al. 01, 04] show the negative effects of interruptions on user's task performance and emotional state. Compared to a non-interrupted task they stated an increased performance time for an interrupted task. The users experienced a higher level of annoyance, anxiety and complexity for the interrupted task, whereas the category of the performing task and the time at which an interruption occurs also influence the perceived impact of the interruption. McFarlane [McFarlane 02] examined four strategies for deciding when to interrupt a person; immediate, negotiated, mediated and scheduled. He stated that none of these methods solely is the best across all task performance measures. Czerwinski et al. [Czwersinki et al. 00; Cutrell et al. 01] examined interruptions caused by instant messages and their influence on different tasks. They could show that the impact of a disruption depends on the time it occurs and on the relevance of the incoming message on the receiver's activity. Dabbish and Kraut [Dabbish, Kraut 04] explored the effects of awareness displays and social motivation on interruptions and their handling. They showed that the interrupted person was better in performing their primary task when the interrupter got information about the communication partner. Further they stated a performance increase on receiver's side if both parties had a common group sense caused by a more empathetic interruption scheduling.

2.2 Strategies for Dealing with Interruptions

Dealing with interruptions in communication provides two strategies depending on the location of the responsibility for communication initiation: the communication initiator's responsibility and the system's responsibility. The first strategy is based on the approach of social translucent systems [cf. Erickson, Kellogg 00]. They provide the contacting person with context information about the receiver gained by various sensors to decide about the appropriateness of contact initiation. For instance, the systems Lilsys [Begole et al. 04], MyVine [Fogarty et al. 04] and myTeam [Lai et al. 03] used this approach. They tried to derive a person's presence and availability by analyzing sensors like e.g. speech, motion, location or computer activity. The systems then present this information to the communication partners. Some also show the other person's activity or suggest suitable communication channels. Admittedly, results of pilot studies indicated that the systems often fail in avoiding interruptions.

The second strategy assigns the responsibility to the system. Using sensors to infer a person's interruptibiliy the systems automatically enable or disable communication on the receiver's side. For instance, the BusyBody system [Horvitz 04] calculates the receiver's cost of interruption with the use of Bayesian networks and then decides whether an interruption is appropriate; but it does not take the initiator's preferences into account.

However interruptions are not always disruptive. Interruptions also can be advantageous if they convey useful information e.g. for achieving group goals as Hudson et al. [Hudson et al. 02] found out in investigating managers in research organizations. So that the appropriateness of an interruption caused by communication depends on factors concerning the context of both: the communication initiator and the receiver.

3   Approach: Context-Aware Mediation

To overcome this gap in communication between the learner, who spontaneously wants to request the informal teacher for help, and the informal teacher, who wants to avoid inappropriate interruptions, we present our approach of *context-aware mediation*. This mediation aims to consider the learners' current situation and their need for a helping hand as well as the informal teachers' current situation and their availability. Therefore it is necessary (1) to analyze the learners' and the teachers' contexts, (2) to match these contexts to minimize the costs and to maximize the benefits on both sides, and (3) to adapt the mediation appropriately. Thereby each role implies specific requirements and factors which determine such a context-aware mediation and which we present in the following (cf. tab. 1).

The Teacher	The Learner
Current Task	Current Task
Relevance of Request	Matter of Request
Interruptibility	Urgency
Preferred Communication Channel	Preferred Communication Channel
Cost of Interruption	Cost of Delay
Competence Level	Competence Level
Social Relationship with the Learner	Social Relationship with the Teacher

Table 1: The teacher's and learner's decisive factors for context-aware mediation

3.1   Factors for Context-Aware Mediation

On the teacher's side, the most important factor is her *interruptibility*, i.e., her receptiveness for interruptions carried by the desire not to be disrupted in *current task*. For instance, if the teacher is lost in a complex task or currently in a meeting, a question by a learner would be disruptive and annoying. Further, several communication channels require different attention by the user. For instance, the receiver initially can ignore an incoming email and respond to it later, whereas it is hard to ignore a ringing phone. Moreover, not every communication channel is always available. So that we also have to consider the teacher's *preferred communication channel*. The c*ost of interruption* represents another factor. It defines the economic costs arising for the informal teacher if she is interrupted by the learner's request and thereby distracted from her actual task. In addition, we have to determine the teacher's *competence level*. For acting as teacher, it is necessary that the teacher holds a higher competence level as the learner. Based on this competence

level, the context-aware mediation can recommend her as a teacher; especially, if any *relevance of the learner's request* can be stated for the teacher. For instance, if the informal teacher has recently experienced the same learning process as the learner and she now can repeat what she learnt and consolidate her knowledge. Here, social aspects also play a decisive role because the expert is not always the most suitable teacher. For example, the learners often favour a person being on a par and at the same competence level; e.g. a person who recently faced the same difficulties. On the teacher's side, the quality of the *social relationship with the learner* affects her general openness for answering requests. Thus people are rather disposed to help friends than to help unknown persons, or they are less annoyed about frequent requests of a friend than of a person they cannot get along with.

On the opposite, there are the learner's requirements. The learner wants to get good and quick support. Here, the urgency plays a decisive role. Sometimes the learner only wants to ask a short question that does not require an immediate answer; sometimes the learner is helpless without any immediate support, so it is necessary to convey this support as quick as possible. There, we also have to take into account the learner's *preferred communication channel*. It defines the devices the learner prefers to communicate with and which are available. As for the teacher, economic costs, so called *cost of delay*, can also arise for the learner if she does not get any help and eventually cannot continue in her task. In this way, the *current task* determines where the learner's knowledge is insufficient and, together with her *competence level*, how much she needs to know. In addition, the competence level helps to identify the appropriate informal teacher whereas the *subject of the learner's request* is important, too. If it bears reference to the informal teacher's current task, the teacher is not completely pulled out of her context. Moreover, the informal teacher can give a faster and better answer. But the *social relationship with the teacher* for the learner's purpose is an important factor as well. For instance, it is easier and less awkward to approach a confided person for help than a person you do not like and cannot get along with.

4 Implementation

4.1 Context-Aware Instant Messaging Mediation

In a first step, we realized the context-aware communication mediation considering as an example instant messaging communication. The feasibility was shown within the scope of the MatchBase project [Gross et al. 06]. We transferred the experiences for the implementation of the context-aware mediation of instant messaging communication to workplace learning. The system architecture for the context-aware mediation can be presented as followed (see fig. 1):

For capturing the learner's and the potential teacher's context, they are equipped with various hard- and software sensors. For instance, we conceived a phone sensor that indicates if the phone receiver is hung up or lifted up. The phone easily enables a reliable statement about the user's interruptibility. If the users are talking on the phone, they definitely are not receptive to incoming requests. An application sensor retrieves all opened applications and which of them is the front-most. This sensor

provides information about the user's current task. Further, the workload and thus the user's interruptibility can also indirectly be derived from the types of running applications, e.g. programming applications typically require considerable attention.

These sensors continuously collect data about their current situation, which are stored on server side by the user context manager. If the learner wants to write an instant message to the teacher, this is recognized by the instant messenger's actuator. The actuators build an interface between the system and the users. They control the instant messaging application and execute the appropriate adaptation of the mediation on users' side. Further, they send a notification to inform about the communication initiation so that the system requests and analyzes in a further step the needed information about the learner and the teacher to determine the best strategy for dealing with the communication situation. The system matches the factors of the learner and the teacher and calculates a so called degree of efficiency–brief *DOE*. This degree of efficiency determines the further system behaviour; that means the immediate delivery of the instant message in case of a high value or holding back the message in case of a low value, until a better moment for message delivery could be found. The system provides the result of the matching to the clients. On the teacher's side the actuator manipulates the instant message application and holds back the incoming message, which was transmitted via its standard protocol, until the result of the matching—the DOE value—is available and the appropriate actions can be applied. On the learner's side the actuator informs her about what happens with her message on teacher's side.
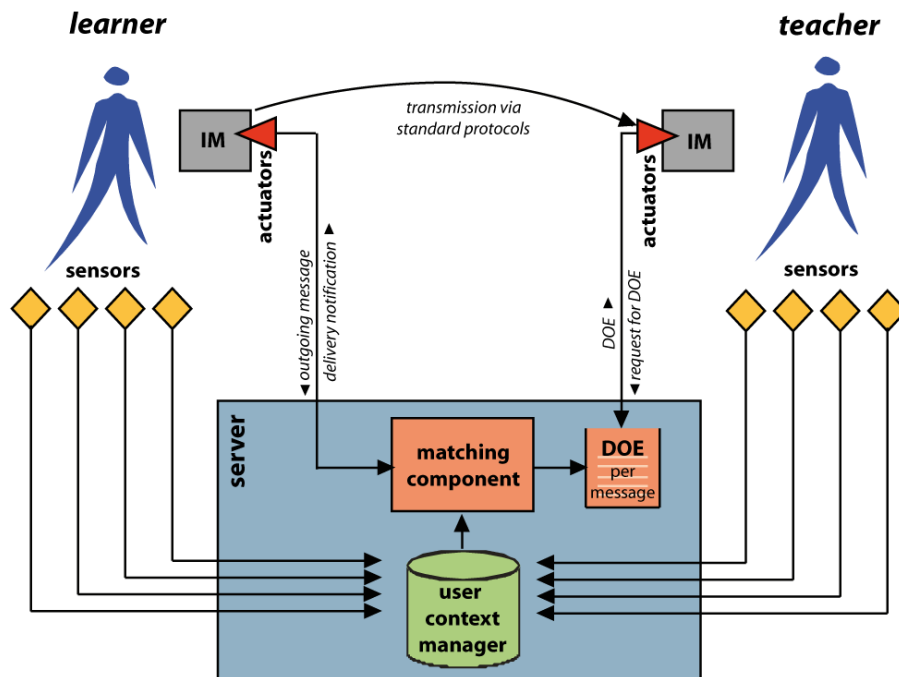

Figure 1: System Architecture

4.2 Distributed User Context Management as an Enabler

In a second phase, we have been combining the approach with the user context management infrastructure of *Learning in Process* [Schmidt 05]. This infrastructure deals with the imperfection of sensed and inferred context information and its dynamic properties, e.g., it allows for context feature specific aging, and confidence-based conflict resolution. That way, various sensors (or context sources) with different quality and overlapping scope can be combined to improve the overall quality of the collected data.

The more important benefit of this infrastructure addresses privacy issues naturally arising from such applications. This particularly applies to estimations of the quality of social relationships (which the user might set manually). It is trust-building measure to avoid storing this data in a centralized location and rather allow for local storage of this data on the respective user's machine with full access control for the user. The infrastructure allows for such a distributed approach where a central user context management component will route requests from the Matching Component to the local context stores, which answers only if the respective user has granted access privileges to the Matching Component.

5 Conclusions and Outlook

Informal teaching strongly depends on healthy social relationships and positively valued communication processes. But we have to acknowledge that teaching—even more than learning—is a cognitively demanding task that can lead to a deepened level of understanding and to increased social esteem. However by distracting people from their regular activities it can ultimately increase their stress level and make them feel annoyed. This annoying can be mainly traced back to a lack of understanding of "the other side". In order to improve informal teaching processes, we propose to impose a context-aware mechanism of mediated communication which goes beyond simple awareness mechanisms. A first implementation based on instant messaging has been successfully realized.

The next step is to broaden the basis of communication channels to phone and email, which requires additional methods for eliciting and applying contextual knowledge about the user. Ultimately, this approach can yield a socially aware combination of unified messaging techniques and workplace learning support.

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