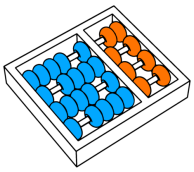
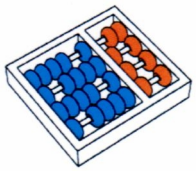


Heiko Horst Hornung

"Interaction Design in the Pragmatic Web – Reducing Semiotic Barriers to Web-mediated Collaboration."

"*Design da Interação na Web Pragmática – Reduzindo Barreiras Semióticas na Colaboração Mediada pela Web.*"

CAMPINAS
2013



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"Interaction Design in the Pragmatic Web – Reducing Semiotic Barriers to Web-mediated Collaboration."

Supervisor:
Orientador(a): **Prof. Dr. Maria Cecília Calani Baranauskas**

"Design da Interação na Web Pragmática – Reduzindo Barreiras Semióticas na Colaboração Mediada pela Web."

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Interaction Design in the Pragmatic Web – Reducing Semiotic Barriers to Web-mediated Collaboration.

Heiko Horst Hornung[1]

December 11, 2013

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Abstract

The Web and its underlying technologies enable interactions among people that were unimaginable a few years ago. An important type of purposeful interaction is collaboration. Mediated by the Web, people from different social and cultural backgrounds, with different needs, preferences and capabilities can collaborate with each other. Collaboration often takes place in heterogeneous contexts that are not only defined by the actual situations of the collaboration partners, but also by individual and collective past experiences. The Web as a medium has an impact on collaboration and facilitates or enables certain aspects of collaboration while making others more difficult.

In this PhD thesis we investigate Interaction Design related questions about web-mediated collaboration under a Pragmatic Web perspective. Our prime objective is to understand semiotic barriers to web-mediated collaboration and propose an approach to Interaction Design that reduces these barriers. Semiotic barriers are barriers related to communication, mediation and representation. These barriers emerge during web-based collaboration since many mechanisms of interpersonal face-to-face communication are not available. Depending on the context, semiotic barriers often have a negative impact on collaboration, but in some cases they might also have positive effects.

The approach to Interaction Design proposed in this PhD thesis is rooted in the Pragmatic Web and uses Organizational Semiotics and Activity Theory as its theoretical and methodological frames of reference. The theoretic investigations were practically grounded in real world practices by participating in a research project in the domain of inclusive education. We materialized the proposed approach in the design of a prototype and the implementation of the corresponding tool that supports a practice of inclusive education professionals. Furthermore we proposed and applied a pragmatics-driven evaluation method in a longitudinal case study. Prototype design, tool implementation, and the conducted evaluation provided evidence that the proposed approach to pragmatics-driven Interaction Design can reduce semiotic barriers and thus promote web-mediated collaboration.

Resumo

A Web e suas tecnologias de base facilitam interações entre pessoas que alguns anos atrás não eram imagináveis. A colaboração é um tipo importante de interação que tem um propósito. Pessoas de diferentes contextos sociais e culturais, e com diferentes preferências e habilidades, podem colaborar mediadas pela Web. A colaboração muitas vezes acontece em contextos heterogêneos, que são definidos tanto pelas situações atuais dos parceiros na colaboração, quanto pelas experiências passadas, sejam elas individuais ou coletivas. A Web como um meio/uma mídia tem um impacto na colaboração e facilita certos aspectos da colaboração enquanto dificulta outros.

Adotando uma perspectiva informada pela Web Pragmática, nesta tese investigamos questões da colaboração mediada pela Web, relacionadas com o Design da Interação. Nosso objetivo principal é entender barreiras semióticas da colaboração mediada pela Web e propor uma abordagem ao Design da Interação que reduza tais barreiras. Barreiras semióticas são barreiras relacionadas à comunicação, mediação e representação. Estas barreiras surgem na colaboração mediada pela Web pois muitos mecanismos da comunicação interpessoal face-a-face não estão disponíveis. Dependendo do contexto, barreiras semióticas frequentemente exercem um impacto negativo à colaboração; entretanto, em alguns casos o impacto pode ser positivo também.

A abordagem ao Design da Interação aqui proposta tem suas bases na Web Pragmática e utiliza a Semiótica Organizacional e a Teoria da Atividade como referenciais teórico-metodológicos. As investigações teóricas contaram com uma contrapartida em termos de um embasamento em práticas reais através da participação em um projeto de pesquisa no domínio da educação inclusiva. Materializamos a abordagem proposta no design de um protótipo e na implementação de uma ferramenta correspondente ao protótipo, que apoia uma prática de profissionais no domínio da educação inclusiva. Além disso, propusemos e conduzimos um método de avaliação guiada pela pragmática dentro do contexto de um estudo de caso longitudinal. O design do protótipo, a implementação da ferramenta e a avaliação conduzida fornecem evidências de que a abordagem proposta ao Design da Interação guiada pela pragmática contribui para a redução de barreiras semióticas e para a promoção da colaboração mediada pela Web.

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Luckily, writing a PhD thesis is not a solitary enterprise. During the last years, I had the privilege to collaborate or exchange ideas with many people who knowingly or unkowingly left their marks on this work. First and foremost, I would like to thank my *orientadora* Cecilia Baranauskas who inspired, challenged, and guided me, finding always the right dose and setting an example on a professional and personal level.

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"All that I want is keeping it easy.
It's what I want that's easy,
It's getting it that's complicated."

Torbjørn Brundtland, Svein Berge (Röyksopp)

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Chapter 1

Introduction

The Web has long since become a medium of interaction among people. People use Web-based services and applications in many different kinds of situations: for professional or personal purposes, at work, at home or en route, while working, learning, playing, relaxing, etc. While interacting they might encounter different kinds of barriers. Some of these barriers are topics of interest in the Human-Computer Interaction (HCI) field and related disciplines. These barriers refer to different aspects of the social relations among people, the applications they use, and the purposes and situations of use. For example, accessibility and usability both focus on barriers considering the relation between a person and the user interface of an application.

In this work, we are concerned with barriers of collaboration among people in the context of practices mediated by web-based systems. We use the word "collaboration" here to denote "working together with others toward a common goal". With "practices" we mean the actual executions of purposeful actions. A practice is not only defined by its actions or purpose, but also includes the participants with their needs and preferences, the tools they use, as well as the situational context and cultural values. Practices are not necessarily defined formally or explicitly. People participating in a practice might have individual understandings of a practice. In order to successfully conduct a practice, there usually have to exist some common understandings of the practice. Furthermore, practices may change or evolve over time, as participants aggregate experience. In many contexts, practice evolution is explicitly desired, e.g. in educational systems, but also in business systems where efficiency or performance increases are important goals.

"Mediation" means that practices are not carried out directly ("immediately") on the object of collaboration but mediated, for example using a representation of an object that needs to be interpreted. Thus, the medium has a strong influence on practice conduction and might facilitate some actions while making others more difficult. Changes in the medium might result in changes in practices and vice versa. We focus on web-based

systems as mediators of collaborative practices, i.e. we are especially interested in how tools (the functionalities provided by a web system) and the web-based system as an environment mediate practices. The Web as a technological platform for mediation implies that collaboration can occur distributed in time and space, using different devices in different situations. An arbitrary number of different people may collaborate, with different preferences and different degrees of knowledge about the practice as well as about each other.

As an example of a collaborative, web-mediated practice consider the collaborative writing of a scientific article. A primary object of collaboration is the article itself, in which for example research results are reported with the goal of disseminating or sharing knowledge. Secondary objects of collaboration might be the processes of submitting and publishing the article. Some parts of this practice are formally defined. For example, depending on where the article is to be published, there might be defined an upper limit of the article size, formatting guidelines or a submission deadline. Other parts of the practice might be implicitly defined. For example, an article reporting research results should at least explain the research problem, the objectives and the method, and present and discuss the results. Still other parts might not be defined at all, but might be negotiated before starting the practice (e.g. whether to use the camera-ready formatting template), or emerge during practice (e.g. the layout of figures and tables, used abbreviations). The authors might or might not have previous experience writing scientific articles individually or collaboratively, and might or might not know some of the co-authors. All this has an influence on how each author will contribute to the writing process, and depending on previous experiences, an author might approach collaborative writing differently than last time. Regarding mediation, different tools and environments favor different kinds of practice conduction. Round- or token-based editing on the one hand and real-time online collaborative editing on the other hand facilitate certain kinds of writing while complicating others.

This short example already illustrates some important aspects of web-based collaboration relevant to this work and hinted at possible barriers. In the remainder of this introduction, we will present the problem we are treating in this work, our objectives and method, and present the outline of this thesis.

1.1 Problem

Web-mediated collaboration has three important aspects that are part of the problem treated in this work: communication, representation and mediation.

Generally, successful communication is a prerequisite of successful collaboration. An important element of communication among people is the interpretation of intentions of

the communication partners. During face-to-face communication, non-verbal clues such as facial expressions, gestures, inflection, etc. facilitate the interpretation of intentions. These clues and their interpretation are determined by linguistic, social, cultural, and other aspects which delimit the communication partners' behavior and provide common ground. During written or computer-mediated communication these mechanisms are not always directly available, even when using video communication tools. Thus, communication and consequently collaboration might be impaired and breakdowns might occur that need to be resolved. This situation even aggravates when considering that computer-mediated collaboration is often temporally and spatially distributed and that people often collaborate even not knowing each other very well.

During collaboration in the physical world, we can either directly access the object of collaboration or access a representation of it. When building a house or repairing a car we can directly access the construction site or the car, or we can work with floor plans, scale models, wiring diagrams, etc. Both direct access and representations support different actions differently, e.g. planning, troubleshooting, or fixing. On the other hand, during collaboration in the digital world, we always access representations. Note that even in the case of "direct manipulation" [114], we ultimately access representations of ideas, messages, stories, etc. Collaborating in the physical world, we are able to create some representations autonomously, using our own tools. Those who cannot create their tools usually have a choice of different tools, which might be customized. This is also true to some limited extent for collaboration in the digital world, where users have some choice, e.g. regarding hardware form factor, operating system, or software. However, in the Web, today most people depend on the tools others made, e.g. one might be able to use the web browser or search engine of ones choice, but in order to participate in a discussion forum, one usually still has to use the forum software the forum owner provides. These digital "tools" sometimes have restrictions regarding the task intended by the tool user, and oftentimes are actually representations themselves that need to be interpreted or "understood".

Web-based collaboration is always mediated, i.e. any action such as manipulation of the object of collaboration or communication in order to coordinate manipulation is shaped by mechanisms or systems before it becomes effective and can be perceived by collaboration partners. Representations, tools, and the web-based systems themselves are examples of mediators. A mediator often shapes or transforms the actions or contents that it mediates, enabling or facilitating certain actions while making others more difficult or even impossible. A diagram as a visualization of a data set might lead to insights that are different from interpreting a table or the raw data. The opposite direction is also possible, i.e. the mediated also has an influence on the mediator. For understanding "big data", i.e. very large and complex data sets, new visualizations are required.

The web-based system or environment in which collaboration takes place can be seen as a medium itself. Implicit and explicit norms valid in the system are mediators of the relationship between people, and members of the system can have an influence on the relationships between other members.

Another important aspect of mediation is that of flexibility, e.g. the possibility to choose or customize a tool and to use it the way one "sees best fit". When engaging in collaborative practices, people have different needs and preferences with regard to which tools to use and how to manipulate or access shared artifacts. Musicians usually bring their own instruments to a jam session, construction workers might prefer one brand of tools over another. Novices might perform reasonably well using the instruments or tools they are accustomed to, but their performance might decrease dramatically when e.g. playing the guitar of a friend. In the cases of e.g. machine operators or aircraft pilots, even considerable training is required in order to be able to use another tool of the same kind. Experts are often able to switch tools more easily, but even then they might not be able to achieve the same level of performance. A player of a pipe organ usually needs some time to get accustomed to a new organ, because keyboards and pedalboard have different characteristics, stops have different positions and trigger different types of pipes, etc. Tool choice not only affects performance, but the overall user experience, and, most importantly for the context of this work, interpretation or "making sense of things". Data presented in a table may facilitate different interpretations than the same data presented as a graph. For different kinds of data one representation might be more adequate than the other, and different people might prefer different representations.

In the case of web-mediated collaboration, due to limited interoperability and relative closedness of web systems, flexibility is very limited. When choosing a web application or system for collaboration, all participants have to use the same set of tools and representations.

In summary, there exist barriers to web-mediated collaboration that are related to limitations regarding communication, representation, and mediation. These barriers make it more difficult to express and interpret intentions, i.e. to individually and collaboratively construct meanings and successfully conduct practices and develop them further. It should be noted that the three types of barriers are not arbitrary choices. At the beginning of this study, we had no classification for the barriers described in this section. They were "just" barriers, some reported in scientific literature, some observed during practical experiences of participating in different research and design projects. After defining our theoretical and methodological frame of reference (Chapters 3 and 4) and after identifying Organizational Semiotics and Activity Theory as fundamental base in the research (Chapter 4 and Appendix A), we realized that these barriers were related to communication, representation, and mediation, which are core concepts and units of analysis of

Organizational Semiotics and Activity Theory.

1.2 Objective

The barriers described in the previous section are essentially semiotic ones, i.e. they are related to how and why people produce, interpret and use signs during web-based collaboration. Thus, the main objective of this thesis can be formulated as follows:

> "Investigate semiotic barriers to web-mediated collaboration, and propose an approach to Interaction Design that reduces these barriers."

We have already presented our understanding of "web-mediated collaboration" and explained the barriers and other relevant aspects at the beginning of this introduction. The term "approach" in our objective is used in contrast to "method" and "technique", borrowing from Anthony [6] in the context of English language teaching, and from Dix [43] in the context of theory creation in HCI: "techniques carry out a method which is consistent with an approach. [...] An approach is axiomatic. It describes the nature of the subject matter to be taught. It states a point of view, a philosophy, an article of faith - something which one believes but cannot necessarily prove. It is often unarguable except in terms of the effectiveness of the methods which grow out of it" [6, p. 63f.]. "A theoretical approach is also not so much a method or technique that is applied to research, but an attitude and a desire to understand, in some ordered way, the phenomena around us. This approach can influence design and research methodology [...]" [43, p. 175].

Of course, regarding a PhD thesis, the parts "[...] something which one believes but cannot necessarily prove [...]", and "[...] often unarguable except in terms of the effectiveness of the methods which grow out of it [...]" are problematic. Thus, a secondary objective of this work must be:

> "Demonstrate that it is possible to define an Interaction Design method that can be carried out using respective techniques and that results in a decrease of aforementioned barriers."

In terms of scientific work, this is an "existence proof", i.e. a proof that our proposed approach can in fact be instantiated by defining and carrying out a method, leading to meaningful results. A stronger, alternative objective would be to define a method and validate it, or "prove" that this method is at least as "good" as other related methods, where "good" would have to be defined in terms of some measurable criteria. Our PhD thesis is a qualitative as opposed to a quantitative work. In HCI, qualitative research and design methods can be validated by justification and evaluation [43]. Justification may use

expert opinion, published results, and argumentation based thereupon. Evaluation may use peer review, comparison with previous results, or empirical evaluation methods [47]. Empirical evaluation is meant as only one component that contributes to the evaluation part of validation and comprises different evaluations in different contexts by different evaluators. At UNICAMP, there is a four to six years time frame for concluding a PhD thesis. Our proposal of an approach to Interaction Design reached sufficient maturity at a later stage of our doctoral research. It would be quite unlikely to find different contexts and external evaluators that produced meaningful results given the typical four to six years time frame of a PhD project. Furthermore, basing the evaluation on a single empiric evaluation by ourselves would be methodologically quite unsound [43]. Hence, while this PhD thesis provides the justification part of validation, it cannot provide the evaluation part. Thus, we defined our secondary objective as an existence proof and not as a validation. In this context, please also note that the chapter about evaluation in this thesis is not a validation or evaluation of our approach, but an evaluation employing our proposed approach.

A pertinent question is, why our objective is to propose a new approach and not a new method within an existing approach? In recent years, different authors have noted that new challenges for HCI have arisen (e.g. [9, 29, 64, 115]). These challenges are related to the fact that the use of information technology is permeating all aspects of life and that people with an ever increasing diversity of characteristics interact with each other in an ever increasing diversity of situations. The challenges that emerge from our problem of web-mediated collaboration described in section 1.1 are well aligned with the challenges described by Bannon, Bødker, Harrison, and Shneiderman. In order to solve these challenges, some authors claim that radical changes in HCI research and practice are required, e.g. Bødker identifies a third wave, Harrison a third paradigm of HCI. Bannon and Shneiderman identify traces of novel HCI research and practice, and Bannon concludes with a call-to-action, "[...] encouraging an openness to new forms of thinking about the human-technology relationship [...]" [9, p. 57]. On this background, our decision for this PhD thesis was to propose and explore an approach to Interaction Design that is adequate for discussing contemporary challenges for HCI theory and practice.

1.3 Method

The main contribution of this PhD thesis lies in the development of an approach to Interaction Design research and practice as opposed to the development of methods and techniques within a theoretical framework or approach. Before presenting the method employed we thus must make explicit the ontological and epistemological assumptions that are the basis of this work. We subscribe to a neo-humanist paradigm [69], i.e. the

view that the world is subject to change and conflict, and that knowledge about the world is subjective as opposed to objective. A subscription to the neo-humanist paradigm also entails a statement about our role as a researcher and designer: "The neohumanist paradigm seeks radical change, emancipation, and potentiality, and stresses the role that different social and organizational forces play in understanding change. It focuses on all forms of barriers to emancipation – in particular, ideology (distorted communication), power, and psychological compulsions and social constraints – and seeks ways to overcome them" [69]. This quote might seem radical to some readers. However, with the adoption of Participatory Design by HCI at the latest, it has become clear that research and design are not independent of social or political questions and that researching and designing also means to be aware of these questions and to take a position. We take the position described in this paragraph, a position that we believe is compatible with what Baranauskas [10] describes as "Socially Aware Computing", and a position that we believe is aligned to Interaction Design as described by Löwgren and Stolterman [85].

The general method adopted for this PhD thesis consisted of the following elements:

- characterization of the problem and objectives,
- literature review for theoretical grounding,
- subscription to a world view (epistemological and ontological basis),
- participation in research projects for practical grounding (empirical frame of reference),
- definition of the theoretical and methodological frame of reference,
- definition of our approach to solve the problem,
- application of the approach,
- analysis and partial validation, and
- conclusion.

As already indicated by the last paragraph of section 1.1, this method was not executed in a sequential, waterfall-like order. Based on a continuous literature review and the epistemological and ontological basis ("world view") of neo-humanism [69] we chose and continually refined a theoretical and methodological frame of reference. Furthermore, an empirical frame of reference was taken for practical grounding. Our proposal of an approach to Pragmatics-driven Interaction Design was based on these frames of reference and was applied to a system design and evaluation in order to provide validity

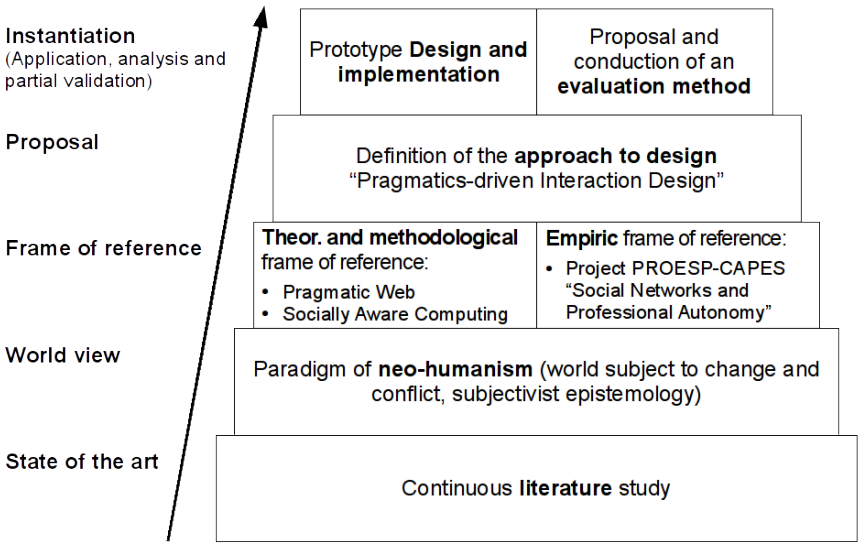

Figure 1.1: Method as conducted in this thesis.

to the proposal. Figure 1.1 provides a graphical representation of how the method was conducted.

This PhD thesis is an articles-based thesis, i.e. with exception of this introduction and the conclusion, the chapters are scientific articles that have been published or submitted to publication. Furthermore, although the method elements follow a rough order, they do not form a rigid sequence of steps. Consequently, the sequence of elements of the adopted method does not match the sequence of chapters in this thesis. We have already described the problem and objectives of this work. Additional aspects of the problem and objectives can be found in the early chapters of this work. A critical literature review was an ongoing activity of this work and thus is part of most chapters of this thesis. The definition of the theoretical and methodological frame of reference for treating the problem has to be aligned to the epistemological and ontological assumptions. Furthermore, the frame of reference has a crucial impact on the definition, application, analysis, and partial validation of our proposed approach. Important aspects of the problem and objectives of this work are related to linguistics and semiotics, and more specifically to pragmatics. Examples of these aspects are questions such as how and why people use language and other signs during collaborative meaning construction and negotiation in the Web. We thus chose the Pragmatic Web [111] as our theoretical and methodologi-

cal frame of reference. The Pragmatic Web is based on Organizational Semiotics (OS; [83]) and the Language/Action Perspective (LAP; [58, 131]). The Pragmatic Web per se makes no statement about Interaction Design. Thus, we had to complement our frame of reference with our view of Interaction Design that is compatible with Baranauskas' [10] Socially Aware Computing.

The same way that the work was informed by and articulated with scientific literature, all research activities were grounded in practical experiences and data gathered during our participation in research and design projects. Two projects inspired and informed our work, and provided the means to apply and validate our theoretic findings. The first project was the e-Cidadania project [12], a project with the objective of studying and proposing inclusive solutions for exercising citizenship. This project served as motivation for this PhD thesis, since we realized that besides the barriers related to universal and participatory access [120] addressed by the e-Cidadania project, there are yet other barriers, namely the semiotic barriers addressed by this PhD thesis. The project also served as a background scenario for Chapter 2 of this thesis and for [75]. The second project was the project "Projeto Redes Sociais e Autonomia Profissional"[1] (English: "Social Networks and Professional Autonomy"). This project investigates how to facilitate lifelong learning of teachers in the field of special education in Brazil's public school system. Within the project, the social network "Todos Nós em Rede"[2] (TNR; English: "All of Us Networked") is a system where special education teachers can socialize, share experiences and discuss matters related to work practices. At the time of writing this thesis, the project is ongoing and the TNR system is under development. The project served as a background scenario for Chapters 3 to 6 and was crucial for applying and partly validating our approach. For the sake of brevity, we sometimes use "TNR" in this PhD thesis as a homonym, denoting either the research project or the social network system.

Figure 1.2 relates the elements of the method with the chapters of this thesis. Smaller squares signify that the respective chapter only makes a minor contribution to the respective method element. Since the literature review and the grounding in practical experiences occurred along all activities of this work, we omitted these two elements from Figure 1.2.

1.4 Outline of the Thesis

As already stated, this thesis is organized as an articles set. With exception of this introduction and Chapter 7, all chapters have been published or submitted to publication. Chapters 2, 3, and 5 have been presented at scientific conferences and published in the

[1] `http://www.nied.unicamp.br/tnr`
[2] `http://tnr.nied.unicamp.br`

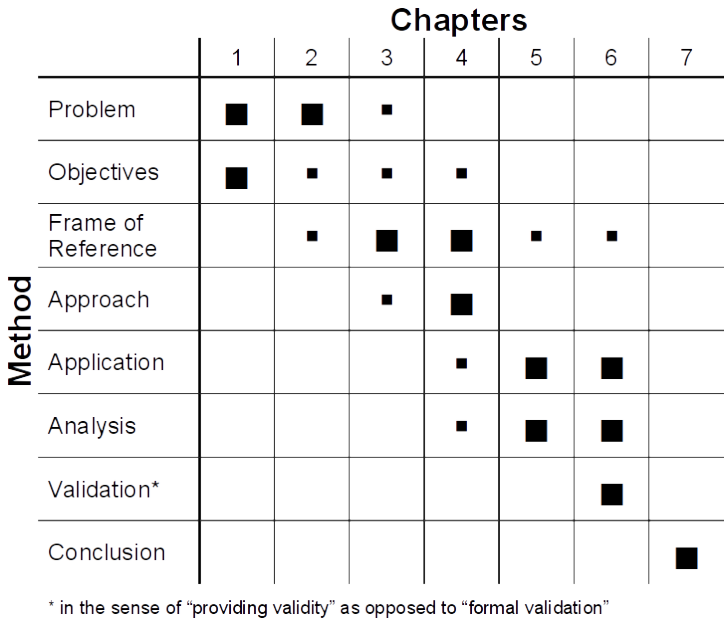

Figure 1.2: Distribution of the research method over the chapters of the thesis.

respective proceedings. Chapters 4 and 6 have been submitted to journals.

Chapter 2 puts the problem treated in this work into the context of Bødker's third wave of HCI and investigates how the Pragmatic Web might contribute to Interaction Design. It focuses on two main aspects of the problem: meaning negotiation among people and its support by the action repertoire provided by web-based systems. Regarding meaning negotiation, the chapter presents related literature from the area of the Pragmatic Web. Regarding action repertoires, literature about affordances and actability [35] is presented and put into the context of Interaction Design in the Pragmatic Web. Using actual and possible examples from the e-Cidadania[3] project, issues related to meaning representation and negotiation as well as action repertoires are discussed. These issues are structured using Stamper's "organizational onion" [122], a conceptualization of an organization as an information system consisting of 3 layers: the informal, the formal, and the technical.

The main contributions of Chapter 2 are:

- an articulation of Bødker's third-wave HCI with the Pragmatic Web,
- the conclusion that a further development of Interaction Design related concepts and theories is required to treat the presented issues, and

[3] `http://www.nied.unicamp.br/ecidadania`

- the insight that the Pragmatic Web might contribute to the identification and definition of these concepts and theories.

Chapter 2 has been published as:

Hornung, H. and Baranauskas, M. C. C. (2009). An Interaction Design Perspective on the Pragmatic Web: Preliminary Thoughts. In I-SEMANTICS'09: Proceedings of the 5th International Conference on Semantic Systems*, 2-4 September 2009, Graz, Austria, pp. 695–705.*

Chapter 3 investigates how web-mediated interaction can be facilitated employing a Pragmatic Web perspective. It identifies barriers people encounter while interacting in the Web. These barriers are related to information relevance, information presentation, and flexibility of use. The chapter presents a conceptual model of interaction under a Pragmatic Web perspective. The model has been created by analyzing a scenario inspired by the TNR project using concepts from post-cognitivist HCI frameworks [78] and neo-humanist Information Systems frameworks such as OS and LAP. Its main building blocks are people who interact with each other accessing content via services flexibly and context-dependently. This vision is substantially different from a vision of web-based interaction characterized by user accounts, interface features, and document access that depend on a specific web application.

The main contributions of Chapter 3 are:

- a first definition of our vision of "Interaction Design in the Pragmatic Web",
- the methodological and theoretical grounding of the research in post-cognitivist HCI frameworks, neo-humanist IS frameworks, and Web Science [15], and
- a conceptual model for understanding web-mediated interaction given the proposed perspective.

Chapter 3 has been published as:

Hornung, H. and Baranauskas, M. C. C. (2011). Towards a Conceptual Framework for Interaction Design for the Pragmatic Web. In HCII'11: Proceedings of the 14th International Conference on Human-Computer Interaction, Part I*, 9-14 July 2011, Orlando, FL, USA, pp. 72–81.*

Chapter 4 presents a Pragmatic Web-based approach to conceptualizing and designing web-based applications for mediating social interaction. This approach is articulated with contemporary challenges for HCI theory and practice discussed in [9] and [115]. It builds upon the model presented in Chapter 3, a further analysis of related

conceptual frameworks (Organizational Semiotics and Activity Theory; cf. [73] and Appendix A), and an analysis of empirical data from the TNR project that identified pragmatic patterns of interaction ([74]; cf. Appendix B). The chapter instantiates the work presented in Chapter 3 using the TNR project as a concrete research and design project, and the cyclic Design and Research process proposed in [63]. It is shown that, by focusing on people's actual practices and by explicitly considering the pragmatic dimensions of context, our vision of "Interaction Design in the Pragmatic Web" concretely contributes to the design of web-based collaborative systems.

The main contributions of Chapter 4 are:

- a characterization of the Pragmatic Web,
- a more detailed, instantiated definition of our vision of "Interaction Design in the Pragmatic Web", and
- evidence that the Pragmatic Web is a workable approach to the design of Web applications that facilitate collaborative meaning construction and negotiation.

Chapter 4 has been submitted to a journal:

Hornung, H. and Baranauskas, M. C. C. (submitted). Pragmatics-driven Design of Web-Mediated Interaction. Submitted to a journal.

Chapter 5 applies the approach presented in Chapter 4 to create a low-fidelity prototype of a tool for web-based collaborative problem solving. The tool uses a timeline metaphor for information visualization and is supposed to facilitate the concrete practice of a "case discussion" within the context of the TNR project. Regarding problems in the scope of Interaction Design in the Pragmatic Web, the following aspects are addressed: flexible information presentation, facilitation of meaning negotiation, as well as flexible and creative practice conduction. The process of constructing the prototype covered the stages "understand", "study", and "design". Subsequently, and not reported in Chapter 5, the prototype has been transformed into a functional prototype (cf. Appendix C). Thus the "build" stage is also covered.

The main contributions of Chapter 5 are:

- application of "Pragmatics-driven design" in order to design a prototype, and
- discussion of an existing information visualization metaphor under the perspective of "Interaction Design in the Pragmatic Web".

Chapter 5 has been published as:

Hornung, H. and Baranauskas, M. C. C. (2012). Timelines as Mediators of Lifelong Learning Processes. In IHC'12: Proceedings of the 11th Brazilian Symposium on Human Factors in Computing Systems*, 5-9 November 2012, Cuiabá, Brazil, pp. 99–108.*

Chapter 6 proposes an approach to evaluation of web-based collaborative systems within Pragmatics-driven Design as described in Chapter 4. The approach is positioned as a goal-free evaluation within a continuous design-in-use cycle in which design and evaluation are understood as two sides of the same coin. The main characteristics of the proposed approach are: immersion of the designer-evaluator in the system to be evaluated, involvement of relevant stakeholders in the evaluation process, observation of a real practice "in situ", and a group activity for collaborative sense-making. The approach is instantiated within the context of the TNR project. The evaluation uncovered semiotic barriers and positive and negative tensions between these barriers. Furthermore, it informed design and redesign as well as future evaluations.

The main contributions of Chapter 6 are:

- a description of Pragmatics-Driven Evaluation (PDE) and an application of the approach,
- a demonstration that PDE leads to a deeper understanding of phenomena occurring in the evaluated system,
- evidence that PDE can result in concrete implications for design, and
- additional validation of the pragmatics-driven approach proposed in this thesis by showing that PDE produces meaningful results.

Chapter 6 has been submitted to a journal:

Hornung, H. and Baranauskas, M. C. C. (submitted). Pragmatics-driven Evaluation of Web-Mediated Interaction. Submitted to a journal.

Chapter 7 concludes and presents a critical reflection as well as future work.

Appendices A and B as described in subsection 1.4.1 present some of the conceptual topics and their application in more detail.

Appendix C describes the high-fidelity prototype that corresponds to the low-fidelity prototype presented in Chapter 5.

Appendix D contains a copy of the Approval Certificate of the Ethical Review Board regarding the TNR project that serves as recurring example and case study to this thesis.

Appendix E contains the copies of the permissions from the respective publishers to include the papers that have been published elsewhere into this thesis.

During the course of our PhD project we published other work. The work related to this thesis is presented briefly in subsection 1.4.2.

1.4.1 Supplemental Texts

We included two chapters into the Appendix that discuss some topics in more detail and thus provide complementary information especially to Chapters 4 and 6. The first investigates conceptual frameworks that are compatible with the Pragmatics-driven design and evaluation presented in this thesis. The second applies the concepts in order to support the identification of recurring problematical or positive situations during web-mediated problem solving, a special case of web-mediated collaboration.

Appendix A investigates how to choose a conceptual framework as the theoretical frame of reference for a concrete Interaction Design problem. To guide this choice, filter criteria are proposed that are based on the socio-technical context of the design problem and the skills, attitudes and experiences of the involved people (previous projects, multidisciplinary mix, stance towards ontological, epistemological and pedagogic questions). These filter criteria are applied to the context of the TNR project that also serves as recurring example and case study in this thesis. As a result Activity Theory (AT) and Organizational Semiotics (OS) are identified. The chapter presents and discusses both frameworks in the context of the TNR project and with respect to their support to different stages of Interaction Design. Appendix A has been published as:

Hornung, H. and Baranauskas, M. C. C. (2013). Conceptual Frameworks for Interaction Design: Analysing Activity Theory and Organizational Semiotics Contributions. In ICISO'13: Proceedings of the 14th International Conference on Informatics and Semiotics in Organisations*, 25-27 March 2013, Stockholm, Sweden, pp. 136–146.*

Appendix B presents a practical application of the theoretical concepts related to Pragmatics that are presented in this thesis. It is based on previous work that examined data gathered during so-called "scenarios", participatory practices that examined different web-based systems with regard to their adequacy as systems to support practices in the context of the TNR project [24, 23]. In Appendix B we conduct a micro- and macro-pragmatic analysis to identify pragmatic patterns of collaborative problem solving. These patterns describe recurring situations of use which might

require design of solutions that facilitate, promote, or avoid the manifestation of the pattern. Appendix B has been published as:

Hornung, H., Bonacin, R., dos Reis, J. C., Pereira, R., and Baranauskas, M. C. C. (2012). Identifying Pragmatic Patterns of Collaborative Problem Solving. In ICWI'12: Proceedings of the IADIS International Conference WWW/Internet*, 18-21 October 2012, Madrid, Spain, pp. 379–397.*

1.4.2 Related Work

The following three papers present work related to this thesis. The first two present micro-pragmatic analyses of data gathered during participatory practices conducted during the TNR project. They were informed by some theoretical concepts presented in this thesis and in turn provide some empirical basis to Chapters 4, 5, and 6. The third paper illustrates some of the concepts presented in Chapters 3 and 4 using the example of the inclusive social network "Vila na Rede" built during the e-Cidadania project.

Bonacin et al. 2013 perform an analysis of data collected during participatory practices of the TNR project. The main object of this analysis is that of "dynamic knowledge" during collaborative problem solving, i.e. the meaning making and negotiation processes. The analysis includes a pragmatic function analysis which is based on Semiotics and Speech Act Theory. The authors identify research challenges and possible new interaction mechanisms that are enabled by knowledge about pragmatic aspects of interaction. They furthermore identify a preliminary research framework for the computational, conceptual and interactive dimensions of this problem. This paper is an extended version of [24] and has been published as:

Bonacin, R., Hornung, H., dos Reis, J. C., Pereira, R., and Baranauskas, M. C. C. (2013). Pragmatic Aspects of Collaborative Problem Solving: Towards a Framework for Conceptualizing Dynamic Knowledge. In Enterprise Information Systems, volume 141 of Springer Lecture Notes in Business Information Processing (LNBIP)*, pp. 410–426.*

Bonacin et al. 2013 build upon the previous paper and present a model expressed in the Web Ontology Language (OWL). The OWL model can be used to represent some pragmatic aspects of communication. By instantiating the model using the data gathered during two participatory practices of the TNR project, the authors illustrate some possible information retrieval scenarios and discuss some limitations of a pragmatic communication analysis using formal semantic web techniques. This paper is an extended version of [22] and has been published as:

Bonacin, R., dos Reis, J. C., Hornung, H., and Baranauskas, M. C. C. (2013). An ontological model for supporting intention-based information sharing on collaborative problem solving. International Journal of Collaborative Enterprise*, 3(2/3):130–150.*

Hornung et al. 2013 illustrate the vision of "Interaction Design in the Pragmatic Web" using the example of the inclusive social network system "Vila na Rede". The paper presents a further elaboration of some ideas presented in Chapter 3 and preliminary ideas that have been further developed in Chapter 4. Among others, it discusses the relation between inclusive access to information and the Pragmatic Web, as well as contextualized and customized interaction using the conceptual model of Chapter 3 on the example of "Vila na Rede". This paper has been published as:

Hornung, H., dos Reis, J. C., and Bonacin, R. (2013). Sistemas inclusivos sob a ótica da Web Pragmática (in Portuguese). In Baranauskas, M. C. C., Martins, M. C., and Valente, J. A., editors, Codesign de redes digitais: tecnologia e educação a serviço da inclusão social*, chapter 14, pp. 275–293. Penso, Porto Alegre, RS, Brazil.*

Chapter 2

An interaction design perspective on the Pragmatic Web: preliminary thoughts[1]

2.1 Introduction

During the last years, digital artefacts are being used in more and more diverse configurations. Within the context of this paper a "digital artefact" is anything created by humans and accessed via computerized technology (e.g. a word processing application running on a local PC, an electronic government service accessed via a mobile device, digital interactive television). Not only professionals are interacting with digital artefacts in a purposeful manner, but people are accessing services anywhere, anytime for different purposes, be it in a work context or simply for entertainment or other leisure related activities. Bødker has coined the term "the third wave of HCI (Human-Computer Interaction)" to characterize this broadening and intermixing of use contexts and application types [29].

This third wave can be best described via juxtaposition with the second wave: the third wave is about non-work contexts, non-purposeful or non-rational actions, etc. It focuses on the cultural level and expands the view from mere cognitive to emotional aspects. This shift to the third wave in the HCI discipline – although leaving open still unsolved issues of the second wave – poses many new challenges and questions regarding

[1] **Article presented at I-SEMANTICS 2009 and published as "Hornung, H. and Baranauskas, M. C. C. (2009). An interaction design perspective on the Pragmatic Web: preliminary thoughts. In Paschke, A., Weigand, H., Behrendt, W., Tochtermann, K., and Pellegrini, T., editors, *Proceedings of the 5th International Conference on Semantic Systems (I-SEMANTICS '09)*, Sept. 2–4 2009, Graz, Austria, page 695–705."**

interaction design.

We must not forget that a great number of potential users has difficulties to access those applications or services or has no access to them at all. Reasons for this are manifold: illiteracy, no experience in using digital artefacts, or special needs not attended by the service in question, only to name a few. In the context of Brazil for example, the Brazilian Computer Society has addressed this issue when defining the fourth of five "Grand Challenges in Computer Science Research in Brazil" as "Participative and Universal Access to Knowledge for the Brazilian Citizen" [120].

The challenge refers to technological, educational, cultural, social and economical barriers to the access and the interaction with digital artefacts, whereas "access" is not only defined in the narrower sense of accessibility but in the more comprehensive sense of legibility, that addresses the problem of how to deliver information that makes sense and is relevant to users.

With regard to applications or services accessed via the Internet, today's HTML-based so-called Syntactic Web does not offer many mechanisms to facilitate the understanding of content apart from content formatting and structuring. For example, the Wikipedia article on "Semantic Web" contains a thumbnail of the W3C's Semantic Web logo (`http://en.wikipedia.org/wiki/Semantic_web`), but apart from the logo caption, nothing indicates that the depicted image is the logo of a W3C activity related to the subject of the Wikipedia article. Furthermore, it is not clear, how the article and the activity are related (e.g. if the article is a summary of the activities key findings, if the activity is an example of an institution incidentally working on the same subject as the article's authors, etc.)

The Semantic Web has been proposed as an extension to the current Web with the intent to introduce meaning to Web pages, processable by human or machine agents [16]. Currently, many languages exist (e.g. RDF Schema; `http://www.w3.org/TR/rdf-schema`), or the Web Ontology Language (OWL; `http://www.w3.org/TR/owl-features/`)), that allow for knowledge modelling and meaning sharing, and that provide a basis for semantic interoperability [113]. However, the augmented semantic contents to a great extent remain inaccessible or unintelligible for human agents.

Gandon illustrates some of the problems of retrieval of semantically annotated information and proposes a mechanism to facilitating the interpretation of query results [52]. However, he does not treat questions related to interaction design. Despite this and other efforts having been made to make the Semantic Web intelligible for humans, according to McCool it will never achieve widespread adoption "because it's a complex format and requires users to sacrifice expressivity and pay enormous costs in translation and maintenance" [87, p. 86]. However, Singh claims that the vision of the Semantic Web can be implemented via Pragmatics, a branch of Semiotics that deals with context-based

meaning [118]. The purpose of this paper is thus to investigate how the vision of the Pragmatic Web can contribute to the interaction design of services that are accessible, intelligible and relevant, whereas – in contrast to the Semantic Web – the interaction happens primarily between human agents. The paper is organized as follows: section 2.2 gives an overview of relevant literature in adjacent areas, section 2.3 proposes an initial approach to conduct interaction design in the Pragmatic Web, and discusses the unveiled issues, section 2.4 concludes.

2.2 Related Work – Pragmatic Research and the Pragmatic Web

The challenges that arise with the third wave of HCI require a socio-technical view. Organizational Semiotics (OS) is a discipline that recognizes the need to approach the question of how to facilitate and promote access to digital artefacts in a way that considers technical as well as social issues [124]. It focuses on understanding the different properties of signs on various levels to analyse and design information systems in terms of three human information functions: expressing meanings, communicating intentions and creating knowledge.

The primary focus of this paper lies in the pragmatic aspects of digital artefacts, i.e. intentions, motivations, negotiations or, in other words, the different actions that are possible to be executed on a digital artefact and the question why and how actions are executed. Pragmatics deals with intentions, communications, conversations, negotiations, etc., i.e. with the purposeful use of signs. Important concepts with regard to Pragmatics are the "pragmatic information", i.e. the personal knowledge and experience of each communicating partner, the shared knowledge (that is higher if the partners are from the same cultural community), and the context where the communication takes place, whereas the context is comprised of elements such as speaker, hearer, intention, purpose, theme, time, location, etc. [83, chapter 3.2].

Besides Organizational Semiotics there exist other approaches that are suitable to investigate these questions of users acting in a broader organizational context, whereas organization is defined in a broader sense than for example the work context. Cordeiro and Filipe [32] compare the Language/Action Perspective (LAP), Organizational Semiotics (OS) and the Theory of Organized Activity (TOA) and propose an integration of the three approaches into a combined one.

Cordeiro and Filipe [32] and Goldkuhl [55] show that there still exist many open questions with regard to conceptualization, explanation and understanding with the help of different action oriented or pragmatic theories. Theories adapted from reference disci-

plines have different strengths and weaknesses. The Language/Action Perspective for example presumes that actions are purposeful, neglects tacit communication and has a focus on a professional work context [130].

The integration of LAP, OS and TOA proposed by Cordeiro and Filipe starts from a TOA activity and is based on a vocabulary mapping and on drawing analogies between the respective key concepts [32]. Within their integration model, the human within his social domain is acknowledged as the central concept. OS'es information fields like family, religion or country expand the activity domain.

LAP, TOA and OS are often applied to business contexts that substantially differ from Bødker's third-wave HCI. In this context users that interact with each other might be influenced by entirely different information fields, thus in the worst case, the only implicit shared context that can be assumed is the URL accessed via the browser. Actions are not always rational; often the primary purpose of an action is entertainment or distraction.

Regarding the analysis of actions and action repertoires, depending on the theoretical frame of reference, different concepts exist. Gibson defined, "the affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or for ill" [54, p. 177]. An affordance is "something that refers to both the environment and the animal". Affordances in the sense of Gibson are inherent properties that simply exist. Norman [95] introduced the term into design in 1988, referring himself to "perceivable affordances", i.e. properties that do not simply exist, but that have to be perceived. Since then, the term has been widely adopted by the HCI community, not always in the sense originally intended by Norman. In a later essay, he introduces the term "(social) signifier" that should replace the term "affordance". The term "social signifier" reflects the social character of most actions that we perform and on the other hand allows accidental signifiers: "the perceivable part of an affordance is a signifier and if deliberately placed by a designer, it is a social signifier" [95, p. 19].

In OS, affordances are used in the original sense of Gibson: they are invariant repertoires of behaviour and as such constitute the perceivable reality of a human agent [124]. Thus, Norman's "social signifiers" can be seen as an approximation to the affordances as defined in OS.

"Actability" is a similar concept that is concerned with social actions mediated by information systems. It has been defined as "an information system's ability to perform actions, and to permit, promote and facilitate the performance of actions by users, both through the system and based on information from the system, in some business context" [35, p. 1076]. Goldkuhl provides a comparison of "actability" with "affordances" in Gibson's sense [56].

From the perspective of interaction design, social signifiers, affordances and actability are concepts that are concerned with a pragmatically oriented action repertoire, i.e.

the different actions a human agent can perform on a digital artefact. "Social signifiers" and "actability" seem to have a closer relation to the human-computer interface, whereas "affordances" in the OS sense emphasize the social context of the human agent. Furthermore, "affordances" exist independently of the digital artefact and thus seem to be an appropriate concept to be already considered in the phase of artefact creation.

Regarding the implementation of the Pragmatic Web vision using the theoretical constructs described above, examples from literature often refer to web services. A main difference of the approaches described below and our interaction design perspective is that web services often refer to electronic and not to human agents. However, many results below can be mapped or adapted to our case.

With relation to web services, Singh identifies challenges that cannot be addressed by merely considering the Syntactic or Semantic Web, but that require a pragmatic view of the problem [118]. For example, web services cannot be fully described by the methods they provide; instead, a model that permits the negotiation between service provider and consumer about if and how to interact with each other would be more adequate. Singh lists three principles of pragmatic web service design: user before provider, process before data, and interaction before representation [118].

Although Singh is concerned with web services provided and consumed by electronic agents, the challenges and principles he identified can be partly matched to human agents. E.g., the principle "interaction before representation" that refers to hiding "excess" semantics when describing the interaction specifications of services clearly applies to the modelling and implementation of (inter-)action repertoires in the human-computer interface [118].

Another milestone in the relatively recent history of the Pragmatic Web is the paper by Schoop et al., in which the Pragmatic Web vision is defined as "to augment human collaboration effectively by appropriate technologies, such as systems for ontology negotiations, for ontology-based business interactions, and for pragmatic ontology-building efforts in communities of practice" [111, p. 76]. Scientific contributions in the area reveal different understandings and accentuations of the term "Pragmatic Web".

De Moor and van den Heuvel adopt a semiotic perspective to examine how virtual communities can pragmatically select web services [40]. Since the purpose of their work is theory construction, it has to be examined whether and how this methodology can be adopted to our usage scenario. On the other hand, it has to be questioned, if their approach can be adapted to be applicable by communities of "non-expert"/non-technical users. Furthermore, it is not clear, how the challenges identified by Singh [118] are addressed.

Liu explores the context of pragmatic web services [84]. He describes methods of how to construct, discover and rank pragmatic web services in order to be able to use the

right service at the right time. Although the author works with computational agents, some of the concepts might be mapped to human agents. For example, a pragmatic web service can be interpreted as an element of the action repertoire. For a given user, alternative candidates may exist that all yield the desired result, but that may be more or less appropriate.

De Moor addresses the problem of modelling context in the Pragmatic Web and proposes pragmatic patterns for the meaning negotiation processes. Meanings are assigned to syntactic resources and formalized in ontologies [37]. Meaning alignment is concerned with the compatibility of ontologies. Ontologies are modelled on the semantic and used on the pragmatic layer: agents in the Pragmatic Web select meanings and meaning representations and negotiate meanings among each other.

In our approach, we adopt the conceptual model of the Web by de Moor [37] with semantic resources in the Semantic Web layer and a set of pragmatic contexts in the Pragmatic Web layer. The semantic resources exist mainly in the form of ontologies, i.e. we agree with de Moor and use a mix of large, detailed, standard ontologies and independent, domain-specific micro-ontologies. These are supplemented by potentially large folksologies, i.e. ontologies that contain an unrestricted and non-stable set of entities and that are generated by amateur users in an uncoordinated way [121].

2.3 A view on interaction design in the Pragmatic Web

The previous section has shown that the Pragmatic Web is a still emerging area with different ideas and approaches, many of which build on the Syntactic Web and are concerned with (semi-)automated agents or expert human agents. The goal of this section is to explore how the concepts of the Pragmatic Web can be applied to the interaction of non-expert human agents and what design questions arise in this context. “Non-expert human agents” include users with special needs, low or no literacy skills and no or low computer skills.

Regarding non-expert human agents, the following questions arise: How can users select meanings from already existing ontologies? How can users create or adapt meanings? What are good meaning representations? How can users negotiate meanings with other users or non-human agents? These questions are interrelated and have a common denominator: How can users benefit from more legible and more relevant information without having to worry about the conceptual aspects of the Pragmatic Web. For example, we cannot expect users to construct meanings querying and aligning different existing ontologies. End users should not be concerned with reading ontology diagrams or other

representations. Required meaning negotiation processes should occur transparently to the user.

Under an actability perspective, the action repertoire of a system can be induced from the individual user's pragmatic context, i.e. it is the result of meaning selection and negotiation. In contrast to examples of actability related papers (see [56] for further references), we cannot always presume a work-practice context and structured interaction among users. The action repertoire depends on the individual pragmatic context and can be different for different users. Moreover, the action repertoire cannot be exhaustively pre-defined and hence must be extensible to accommodate different meaning selection and negotiation processes and to enable novel ways of use. Finally, the action repertoire should not be defined on a per-system, but on a per-concept basis to ensure consistency of action repertoires for similar concepts in different systems.

2.3.1 An example and a preliminary case study

The following example serves to illustrate our considerations and to indicate some of the arising questions. In contrast to scenarios often found in the Semantic Web literature (e.g. [16]), this example does not include electronic agents that automatically interpret or negotiate meanings but has a focus on pragmatic aspects of interaction between human agents.

A user of a social network service (SNS) like Facebook or MySpace is confronted with various pieces of information when moving around in the network. Depending on how the user interprets these pieces of information, different actions are afforded, all of which depend on the pragmatic context of the current user. Initially, meanings and action repertoires might be limited by the current service. For example, within the context of the SNS in question, a user is defined by a user name, an optional e-mail address and a personal page with a guest book. The action repertoire associated with a user and provided by the SNS is comprised of leaving a message in the guest book, adding a user's e-mail address to one's personal address book and sending synchronous or asynchronous messages to a user using tools provided by the SNS.

In this small example the repertoire of relevant actions could already differ for two distinct users: the e-mail address would be irrelevant to a digitally illiterate or semi-literate user without an e-mail account, and thus, the action "add to address book" would not be part of her/his personal action repertoire. On the other hand, a blind or illiterate user would opt to send and receive audio instead of text messages, whereas a deaf and literate user would prefer to send video messages in sign language to a user who accepts incoming video messages in sign language. A simple implicit meaning negotiation process between a literate and an illiterate user would yield the result that "send message" means "send

an audio message".

Meanings and action repertoires can be extended if the user acts outside the SNS in other systems. For example, if the user is also a member of another SNS, he might be able to perform additional actions depending on whether other users (or any other concept) reside in only one or both SNSs. If a user is also defined by a telephone number in the other SNS and the user in question has got a Voice over IP (VoIP) account from a third provider, s/he should be able to call telephone numbers of users in the SNS via her/his VoIP account. On the other hand, if two users already share a pragmatic context, they could also share meanings of further concepts and action repertoires associated with those concepts. For example if two users are part of the same SNS, have a shared pragmatic context with regard to the "user" concept, and similar action repertoires associated with that concept, user A could share a new communication method (e.g. "send SMS") with user B.

The above examples are inspired by the e-Cidadania (engl.: e-Citizenship) project, the goal of which is to search for methods and system designs that provide access and make sense to the users' community, thus supporting the formation of a digital culture that respects the diversity in our society. Within this project, a SNS is being developed using OS as a frame of reference and following principles of Universal Design and Participatory Design (cf. [91] and `http://www.nied.unicamp.br/ecidadania`).

Many of the pilot users have no or almost no experience in the use of computers, the Internet and SNSs, some users have low literacy levels. The pilot users can be characterized as mainly belonging to the social class of the working poor and usually access the Internet at the local telecenter. Many of the pilot users own no e-mail account; most of them do not use instant messengers or other online communication tools.

The SNS implementation is based on an off-the-shelf content management system (CMS) that has been enhanced with additional functionalities. One of the core functionalities is the possibility to record video and audio messages as a complement to text. During activities with the pilot users, it became clear that the action "making a comment" does not necessarily mean to "write a comment and optionally add an audio or video message", but could mean just to "leave an audio or video message". As a result, the comment form has been changed to not requiring a text body as originally designed by the CMS provider.

An example to illustrate the different perspectives of actability and affordances is the area containing the list of online users. Regarding actability, clicking the user's name permits viewing his or her profile. Seeing a user's name in the list of online users affords to start a conversation even if the system does not permit it (yet). Hence, the actability perspective permits to detect e.g. a missing functionality during the analysis phase, whereas an analysis of affordances would have defined the need for this functionality

during requirements specification.

2.3.2 Discussion

The example and preliminary case study above and the approach to use Pragmatic Web techniques for direct interaction between human agents raise many questions. From the point of view of pragmatic interaction design, most of these questions are concerned with meanings, actions, and action repertoires. In order to structure the discussion, we use the organizational "onion" [122], which describes an organization as consisting of three main layers of information systems: the informal, the formal and the technical information system (IS).

For each issue or question discussed, we indicate the implications on interaction design.

Technical IS: Storing of meanings and action repertoires. Meanings and actions should be shareable or reusable across system boundaries. Furthermore, a user potentially accesses Web based services via different channels in different environments. Thus, a purely local approach to storing would be infeasible. On the other hand, a remote centralized or distributed approach would have to be flexible and easy to use. Regarding interaction design, storing or accessing meanings and action repertoires should be as transparent as possible, and a user should not be bothered if storage is central or distributed.

Technical IS: Interoperability. The access to proposals of meanings or instantiations of action repertoires provided by different entities might require a prior registration. Thus, authentication and seamless, interoperable service execution are important aspects. E.g. two users who meet in a SNS and want to start a conversation using a tool outside the SNS they met in, should be able to do this transparently without needing to authenticate twice and without even leaving the SNS.

Formal IS: Formal representation of meanings and action repertoires. There exist various languages or notations to represent meanings. A representation of actions and action repertoires could be inspired by web service notations, bearing in mind the shortcomings described in section 2.2. A great challenge for interaction design will be to translate the formalisms into user interfaces and processes that are meaningful to the user.

Formal IS: Creation, adaptation, and sharing of meanings and action repertoires. Based on the formal representations mentioned in the previous item, procedures have to be established to enable sharing and adaptation of meanings and action repertoires. The challenge for interaction design does not only lie in the translation of those procedures into meaningful interactions, but also in the impact this item has on the informal IS. E.g., privacy is an important issue here, since a user might want to share certain meanings only with certain users. One approach would be to share only meanings that are minimally required for the interaction with a current user. However, this approach could unnecessarily

limit the evolution of other users.

Informal IS: Meaning negotiation. The example above has shown a simple case of implicit negotiation. However, if two users have to negotiate the meaning of concepts that either user selected from different semantic resources, mechanisms have to be provided that are compatible with the abilities of the end users. E.g. for a user with some digital literacy, "collaboratively creating a document" might mean "locally editing a document and sending it via e-mail to the collaborator", whereas to a fully digitally literate user it might mean "using an online collaborating tool". Conversation patterns like "Conversation for Possibilities" might provide a starting point for further investigations. Meaning negotiation can be complex. A challenge for interaction design is to enable meaning negotiation considering the different abilities and needs of users.

Informal IS: Changing pragmatic contexts. Users may move in different pragmatic contexts, for example work and private contexts. Meanings or actions relevant in one context might be irrelevant in other contexts or even differ. Depending on the current pragmatic context, it must be possible to select the adequate set of meanings and actions. Furthermore, different meanings and differences in the action repertoire have to be accommodated by interaction design. E.g. compared to the work context, within the private context, an action "invite user to event" might propose a less formal invitation template and use a different channel for sending the invitation.

All layers: Theory of interaction design. The items above show that the Pragmatic Web affects interaction design on all three layers of information systems. We expect that "third-wave HCI" services that focus on concepts, meanings and associated actions pose other new requirements on interaction and interface design. Because of the greater diversity, we as HCI practitioners know our users and their use contexts less than ever. Regarding relevant meanings and action repertoires, it is not enough to rely on assumptions made by software engineers, interface designers and the like. Participation of end user representatives is crucial. Thus, we recommend an inclusive, universal and participatory approach in analogy to [11]. As to methods for defining meanings and action repertoires, the Semantic Analysis by Stamper [123] seems promising, since ontology diagrams in this method already consider agents and affordances.

A problem that remains is the question of how to establish that connection between the formal and the informal. HCI theory has only recently begun to embrace the informal aspects of interaction design. Methods are emerging, but are not yet complete enough to analyse all phenomena, let alone design interaction comprehensively considering informal aspects.

2.4 Conclusion and Future Work

Based on the observation that the use of digital artefacts has significantly changed during the last years and that today users interact with those artefacts in different contexts, with different purposes and competencies, we investigated how the vision of the Pragmatic Web can contribute to the interaction design of services that must be accessible, intelligible and relevant.

Concepts currently being elaborated by the Pragmatic Web community, such as pragmatic patterns, pragmatic contexts, as well as methods and techniques from other areas, such as Organizational Semiotics, Language/Action Perspective or Socio-Instrumental Pragmatism provide promising starting points to define a frame of reference for analysing and designing accessible, intelligible and relevant services. The example and discussion from the previous section have posed many questions one of the more important ones in our research context being the question of designing interaction inclusively and universally.

Our next steps in this research include the formalization of a methodology to be adopted drawing on already existing methods from related areas. In parallel we envisage the participatory design and development of a prototype that explores our considerations from section 2.3 regarding pragmatics in the inclusive usage of the Web.

Chapter 3

Towards a Conceptual Framework for Interaction Design for the Pragmatic Web[1]

3.1 Introduction

In the World Wide Web (Web in the following) useful information on web sites is often mixed with a lot of information that is not relevant to a user at that particular moment. Furthermore, information may be presented in a format that is not optimal for a particular person. Approaches to alleviate these problems include: designing web sites adhering to accessibility and usability guidelines, placing links to frequently accessed content prominently on a page, offering customization options, and offering a search function or a site map. These approaches are all site-specific and may be implemented differently or not at all in different sites, which means that a user has first to try to find her way around when entering a new site. This is a problem that affects all users, but especially those with less experience in Web use and the users of less frequently requested services (e.g. requesting a new passport after a loss).

User-specific strategies to alleviate the problem of retrieving relevant information include using browser bookmarks, memorizing URIs, or using site-external search engines. These strategies impose an additional cognitive load on the users, e.g. the organization of large bookmark collections or the localization of the desired result in the list presented by

[1]**Copyright 2011 Springer. Article presented at HCII 2011 and published as "Hornung, H. and Baranauskas, M. C. C. (2011). Towards a Conceptual Framework for Interaction Design for the Pragmatic Web. In Jacko, J. A., editor, *Proceedings of the 14th International Conference on Human-Computer Interaction (HCII '11), Part I*, 9–14 July 2011, page 72–81, Berlin, Heidelberg. Springer."**

the search engine. Furthermore, in the case of search engines, users often have to phrase their queries using a vocabulary that is relatively similar to the one used on the desired site and potentially relatively different from their own. Regarding the problem of information presentation, solution strategies often involve some form of end-user programming (e.g. user style sheets or web scraping [76]).

We argue that, in order to solve problems related to information relevance, presentation and flexibility of use, approaches are required that are independent of a specific web site or service provider insofar that mechanisms do not depend on a concrete implementation but provide users with uniform ways to access and use information and services that are relevant to them at a particular moment in a way that optimally suits their competences and needs.

A prerequisite for a solution is that a web site needs to provide means to analyze and process its contents computationally. Furthermore, we need to understand how people access and use information and services, as well as how they interact with other people or electronic services. Moreover, this understanding has to inform methods and techniques that can be utilized to effectively design those solutions.

Regarding the analysis and the processing of information in the Web, the HTML-based Web of today, which we will call "Syntactic Web" from now on, offers limited possibilities like analyzing the structure of a document. This makes it difficult to computationally process documents, because code would have to be adapted each time the source document structure changes. In contrast to the document-centric Syntactic Web, the Semantic Web [16] is centered on the meaning of and the relationship between data.

As to the challenge of understanding how people access and use information in the Web and how they interact with each other, the notion of the "Semantic Web" is required, but not sufficient: among the main concerns of the Semantic Web are data integration, interoperability, and automated electronic agents. To date, research that is concerned with user interaction in the Semantic Web often describes only visualization, navigation and search in semantically annotated data sets. The Pragmatic Web [111], on the other hand, permits to analyze the Semantic Web enabled interaction of people with each other or with services. The vision of the Pragmatic Web is "to augment human collaboration effectively by appropriate technologies". Important topics are contextualized meaning, meaning negotiation, and the practices of virtual communities [104].

We hypothesize that, when adopting a Pragmatic Web perspective, the process of interaction design results in information and services that may be more relevant to people, that may use presentations that better fit people's needs, and that may provide a flexibility of use that accommodates a larger variety of competencies. In order to better understand, reason about, and design interactions in the Pragmatic Web, in this work we propose the basis of a conceptual framework. The paper is organized as follows: the

next section presents our view of interaction in the Pragmatic Web, illustrated by a usage scenario, and points out how interaction in the Pragmatic Web differs from interaction in today's Web. After that, we present related work that might provide a theoretical and practical underpinning for such a conceptual framework. The subsequent section provides arguments why the definition of a conceptual framework in fact might contribute to the solution of the problems described in the introduction of this paper. The last section concludes.

3.2 Interaction in the Pragmatic Web

In order to illustrate how the perspective on interaction of people mediated by the Web shifts when introducing the notion of the Pragmatic Web, we describe a short scenario of interaction in the Pragmatic Web and provide a discussion of the differences to interaction in today's Web. While Syntactic Web scenarios are focused on users interacting with other users or with digital artifacts, Semantic Web scenarios often include electronic agents that assist users or execute tasks on behalf of users interacting with other electronic agents or users. As the Semantic Web often is seen as an enhancement and not a replacement of the Syntactic Web, our vision of the Pragmatic Web is that of a Web that builds on the Syntactic and Semantic Web, i.e. uses the respective stacks of protocols, methods and tools. Consequently, Pragmatic Web scenarios include users and electronic agents, but introduce aspects like relevance, intention, or negotiation.

3.2.1 A scenario of interaction in the Pragmatic Web

Alice, an elementary school teacher, still remembers the time when she had to maintain various accounts at different social network, photo sharing or messaging services in order to keep in touch with her friends. Today, when she wants to send a short message to one of her friends, she does not have to worry which social network or messenger he is using. When she takes a photo with her camera or browses her own photo gallery, she can share a photo without having to switch to the client of the photo sharing service or enter their site. She does not have to worry that the principal sees potentially embarrassing pictures of her last birthday party because the fellow teachers that are within her circle of friends are aware that those pictures are not meant to be distributed at work.

Last week, Alice received a reminder from her local government agency, informing that her passport is soon expiring. The reminder contained a list of necessary documents together with the new specifications for the passport photograph. When browsing her photo gallery, Alice is now able to automatically verify if a photo is a

valid passport photograph.

Later in the afternoon, she has an online meeting, where she and other teachers discuss the learning process of students, exchange didactic material, review test results, etc. Until some time ago, Alice was forced to use the commonly agreed upon Content Management System to upload files or discuss cases in a forum. Now, she is able to use the same tools that she uses for e.g. sharing photos and videos or chatting with her friends. The files produced during the online meetings or other activities are organized in a manner that suits Alice's needs, while other teachers organize them according to their needs. Although Alice is using some tools she also uses for private purposes, she is always aware of the work context when engaged in activities with other teachers.

3.2.2 Discussion of the scenario

The base concepts in the scenario presented above are people acting as users of services and creating or manipulating content. In today's Web, the scenario described above would not be possible for various reasons. Users are identified by accounts, i.e. they have to maintain and remember information about different user names, passwords, password recovery questions, etc. Services provide operations and can be accessed via different user interfaces. The content created by a user using a service usually stays within the realm of the service provider (of course, the content can be copied and uploaded to the space of a different service provider). The service provider usually defines the user interfaces and the representation of the content (e.g. if you upload a video to YouTube, the video will be converted to different formats with different resolutions that can be displayed by the player at youtube.com). This means, that Bob, a friend of Alice's, would not be able to view her photo using another service than the one Alice used to upload her photo. In order to view her photo, either Bob has to have an account with Alice's service provider, or Alice's service provider has to accept a single-sign-on solution like OpenID (`http://openid.net`) and Bob has to be a user of this solution. Alice in turn may be able to access her photo via a different service, if all involved services support OAuth (`http://oauth.net`) or a similar protocol. If Alice would like to share a photo with Bob within the context of a working group at school, i.e. would not like him to share the photo with other friends, she would have to add a comment to the photo or notify Bob in a separate message.

In order to put the scenario in practice, syntactic or semantic approaches (e.g. providing access to services via APIs or enabling data portability or interoperability by providing semantic data descriptions), although necessary, would not suffice. Additionally, methods and techniques are required that allow to put meanings into context and enable meaning negotiation and the analysis and design of practices of virtual communities.

3.3 Related Work

We see the "Pragmatic Web" in the intersection of the three major areas of Human-Computer Interaction (HCI), Information Systems (IS), and Web Science. From our own perspective of interaction design, different topics from each area will influence and inform the proposed conceptual framework. In this section we will first explore contributions from HCI, IS and Web Science that are candidates for the theoretical foundation of the conceptual framework.

HCI research has acknowledged a long time ago that humans are not simply components of a system that can be studied in isolation in a laboratory environment [8]. This has led to what some researchers call "post-cognitivist theories", theories that go beyond the study of cognitive abilities, and that have a substantial amount of quantitative and significantly less qualitative elements than more traditional HCI theories rooted in cognitive psychology, human factors or ergonomics. Post-cognitive theories and models often start from the notion of language and the notion of action as a form of language use. Examples are activity theory, distributed cognition, actor-network theory, phenomenology (see [78] for a comparison of the four theories from the point of view of activity theory), or the language/action perspective [109]. Some of these theories are also employed in the field of information systems research [55].

"Information Systems are a multi-disciplinary subject, whose objects of study are information and its functions, information technology and its use in organizational contexts" [83, p. xi]. Understanding "organizational contexts" not only as relationships between people in the formal work context, but as relationships between people interacting together towards some end, theories and methods from the field of information systems research that are concerned with the use of IT artifacts are relevant to our proposal. One valuable contribution to our proposal is the fact that in information systems research social aspects that go beyond the direct interaction of people with IT artifacts have always been a concern. One of the theories and frameworks that consider the use of IT artifacts from a technical as well as a social perspective is Organizational Semiotics [124]. It focuses on understanding the different properties of signs on various levels to analyze and design information systems in terms of three human information functions: expressing meanings, communicating intentions and creating knowledge.

Besides Organizational Semiotics, other approaches exist that consider how humans use IT artifacts in organizational contexts, and different efforts to compare, integrate or synthesize those approaches have been made (e.g. [32]). One notable example is socio-instrumental pragmatism [55], a proposal of an action oriented theory for IS research that synthesizes different action theories and thus is better able to cover different demands from IS research than a single theory. [55] further describes different action themes and

their theoretic roots, i.e. purposeful, social, interactive, mediated, creative or situational action.

Web Science [15] is an emerging interdisciplinary field that sets out to understand the Web not only as a delivery vehicle for content, but as an object of study in its own right. Besides technical or engineering issues like the Semantic Web or web services, also the social aspects like Web use or governance are considered. Among Web Science research questions that are also relevant to our proposal are those about significance, relevance, reputation and trust.

The Semantic Web has been proposed as an extension to the current Web with the intent to introduce meaning to Web pages, processable by human or machine agents [16]. However, the augmented semantic contents to a great extent remain inaccessible or unintelligible for human agents. Some authors claim that considering meanings is necessary, but not sufficient, and that the purpose and context of information also has to be considered (e.g. [39]). Singh thus states that the vision of the Semantic Web can be implemented via Pragmatics, a branch of Semiotics that deals with context-based meaning [117].

Building on the Semantic Web, the Pragmatic Web sets forth "to augment human collaboration effectively by appropriate technologies" [111]. Although there does not yet exist a commonly accepted definition for the term, research topics comprise contextualized meanings, meaning negotiation, and the practices of virtual communities. Hornung and Baranauskas describe the significance of the Pragmatic Web for interaction design [70].

An important concept of Pragmatic Web research is related to intentions that lead to meaningful actions. Within cognitivist HCI theory, translating intentions into actions in order to realize goals using a tool is part of bridging the “Gulf of Execution” [93]. Among the post-cognitivist HCI theories that conceptualize humans as subjects acting intentionally mediated by tools are activity theory and phenomenology [77]. Regarding the analysis and the design of actual actions, the concepts of usability, affordances, and actability exist, whereas the term “affordance” has different significations in the HCI and IS communities [132, 56]. [70] comment on the different notions and their relevance for interaction design.

After having given a brief overview of general related work in the three areas that influence and delimit a conceptual framework for interaction design in the Pragmatic Web, we will point out more specific topics that provide complementary approaches or pointers to answers for the question of how to implement solutions informed by a conceptual framework for interaction design in the Pragmatic Web.

Semantic Web User Interaction is the name of a community that tries to foster the dialogue between the Semantic Web and the HCI communities. Recurring topics in literature are navigation and search in and visualization of structured datasets, semantic

annotation of web pages, creation of semantic data, as well as contextualizing and customizing user interaction [5]. Literature about the Social Semantic Web explores the question of how to apply Semantic Web technologies to the Social Web, combining "the best of the two worlds", i.e. facilitating navigation and searching by semantically annotating content on the one hand and promoting the creation of structured content by using Social Web mechanisms on the other. Main topics in literature are questions of interoperability and integration [25, 20]. The subject of both Social Semantic Web and Semantic Web User Interaction literature is the interaction of humans in a semantically enriched Web, whereas Social Semantic Web literature focuses on questions like interoperability and integration, while Semantic Web User Interaction literature focuses on interaction design. Both strands have the potential to bridge the gap between the often technically and computationally oriented Semantic Web community and the, at this stage, rather conceptually oriented Pragmatic Web community.

3.4 The Pragmatic Web as Proposed

In the scenario of Section 3.2, people have multifaceted identities and exhibit facets of their identities to other people. Depending on the context, two facets of a single person might even contradict and thus give the impression of different identities. Services enable different operations for different user interfaces. They are independent of content, which implies that users have more freedom to choose the user interface with which they access content and the content presentation that is most adequate. Terms of service and terms of use determine rights and obligations of service and content providers and consumers. A content item has an author and different presentations. The context determines under which conditions people may access content in which way. Customization determines which services are used to access which content presentations in what way. The division into the five dimensions people, services, content, customization and context is depicted in Figure 3.1, which shows two fictitious services, each with a different set of operations, user interfaces and terms of service. Depending on the facet of the accessing person's identity, the terms of service, the terms of content use, the service user interface and chosen operation, not all presentations of a content item might be available.

The usage of digital artifacts is not necessarily a primary activity during work and users are not necessarily experts regarding the use of the respective digital artifacts. This point is important regarding our further approach. Breakdowns during artifact interaction of expert users often occur because of usability or accessibility problems of a specific artifact. When considering the interaction of users with a variety of artifacts, e.g. different web sites created by different authors, breakdowns can occur because of what a usability analysis of a single artifact would label "lack of consistency" [92]. Only in this

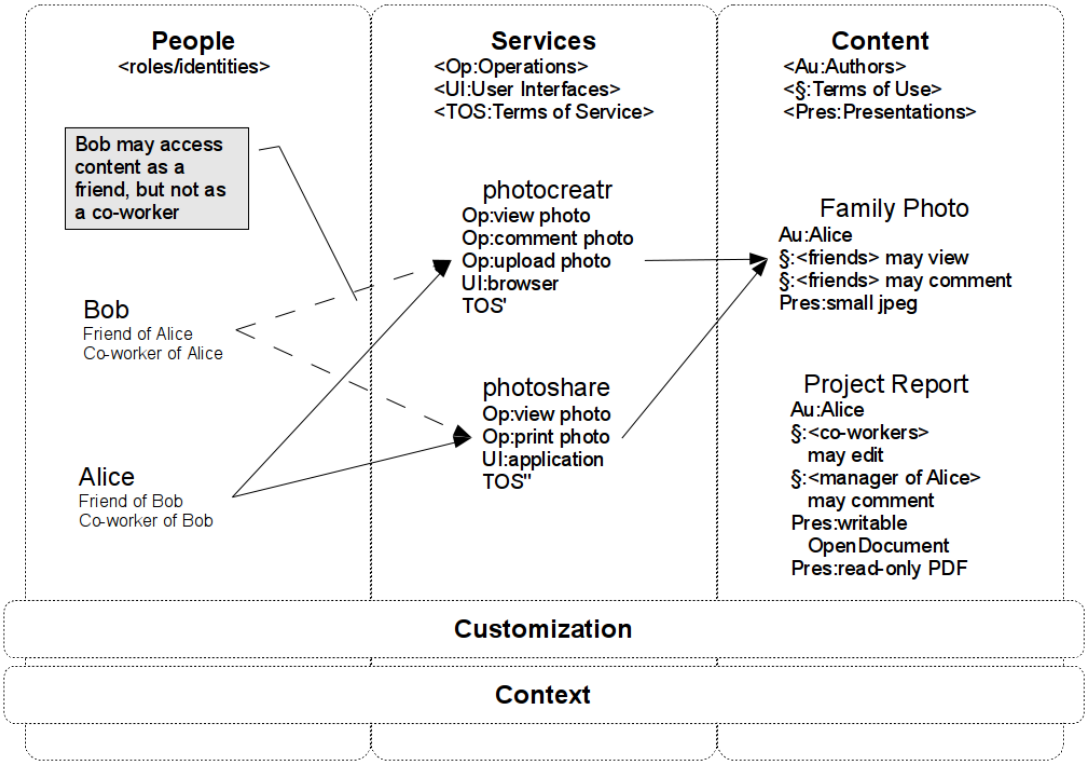

Figure 3.1: *People* access *content* independent of *services* but sensitive to *context*.

case, each artifact could pass a usability evaluation individually and even if the same or similar design principles had been used during the creation of each artifact, inconsistencies are likely to arise when considering a set of artifacts authored by different entities.

When introducing the Pragmatic Web, the focus hence moves from isolated web pages in the Syntactic Web and semantically structured data in the Semantic Web to the question of how and why people actually access information and services. For example, while teachers create or upload video, audio, text or other documents in the Syntactic Web and semantically annotate those files in the Semantic Web, they now share and access materials such as interviews, test results, educational games, etc.

We believe that this shift of perspective enables us to create artifacts that are more relevant and meaningful to a wider range of people. One might argue that, taking a user-centered or participatory design approach would already result in relevant and meaningful artifacts. This might be true for artifacts that are used by a limited or homogeneous set of people. However, even if many users achieve an acceptable performance, often the created artifact is not optimal for most of them [44]. For example, web sites of tax authorities have to accommodate for the whole set of requirements of a country's citizens, corporations and other entities, while usually only a small fraction of the whole site is relevant for a

single citizen [21].

In the Pragmatic Web, the interaction of people mediated by digital artifacts is substantially different from the interaction in the Syntactic or Semantic Web. In the Syntactic Web, interaction is usually based on web sites (in the case of browser based interaction) or on service provider based interaction (in the case of e.g. instant messaging services). In the Semantic Web, interaction is based on datasets. In our vision of the Pragmatic Web, interaction is based on the intentions of people which are materialized by actions (we do not yet want to enter the discussion whether to call the concept action, activity, act, etc.), i.e. interaction abstracts from a service provider who enables the actual action and gives people the control on how the results of their actions are presented and with whom and under which conditions they are shared.

In order to understand and design interactions in the Pragmatic Web, we aim at defining a conceptual framework, the construction of which will be informed by different theories and models from the following areas: HCI, because we need to analyze and design the interaction of people with digital artifacts or with each other mediated by digital artifacts; IS, because we need to understand how people access and process information in an organizational context, whereas by organization we mean any relationship between two or more people; Web Science, because we need to understand the basic mechanisms and the still many open questions of the Web. The base elements of the conceptual framework will comprise people, services, and content. Context and customization are considered as orthogonal dimensions. Among other important concepts that might have to be considered in the conceptual framework are values like trust, privacy, and authority.

3.5 Conclusion

In this work we addressed the problems of information relevance and presentation as well as flexibility of access and use of services and information. We hypothesized that a Pragmatic Web perspective can contribute to the solution of these problems by providing means for understanding how people access and use information and services and how they interact with each other in the Web. We presented our vision of interaction in the Pragmatic Web and proposed to develop a conceptual framework for interaction design for the Pragmatic Web informed by HCI, IS, and Web Science. The framework enables the design of interactions, in which people can collaborate while each participant is accessing services and content presentations that best fit his/her needs.

Considering the implementation of solutions that follow the proposed framework, a number of challenges arises regarding the five dimensions: people, services, content, customization, and context. Those challenges range from technical (e.g. protocols or standards) to formal organizational (e.g. forms of meaning negotiation) and informal prag-

matic and social challenges (materialize intentions into actions, awareness of effects of an action) and include questions related to interaction design. One of our next steps is to identify and analyze those challenges.

Future work includes a case study where the theoretical conceptualizations can be materialized into a proof-of-concept implementation. In order to be feasible, this proof-of-concept implementation will only implement a small fraction of the framework. The actual part of the framework that will be implemented and the concrete implementation depend on the requirements of a research project in which the authors are currently involved.

Chapter 4

Pragmatics-driven Design of Web-Mediated Interaction[1]

4.1 Introduction

In the past, the focus of the Human-Computer Interaction (HCI) discipline was on people interacting in a certain context, using a single device (e.g. a desktop computer), and working either individually or in small groups in which group members knew each other. The focal point was often on single applications or on well-defined sets of applications, as well as on questions regarding ergonomics or how to facilitate novice users' interactions. Today, people often use different devices, whereas multiple devices might be used simultaneously. Moreover, each device runs multiple applications, and users can chose which device and which application on that device they want to use to perform a certain task, e.g. in order to "talk" to a person, one might use different applications on a desktop computer or a smartphone for making a call or sending a text message. The boundaries between contexts of use disappear, i.e. users might perform work tasks at home, or use computing devices in different locations to interact with colleagues, friends, or completely unknown people. The focus of HCI research and practice has expanded from ergonomics and questions of usage efficiency to the user experience with aesthetic, emotional, and societal issues, among others. This expanded focus requires a search for appropriate methods [115]. In a related line of argument, Bannon [9] calls for a reformulation of the HCI discipline, giving "primacy to human actors, their values, and their activities" [9, p. 50]. He describes what he calls a "more human-centred perspective", not to be confounded with "human-centred design", which has already been criticised by Norman [94] for sometimes being focused too much on users and too little on their activities. Bannon

[1] **Article submitted to an international journal.**

argues that, instead of designing for automation, our designs should take advantage of the flexibility and capabilities of people. He illustrates his vision with two examples of how "values" can be considered in design and shows examples of conceptual and methodological approaches that fall into the human-centred perspective. Independently of how to call "Bannon's perspective", we understand that there is a requirement for exploring a multiplicity of conceptual and methodological approaches in order to better understand the challenges he hints at and in order to explore which methods or frameworks might be appropriate for addressing these challenges.

Related HCI methods and techniques that might be built upon for addressing these challenges include those belonging to post-cognitivist frameworks and theories (e.g. Activity Theory, Distributed Cognition; [77]). The common ground of this family of methods and techniques is that it is acknowledged that interaction mediated by digital artefacts stretches beyond the relationship between a human and a computer. Related research questions include those regarding Universal Design (e.g. usability, accessibility, or aesthetics; [127]), crossmedia interaction [112], adaptation as well as questions in the intersection with the area of CSCW [62]. Interaction Design related questions about the Web as an artefact are informed by the area of Web Science [67], which comprises, among others, topics such as how people interact in the Semantic Web (Semantic Web User Interaction; [42]), and how they produce and access semantic data (Social Semantic Web; [26]).

Regarding interaction in the Web, the early Web provided only limited possibilities. The relationship between content creation and content consumption was asymmetric, i.e. one person or organisation provided content, and users "consumed" it. With the evolution of methods and techniques around the Web 2.0 and the Semantic Web, e.g. AJAX, syndication, mash-ups, cloud-based storage and computing, users can now create content. As a consequence, applications and content are used by a large scale of users and in ways that differ from what the original creators may have intended. The often unanticipated technical or social effects of this large scale use in different contexts have been studied in the field of Web Science [67].

Considering the challenges for Interaction Design on Web applications scenarios as outlined before, we investigate the possibilities of the Pragmatic Web as a new foundation. The Pragmatic Web is a research perspective that is rooted in the Language/Action Perspective and in Organisational Semiotics, and that has a strong focus on the pragmatics of human interaction in the Web [111]. Pragmatics, as a branch of Semiotics, is concerned with the relationship between signs and their effects on people who use them. In Peircean Semiotics, "a sign is something [...] which denotes some fact or object [...] to some interpretant thought" [99, vol. 1, par. 346], and which involves a signifier/representamen, a signified/object, and an interpretant. The relationships between these three elements "may differ depending on the context, culture and language" [83, p. 14]. For us, to

"investigate Interaction Design of Web applications from the perspective of Pragmatics" then means to understand Web applications as mediators of interaction among people for different reasons and purposes. Under this perspective the focus of interest is not the Web application with its properties and functions (as in system-centred design) and neither the user with his or her preferences and capabilities (as in user-centred design), but the enabled interaction and pragmatic aspects thereof. We see "interaction" as collaborative practice, i.e. as an evolving process that involves people, mediating Web applications, content, and contextual factors. We acknowledge that in this complex system the four dimensions people, applications, content, and context are interdependent and have to be seen as an atomic unit, e.g. changes in content presentation might result in changing the way people use content, and changes in the use of content might require changing content presentation. "Pragmatic aspects" of interaction are related to the construction, negotiation and evolution of meanings that are mediated by signs, i.e. we subscribe to a neo-humanist paradigm [69].

This article is structured as follows: we start by providing a characterisation of the Pragmatic Web. We then define what we understand under "Interaction Design with a Pragmatic Web focus". Subsequently, we discuss how the Pragmatic Web might concretely contribute to the five stages of an Interaction Design cycle, using experiences from a concrete research project. The last section concludes.

4.2 A Characterisation of the Pragmatic Web

The Pragmatic Web can be understood as a research perspective, i.e. as a way of looking at problems and phenomena of the Web. Proposed as an extension of the Semantic Web, a decade since the term "Pragmatic Web" was first used in scientific publications (e.g. [117]), the area is still being defined by its research community and can thus be considered as an evolving research area. Without aspiring to provide a literature review of the field, we give a brief overview of the Pragmatic Web in the next paragraphs using the following aspects:

- use of the linguistic or semiotic metaphor,
- understanding of the term "pragmatic",
- research methods,
- research topics,
- demarcation from core Semantic Web research,

- juxtaposition of the Web, the Semantic Web and the Pragmatic Web, and
- the Pragmatic Web as a layered information system.

Authors who contribute to Pragmatic Web research understand the term "pragmatic" in different ways. Some authors refer to "pragmatics" in the semiotic sense, as defined by Peirce (e.g. [101]), while others refer to the work of Morris (e.g. [117]). The difference between the definitions in the sense of Morris or Peirce is rather subtle [4]. However, researchers who subscribe to either definition, also subscribe to the notion of "having practical consequences" and to the importance of "action" as a central concept.

One way to characterise the Pragmatic Web is to use the linguistic or semiotic metaphor, i.e. to examine syntactic, semantic, and pragmatic aspects in the Web, the Semantic Web, and the Pragmatic Web, respectively, from a linguistic or semiotic point of view (e.g. [3] or [104]). Key characteristics of the Pragmatic Web are then the consideration of relevant context, intentions, interests and participation by the members of communities of practice, whereas one of the challenges consists in identifying the relevant dimensions of context. However, according to Pohjola [104], these characteristics are not sufficient to delimit the Pragmatic from the Semantic Web. He proposes to include the notion of the interdependence of humans and technology, focusing on "negotiating and cultivating the practices for the development of skills and the enhancement of engagement". From the point of view of Organisational Semiotics, Stamper [125] proposes that an extension of the Semantic Web should include applying semantic analysis to speech acts. That way, the Pragmatic Web would make explicit the exact point in a dialogue and thus minimise misunderstanding or deception and guarantee that changes of knowledge or agreement can be registered and traced to the respective responsible agent.

Conducting research in the area of the Pragmatic Web does not restrict or prescribe the body of methods and techniques. In fact, looking at the literature in the field, there does not seem to exist a universally accepted set of methods and techniques. However, many authors use Organisational Semiotics (OS; [83]) or the Language/Action Perspective (LAP; [58, 131]) as theoretic and methodological frames of reference.

Regarding research topics, the initial forums for discussing and advancing the area were the International Conference on the Pragmatic Web conference series and workshops of the AIS Special Interest Group on Pragmatist IS Research (SIGPRAG). A look at the conference and workshop proceedings reveals that the community is diverse with respect to research foci and research methods (see the Pragmatic Web conference series starting with [110]). Scientific contributions investigate issues in problem domains such as web services [84], self-organising communities of practice [40], multi-agent systems [98], or information relevance and presentation depending on the user's context [71]. The least common denominator of Pragmatic Web research seems to be the paper of Singh [117]

and the "Pragmatic Web manifesto" [111].

As to the demarcation from core Semantic Web research, some authors point out shortcomings or challenges that cannot be adequately answered by a pure Semantic Web vision. Examples include, among others, topics such as meaning negotiation (e.g. [37]) or the evolution of knowledge and practices (e.g. [117]). Meaning negotiation is necessary when two agents (human or artificial) have subscribed to different ontologies and have to agree on the meaning of a certain concept in order to successfully interact. The evolution of knowledge and practices takes place when communities start with a certain understanding of concepts or actions but develop new understandings or perform actions in novel ways. Although Pragmatic Web research started out addressing these challenges, which the Semantic Web could not answer at that time, one cannot characterise the Pragmatic Web solely based on these topics. Semantic Web research also took on challenges such as emerging semantics (e.g. [88]), evolving ontologies (e.g. [50]; the term "ontology" might have different meanings in Pragmatic and Semantic Web research) or the question of how people interact with or in the Semantic Web (see the Semantic Web User Interaction workshop series, e.g. [42]). Consequently, the boundary between Semantic Web and Pragmatic Web research is not a clear cut one. Regarding the notion of the Pragmatic Web as an extension of the Semantic Web, this "extension" could be in the sense of "extending by building on the basis of the Semantic Web" (cf. [1] as an example of work in this category) or in the sense of "extending by complementing the Semantic Web" (e.g. [37]).

We understand the Pragmatic Web as an extension of the Semantic Web, which in turn extends the Web. We can juxtapose these "three Webs", or three perspectives on the Web, by investigating respective atomic units of analysis, formalisms, how people make use of information, and different aspects related to interaction among users (cf. Table 4.1). When looking at atomic units of analysis and formalisms, the differences become quite clear. In the Web, the atomic unit is the document or the web page. Formalisms focus on the presentation of textual or other content, i.e. its structural or syntactic characteristics. We thus will use the term "Syntactic Web" as a synonym for the Web in the remainder of this article when we want to call attention to this characteristic. In the Semantic Web, the atomic unit of analysis is the resource, which is a representation of a thing or concept. Formalisms include those of the Semantic Web stack [15]. As opposed to the Syntactic Web, the focus moves from structure to meaning. In the Pragmatic Web, the unit of analysis is a collaborative action on a resource: since the goal of the Pragmatic Web is to augment human collaboration, the object of collaboration (the "resource") and the collaboration itself (which includes action and actors) have to be understood as one unit. Regarding formalisms, those from related areas such as LAP or OS are applied. The different units of analysis and formalisms imply that there are differences in how

people are supported in making use of information they encounter in each respective Web. While in the Syntactic Web people need to interpret information and put it into context, in the Semantic Web interpretation is supported by computational mechanisms. In the Pragmatic Web interpretation as well as contextualisation is supported by computational mechanisms, i.e. contrary to the Semantic Web, where context is determined by the application domain and where users are presented "facts" that are "valid" within this context, we posit that context is primarily determined by the individual person and respective situation. Hence, instead of "acknowledging the validity of facts", the person needs to interpret the presented information within the current context. Furthermore, the notion of "context" in the Pragmatic Web usually goes beyond objectively observable "facts" (e.g. time, place, screen size, connection speed, Semantic Web domain ontologies), and also includes the systems of beliefs and norms within which the involved participants act. As a simple example, consider cases where people prefer objectively inferior products because of brand loyalty, or because "friends use them too".

The question of how interaction among users is differently supported in the Syntactic, Semantic and Pragmatic Web is important not only because this paper is about Interaction Design in the Pragmatic Web, but also because of the importance of human collaboration in the Pragmatic Web. Interaction among users is one aspect of collaboration. Other aspects that are beyond the scope of this paper are related to organisational questions, norms, values, etc. Focusing on interaction, Table 4.1 illustrates examples of different concepts, mechanisms, strategies and tools for supporting interaction in the Syntactic, Semantic and Pragmatic Web.

The interaction in the Syntactic Web is facilitated by concepts and mechanisms for accessing web pages, e.g. hyperlinks, bookmarks, or search engines. Access to resources in the Semantic Web is facilitated by electronic agents, linked data, etc. The key concepts for supporting interaction in the Pragmatic Web are the shared pragmatic context and collaborative practices that need to be cultivated and that support the development of skills and knowledge. The pragmatic context comprises, among others, the participants in a communication act, their shared pragmatic information (e.g. cultural or social background), theme, time, location, and psychological states [83]. Contrary to the supporting concepts in the Syntactic or Semantic Web, the knowledge about what constitutes a practice and how to execute it cannot always be completely formalized since, e.g. in the case of creative practices, it might depend on past experiences, participants, etc. Thus, part of the knowledge about practices might be defined by explicit descriptions of practices, while another part is defined by the shared experiences constructed during people's participation in past practices.

Interaction strategies vary accordingly, due to the different atomic units of analysis, information usage, and concepts and mechanisms supporting interaction. In the Prag-

Table 4.1: Juxtaposing the Syntactic, the Semantic and the Pragmatic Web.

	Syntactic Web	**Semantic Web**	**Pragmatic Web**
Atomic unit of analysis	document (web page)	resource (representation of a thing or concept)	collaborative action on a resource
Typical Formalisms	e.g. HTML, CSS	Semantic Web stack (e.g. RDF, OWL, SWRL)	imported from LAP, OS, etc.
Usage of information	interpreted and contextualised by humans	interpretation supported by machines, contextualisation by humans	interpretation and contextualisation supported by machines
Concepts and mechanisms supporting interaction	bookmarks, search engines, hyperlinks	electronic agents, artificial intelligence, linked data	collaborative practices, shared pragmatic context
Interaction strategy	1. use a search engine or recall and type a URI 2. find desired content in page 3. execute action (e.g. navigate, fill in form)	1. locate resource 2. navigate using hyperlinks or faceted browsing, make queries (e.g. with SPARQL), etc.	1. identify which action might materialise an intention 2. execute action within current context regarding involved people and resources
General-purpose tools	browser	semantic web browser (e.g. Tabulator)	unknown
Special-purpose tools	web apps	domain-specific editors and browsers (e.g. SKOS-reader, SIOC browser)	tools depend on practice

matic Web, people interact within the context of a collaborative practice, i.e. in order to interact meaningfully, people need to identify which of the actions available within the current state of the practice are compatible with their systems of intentions and goals.

Table 4.1 also shows examples of different general- and special-purpose tools that mediate interaction. Regarding the importance of context, the notion of a general-purpose tool for the Pragmatic Web might seem counterintuitive. However, tools to explicitly design or cultivate practices or to register changes in knowledge might fall into the category of general-purpose Pragmatic Web tools. Special-purpose Pragmatic Web tools depend on the practice, and thus also on the involved actors. For example, an instant messaging (IM) client might be an adequate special-purpose tool, if a practice involves spontaneous file exchange and if the actors involved in the file exchange consider an IM client an adequate tool for this purpose.

It should be noted that Table 4.1 shows typical examples for each category. An example that is typical for one conceptualization of the Web could also be a valid, albeit more peripherical, example for another conceptualization. For example, "collaborative practices" as an example of an important mechanism for supporting interaction in the Pragmatic Web also appears in the Semantic Web, although on a different level of abstraction and with a focus on different aspects, e.g. on ontology development [49].

We can also characterise the Pragmatic Web by looking at the different layers of an information system. In Organisational Semiotics, an information system (IS) consists of three main layers, the informal, the formal, and the technical IS (the so-called "semiotic onion"; [126]). The informal IS is the most important one: here meanings are established among people and intentions are understood. In the formal IS, meanings and intentions are replaced by form and rules, and the technical IS automates part of the formal IS.

That way, by making the transition from the Syntactic to the Semantic Web, part of the technical IS can be augmented (e.g. information retrieval by semantic search or faceted browsing), part of the formal IS can be augmented or even automated and thus shifts to the technical IS (e.g. rule-based scheduling by electronic agents), and part of the informal system can be formalised (e.g. semantic annotation in wikis).

By considering the Pragmatic Web, augmentation on all layers and transitions towards the inward layers from all layers are possible. An augmentation of the informal layer would be to make informal knowledge more explicit. An open and evolving community of practice, for example, could document "best practices" to facilitate the entry of new members into the community. An example of a transition from the informal to the formal layer would be to annotate or make explicit the argumentation structure of a discussion. Examples of transitions from the informal or formal layer to the technical layer are adaptations based on pragmatic context, e.g. sharing of different variants and formats of a document among co-workers or customers.

In summary (cf. Figure 4.1), by shifting from the Syntactic to the Pragmatic Web, parts of the informal IS can be better supported by introducing formalisms (symbolized by a cloud with an arrow into the formal IS) or even automations (symbolized by a cloud with an arrow into the technical IS). It is worth noting that the size of the informal IS is unlimited for practical purposes: in the Web, any person or organisation can become a stakeholder of the IS and thus extend the informal IS with his/her/its values, beliefs, etc. This is indicated in Figure 4.1 by using a dashed line for the external boundary of the informal IS and by increasing the area sizes of each IS layer, resulting in an effective increase of the whole information system. The Semantic and Pragmatic Web introduce new possibilities for people to interact with each other, e.g. existing practices can be conducted differently and new practices are possible. This has effects on the formal, informal and technical levels of the IS.

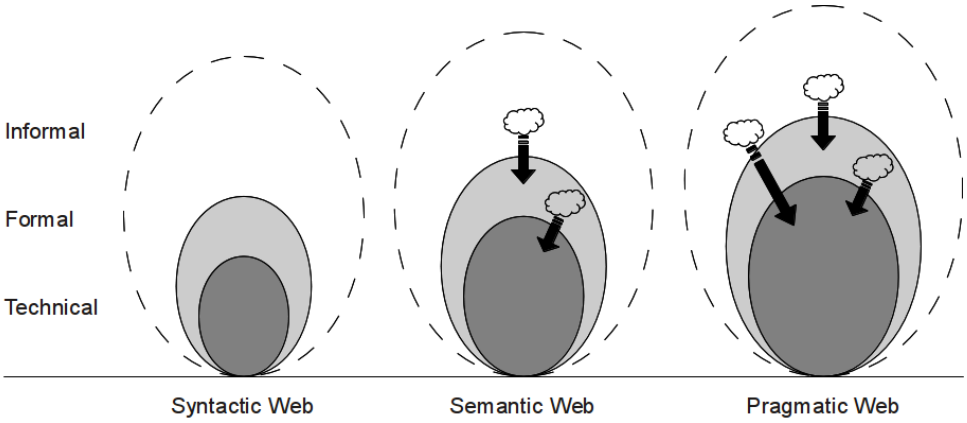

Figure 4.1: The Web as a layered Information System.

4.3 Interaction Design in the Pragmatic Web

After having given a broad characterisation of the Pragmatic Web, we delineate in this section what we understand under "Interaction Design with a Pragmatic Web focus". Many questions that the Pragmatic Web addresses are not new. For instance, the questions of how and why people use digital artefacts, the consideration of context, or the problem of "augmenting human collaboration" are at the core of HCI, IS, and Computer Supported Collaborative Work (CSCW) research. Recently these questions are also investigated considering the Web-scale of the problem. What is new is the investigation of these questions with a focus on meaning negotiation and evolution considering the shared pragmatic context. Regarding Interaction Design, this means that people with diverse individual, cultural, social and other backgrounds, with diverse capabilities and

preferences regarding information relevance and presentation interact with each other. For a successful interaction, these people need to collaboratively construct and negotiate meanings. As a result, meanings evolve over time, and systems that have been designed for a certain purpose might be used differently than intended. These are questions that fall into what Shneiderman calls "macro-HCI". "Macro-HCI researchers and developers design and build interfaces in expanding areas, such as affective experience, aesthetics, motivation, social participation, trust, empathy, responsibility, and privacy" [115].

Figure 4.2 highlights in a simplified manner some relevant topics that Interaction Design in the Pragmatic Web should address and that this perspective is informed at least by the four areas of HCI, IS, CSCW and Web Science. We consider these topics and the four informing areas a minimal set, i.e. depending on research questions or design goals, additional informing areas might enter the picture.

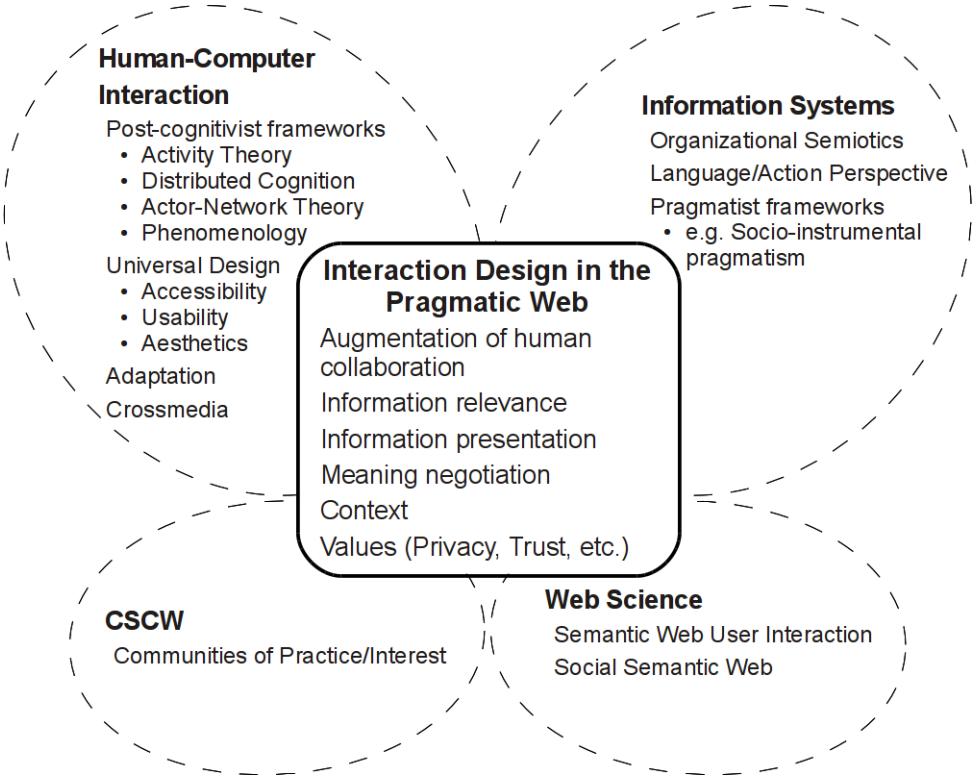

Figure 4.2: The Pragmatic Web perspective on Interaction Design.

To illustrate how Interaction Design in the Pragmatic Web is different from the Syntactic or Semantic Web, we consider situations that are related to information relevance, information presentation and flexibility of interactions [71]: information on web sites is often presented in a format that is not optimal for every user, and that is mixed with information that might not be relevant to a particular user in a particular situation.

Furthermore, when accessing that information in collaborative contexts, a user is often required to use the same tools as the other users, e.g. when agreeing to collaboratively edit a document with GoogleDocs®, a user cannot use Microsoft 365®. This kind of problems opens traditional HCI research questions such as accessibility of filtering/ranking mechanisms, task performance regarding different forms of content presentations, etc. Regarding Pragmatics-driven HCI research, the focus of research questions is extended to include problems that are related to the collaboration of people mediated by digital artefacts in different contexts.

Adopting a Pragmatic Web perspective to questions related to Interaction Design thus enables us to reason about the kind of problems presented above by conceptualising "interaction" as a collaborative endeavour of people who are performing actions on objects of collaboration. This interaction requires flexibility to reflect the opportunities and constraints of the situational context (cf. Figure 4.3 and [71]).

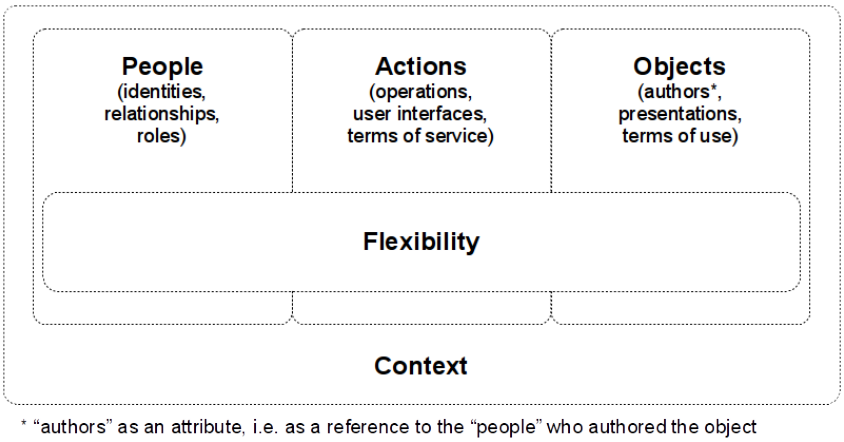

Figure 4.3: Interaction in the Pragmatic Web. Adapted from [71].

Considering the main concepts in Figure 4.3 (people, actions, objects, flexibility and context), a similar abstraction might be conceived for interaction in the Web or in the Semantic Web. However there are significant differences which we discuss in the next paragraphs.

On the basis of Nadin's [90] semiotic levels of sign processes, we can understand the Web as a syntactic representation of the world. Thus, in the Syntactic Web, people are merely represented by user accounts or profiles, e.g. by a collection of different attributes such as name, e-mail address, photo, etc. Actions are services that are represented by their user interfaces. Objects are syntactic content, the presentation of which is predefined and limited by the service, e.g. regarding a video uploaded to YouTube®, possible video or subtitle formats, as well as forms of annotation are limited to those offered by the service. Flexibility enabled by the service or content provider applies to the coupled triple (ac-

count|service|content), e.g. an adaptation of a preferred video format in YouTube® only applies to videos that are accessed with the respective user account, i.e. the adaptation has to be repeated for different accounts or different video sites. Adaptations on the client side (e.g. user style sheets in the browser or ad-blocker) only work as long as certain conventions are followed. Context in the Syntactic Web is e.g. defined by the means of access (screen size, bandwidth, geographic region, etc.), as well as by content-provider-specific user profile data, and generally does not allow, for example, to distinguish between video access "at home" or "at work" in order to automatically select an upper volume limit.

By providing a set of formats and technologies, the Semantic Web lays the groundwork for splitting up the triple (user|service|content) and for moving to a triple (people|actions|objects), thus facilitating access to the same content via different services, or via the interoperability of adaptations. Defining, for example, a service's and a piece of content's terms of use, an electronic agent could automatically decide whether certain content may be accessed via a certain service. Continuing the previous example of video access, the Semantic Web would provide the computational means to distinguish between video access "at home" or "at work" and enable an adaptation that uses a lower volume for video playback "at work". However, it is problematic to perform adaptations automatically. "At home" and "at work" cannot always be identified by syntactic or semantic context parameters (e.g. time and location of access): sometimes we work at home and do private activities at work. Furthermore, "at home" or "at work" are by themselves no situations that always have a fixed context. Regarding the access of a video "at home", the video should not be automatically played back at the volume usually chosen for entertainment purposes, because it might be that there is a sleeping baby in the next room. "At work" video conferences at the desktop or in a meeting room require different configurations.

This is where the Pragmatic Web comes in. The tasks of the Pragmatic Web include: to support people to express their intentions, perceive others' intentions, and to construct shared meanings during interaction; and to support designers and other stakeholders to understand and be aware of the implications of pragmatic aspects of interaction and to design systems accordingly.

4.4 A Case Study on Instantiating Pragmatic Web Research

After having provided a rather conceptual and theoretic account of Interaction Design in the Pragmatic Web in the previous section, we will now illustrate how the Pragmatic Web may contribute to Interaction Design. To this end, we will discuss how Pragmatic

Web ideas support the five stages of an idealized "research and design cycle" proposed in [63]: understand → study → design → build → evaluate. The discussion will be illustrated with situations of an ongoing research project. In practice, the idealized process in [63] is usually not executed sequentially. During the research project described in the next subsection, we conducted the process as depicted by Figure 4.4. Centered on the practices that the project aimed to enable, all further activities depended on continuously understanding and studying relevant aspects. Activities related to designing, building and evaluating the system considered our understanding of the relevant aspects of the practices, and contributed to further study and understand research and design problems.

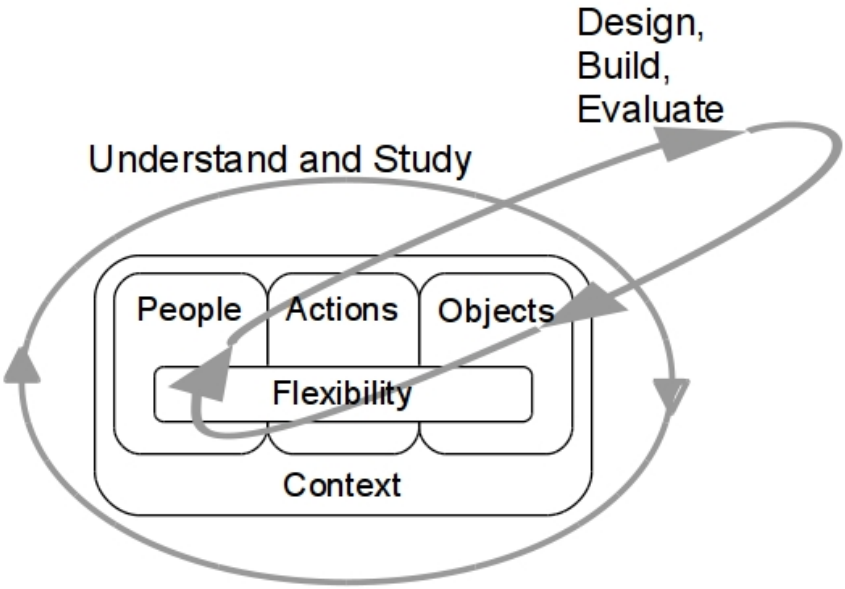

Figure 4.4: Instantiated research and design process.

In the next subsection, we provide a characterization of the research project and its participants. Afterwards, we illustrate how the Pragmatic Web perspective might contribute to the different stages of a design and research process. For the sake of facilitating presentation, we adopt the linear sequence of understand → study → design → build → evaluate.

4.4.1 The Research Project: All of Us Networked – Social Networks and Professional Autonomy[2]

The research project that serves as background is concerned with the design of a lifelong learning system for teachers in the field of special education. Among the project's

[2] `http://tnr.nied.unicamp.br`

main goals are to support the collaborative solving of work-related problems in a non-institutional environment, as well as to facilitate the exchange of ideas, and sharing of experiences. The work described in this section is only one part of this project. Other research activities comprise topics such as human values in design or professional autonomy of Brazilian teachers.

The research team is composed of professionals from areas such as computer science, human-computer interaction, education, pedagogy, and journalism. The methodology adopted by the project requires the participation of end-user representatives during all stages of the project. To this end, a group of 28 teachers has been invited to participate in the research project. These teachers work in the Brazilian public school system and are geographically spread across the country. Most of them do not know each other personally. Regarding common ground or shared knowledge about special education and work practices, all have attended the same 18-month distance learning course about special education, although with different instructors, and each in their respective home state. Among other activities, the course participants discussed so called "cases", fictitious problems of children with special needs regarding school life. A case discussion in the course followed a certain structure, including, among others, problem clarification, discussion, and the elaboration of an educational action plan. One goal of the "case discussion" metaphor is to teach the participants that every problem should be analysed on a case-by-case basis, and that during real work-practice they should not simply pick an off-the-shelf solution from a case repository.

The proficiency regarding IT use varies among the 28 teachers. Some of them use digital cameras or smart phones at home and even laptops in the classroom. They are familiar with uploading images or videos and use social network systems to stay in touch with friends. Others do not have access to computers at home, possess only simple mobile or feature phones and use the computers at school only if required for their job.

The research project involves the design of a system to support the teachers' collaboration on the cases they encounter in their daily practices with special education needs. In order to promote the sustainability of this system, the teachers themselves will participate, among others by defining their own work-practices, e.g. the case discussion, as they are using the system. Many teachers who will use this system will not know each other, i.e. they need to establish common ground and negotiate and cultivate their work practices for successful collaboration. We understand that the Pragmatic Web is a research perspective that is appropriate for treating these topics of meaning negotiation and evolution during Web-mediated human collaboration.

In the remainder of this section, we use the research project and system design to illustrate how the Pragmatic Web perspective might contribute to the different stages of a design and research cycle.

4.4.2 Understand

The conceptual model of Figure 4.3 can be used for a reflection about the design problem and a conceptual analysis. Regarding "people", for example, the expansion of the focus on "users of a system" to "involved people who interact", and their relationships, forces the explicit consideration of stakeholders who are not users but who are affected by the system nevertheless, e.g. students, parents, health professionals, other faculty at school, etc. These stakeholders and their potential involvement might have an influence on how the teachers define their practices (e.g. the case discussion), and how these practices evolve over time. For example, besides questions related to privacy and data protection, an involvement of parents might require teachers to give regular status updates of the discussion process or even entail the possibility to let parents actively participate. The personal information made available to teachers should be edited in a tone that is not perceived as cold/diagnostic/patronizing, etc. In previous work, we identified Organisational Semiotics and Activity theory as two frameworks that are adequate for discussing these kinds of problems [73]. Organisational Semiotics provides methods for identifying stakeholders and analyzing their requirements. Activity Theory provides means to analyse the relationship of a case discussion to practices of special education teachers or other stakeholders. Both frameworks provide us with the insight that meanings and practices are subject to constant change and development, and hence specify the requirements for design to support meaning and practice negotiation and development, as well as flexible execution of practice.

The conceptual model of interaction in the Pragmatic Web generates research questions that must be considered in the subsequent stage discussed in the next subsection. Regarding the different roles and relationships between people, in early stages of our project, the need arose to define whether parents, health professionals, or other faculty should have access to the system, and who should be able to perform which actions on which objects of collaboration.

As already mentioned, one goal of the ongoing research project is to design a Web-based collaborative system for special education teachers and professionals from related areas. Among others, one object of collaboration represented in this system is the "case" with its discussion process, since all special education teachers in Brazil's public schools have to pass the aforementioned distance learning course and thus should be familiar with the concept of the case discussion. In contrast to the distance learning course, in which discussions were moderated by tutors, it is expected that the teachers themselves organise these discussions. Pragmatics provides a rich framework for analysing and understanding these discussions or other kinds of conversations. Hence, a research requirement for the "study" stage could be identified regarding a better understanding of how the teachers discuss cases mediated by the prospective system.

4.4.3 Study

Regarding pragmatic aspects of Web-mediated case discussions, questions that needed to be studied in the project included:

- How do the participants use different Web-based systems that support different conversation styles?
- How do they organise the discussion process in the absence of a leader or moderator?
- Do certain roles emerge during discussion?
- Regarding content, how do the participants deal with authorship and attribution in collaborative settings?

In order to better understand these and other questions, the teachers participating in the research project were asked to discuss different fictitious cases using four different already available online systems that enabled different conversation and collaboration styles (question-answer, forum, blog, chat, etc.). For each of the four systems, the teachers were asked to discuss one case during a period of approximately six weeks. Subsequently they were asked to respond to an online questionnaire and invited to semi-structured interviews via instant messaging tools.

During the case discussions, a member of the research team posted a case description, and the participating teachers engaged in the discussion in the respective system. Interventions by the research team only occurred in order to provide additional details to the incomplete case description. Afterwards, the data generated during the case discussions was analysed on a micro- and macro-pragmatic level.

On a micro-pragmatic level, a pragmatic function analysis was conducted, which attributed illocution types to single communication acts [24]. An illocution is related to the functional part of a message and might reflect a speaker's intention. Liu [83] defines eight different illocution types: assertion, valuation, palinode, contrition, forecast, wish, proposal, and inducement. This micro-pragmatic analysis was exploratory and served, among others, the goal of explaining strong and weak points of different conversation styles underlying the four systems used during the discussion of fictitious cases.

In a subsequent study, the results of micro-pragmatic analysis was re-collocated with the raw data and analysed on a macro-pragmatic level, i.e. instead of analysing single communication acts, these were considered in the context of the whole discussion with its various sub-threads [74]. One goal of this analysis was to detect regularities or other distinctive features in order to inform the design of an own solution. Inspired by Design Patterns in Software Engineering, we identified "pragmatic patterns" that were defined as "recurring situations of use which might require the design of solutions that facilitate,

promote, or avoid the manifestation of the pattern" [74, p. 379]. An important concept for detecting a pragmatic pattern and discussing possible solutions is the "pragmatic context", which is defined by the participants in communication acts, their psychological states and shared cultural or social background, the illocutions and perlocutionary effects, the theme, time, location, etc.

An example of a pattern identified in [74] is "coordination of practice" which in our case refers to situations where participants need to negotiate how to proceed in the current case discussion, e.g. whether the problem needs to be elaborated further, or whether the educational action plan should be constructed for the case. A part of the relevant pragmatic context includes the relationships among the participants and the informal or formal norms regarding the conduction of the discussion. Remembering the conceptual model of Figure 4.3, hierarchical or other asymmetric relationships could result in different access permissions of services and content (e.g. "may comment but not edit", or "view only public information"). Regarding the norms of case discussion, in our project the pattern "coordination of practice" manifested itself during one case study in a form that the participants did not reach consensus regarding the question of whether to continue the problem elaboration or whether to start constructing the educational action plan. They split up into two groups working in parallel but joined later and continued together. A discussion of this pattern regarding the project context of lifelong learning revealed that it should be considered positive to enable the exploration of alternative ways of case discussion. After all, for learning, both the result and the solution process are important. Thus, a respective requirement for the next stage of design was specified.

4.4.4 Design

In the "research and design cycle" proposed in [63], this stage involves reflection on and definition of the design goals. As an example of how the Pragmatic Web might contribute to this stage, we discuss one of its core themes: meaning negotiation. Related to this theme is the pattern mentioned in the previous subsection, "coordination of practice". In collaborative environments, people need to reach a shared understanding of what constitutes a practice and how to conduct it. The way how this understanding is reached depends on different factors of the pragmatic context. In corporate or other formal environments, practices might be defined in an operations manual. If in this case the definition of a practice would not consider the concerns of all stakeholders or would not permit some degree of flexibility, breakdowns might occur, or people might try to circumvent these restrictions by resorting to unanticipated extra tools, unofficial procedures, etc.

In contrast, in our context of non-institutional, informal lifelong learning, the answer to the question of how to enable the coordination of practices is shaped by the project's

goals of promoting teachers' professional autonomy and of providing a platform for lifelong learning. Furthermore, the following assumptions about knowledge and learning adopted by the project team are relevant [73]:

1. *knowledge and practice are interdependent*, i.e. knowledge should have a practical relevance, and practice and experience augment knowledge;

2. *learning is a collaborative effort*, i.e. learners engage in collaborative activities and learn from the process and the outcome of these activities;

3. *diversity improves learning*, i.e. less experienced learners learn from the contributions of more experienced learners, more experienced learners benefit from clarifying and presenting their knowledge to less experienced learners;

4. *learning from real-life problems*, i.e. the learning process is improved when the learner has to solve a real problem that he or she encountered.

These goals and assumptions should be reflected in the design of the practice and in mechanisms that support practice coordination and conduction. Regarding the first assumption, i.e. the relation between knowledge and practice, teachers discuss real cases and apply the discussion results to their practice. Although each case is only immediately relevant to the teacher who posted it, practical relevance is also reflected in the contributions of the discussion which eventually define the educational action plan. The educational action plan in turn is not created to conclude the discussion but to be implemented in class. Thus, regarding the relation of knowledge and practice, it is indispensable to provide feedback about the implementation of the plan. For the feedback-providing teacher, this has the benefit of reflecting about successful and unsuccessful measures defined in the plan. For the other teachers this experience sharing has the benefit of finding out which of their recommendations worked out and which did not. However, in practice, it might sometimes occur that, once the plan is defined and implemented, the teacher omits providing feedback, since for him/her the problem is solved, he/she "has no time", etc. Thus, mechanisms should be designed that promote giving feedback, e.g. reminders or gamification mechanisms.

Regarding the third assumption, it can be expected that the users of the system have diverse preferences and competences, regarding technology use as well as case discussions and other professional practices. These people will interact with each other, and thus the "case discussion" process should be designed in a way that enables flexibility and meaningful interaction regardless of these differences. For example, the "case discussion" consists of several steps. Ways to enable flexibility include allowing to skip or to go back a step, allowing parallel execution of steps, etc. Although the steps of the case discussion

might be clearly defined, much knowledge about what constitutes a good case discussion is informal. In order to promote learning of the discussion process, the community could regularly showcase case discussions it considers exemplary. Furthermore, it can be expected that learning about case discussion influences the process itself. Thus, the system should be designed in a way that permits adaptations to reflect the evolution of the discussion process.

Similar reflections are possible for the remaining assumptions and goals, as well as regarding Pragmatic Web themes other than meaning construction and negotiation.

4.4.5 Build

Regarding this stage in the design/research cycle, [63] advocate to build "more hybrid" systems that might include both software interfaces for multiple devices and "novel amalgams of hardware", e.g. cameras as alternative input devices or other physical user interfaces. This resonates well with our Pragmatic Web perspective on Interaction Design. One could e.g. conceive the creation of learning materials such as board games that automatically produce a record of their use that, respecting privacy, is synchronised with the case discussion of the respective student in order to be analysed and discussed among the teachers participating in the discussion.

An important aspect of our Pragmatic Web perspective on Interaction Design, however, is the strong commitment to actual practice. This means, that as developers and designers, we do not pull something like the aforementioned auto-recording learning game out of thin air, but only facilitate its creation if it emerges out of the users' practices. That is not to say that in this example a user has to explicitly state that he/she needs an auto-recording learning game. A conceptual tool to support the discussion of what should be built or rebuilt are the "pragmatic patterns" mentioned earlier in this section. These are rooted in actual practice and describe recurring problematic or otherwise peculiar situations. To pick up the pattern "coordination of practice" described earlier, we built a prototype that makes, among others, explicit statements about how this pattern should be enabled within the context of the system for special education teachers [74].

This strong rooting in practice often leads to "incremental innovation", i.e. a "problem" in practice is detected, a solution is proposed, implemented and evaluated, and depending on the evaluation results, the next increment is started, or the new implementation is rolled back. Depending on the design goals, a "problem" might be a negative effect that needs to be mitigated, or a positive effect that should be amplified. Although they are much less frequent, the Pragmatic Web perspective does not per se exclude "breakthrough innovation". The strong orientation toward practices that entails a strong involvement of users and other stakeholders might very well lead to radically new conceptions of practice

execution.

4.4.6 Evaluate

Evaluation under a Pragmatic Web perspective draws on existing HCI and CSCW methods and includes the evaluation of accessibility, usability, or awareness, among others. While accessibility and usability belong to Shneiderman's micro-HCI, a main focus of evaluation under a Pragmatic Web perspective is on aspects related to macro-HCI. For instance, when deploying a solution that addresses the pattern "coordination of practice", the evaluation has to focus on the question whether users are able to coordinate their practices according to the defined design goals.

Challenges that arise in this context include the definition of evaluation metrics and evaluation methods, e.g. the questions of which criteria are suitable to determine to what extent a new solution for "coordinating practice" meets the stakeholders' design goals, and how to "measure" these criteria. In many cases, the evaluation criteria and consequently the methods will be of a qualitative nature, e.g. a high-level criterion for determining the effectiveness of providing flexibility for practice negotiation could be whether breakdowns due to unsuccessful practice negotiation occurred and how severe these breakdowns were. Qualitative methods for analysing these breakdowns include questionnaires, interviews, or conversation analysis of posted messages. Another important aspect of evaluation under a Pragmatic Web perspective is that due to a focus on users' actual practices, evaluation must avoid effects introduced by laboratory settings or observers, and thus consider "natural", in situ practice execution, i.e. people working on real problems in their usual environment. Furthermore, new solutions that enable a change in practice execution usually take time until they are adopted, often several months or more. Thus, evaluation frequently will involve longitudinal studies. As a practical consequence, research and development projects need to consider this requirement in project schedules. In the case of iterative, incremental processes for instance, after introducing a certain solution, sufficient time should be reserved, e.g. by scheduling iterations during which other features are developed, before performing an evaluation and implementing adaptations in future iterations.

4.5 Conclusion

When designing systems that enable social interaction by facilitating collaborative activities, it has to be considered that different people have different information representation preferences and requirements, and that the norms for conducting activities people are engaged in may change over time. In this paper, we presented the Pragmatic Web as

an approach for conceptualising and designing applications that facilitate Web-mediated interaction, and as a framework for understanding and discussing related issues. We provided a characterisation of the Pragmatic Web, and showed that due to a variety of research foci, different conceptualisations exist of what actually constitutes the Pragmatic Web. Recurring research topics comprise the effects of mediated acts, or information presentation adapted to a person's context. By contrasting the Pragmatic Web with the Semantic and Syntactic Web, we observed that while in the Semantic Web information is interpreted by machines and contextualised by people, in the Pragmatic Web, both interpretation and contextualisation are supported by machines but ultimately performed by people.

We then illustrated how the Pragmatic Web perspective might contribute to Interaction Design by showing what the Pragmatic Web aggregates to the five stages of a user-centred design and research cycle. This discussion was grounded on theoretical aspects of Interaction Design in the Pragmatic Web and the experiences of a concrete research project that aims at facilitating the practices of special education teachers. Among the main contributions of the Pragmatic Web perspective are the strong focus on actual practice, as well as the explicit consideration of the different dimensions of the pragmatic context.

Pragmatic Web methods and techniques known today are mostly descriptive or explanatory. An interesting question for future work is whether they can also be prescriptive or generative. For example, considering pragmatic patterns, an interesting question is whether these can be used to define design guidelines or recommendations.

In summary, the Pragmatic Web seems to be a way of facing the challenges that arise in the context of Interaction Design of Web-mediated collaboration and thus might contribute to the body of theories and methods required for the new perspectives of HCI. Further work includes the examination of methodological issues such as differences between micro- and macro-HCI, as well as the different epistemological approaches to Semantic and Pragmatic Web research.

Chapter 5

Timelines as mediators of lifelong learning processes[1]

5.1 Introduction

When engaging in a collaborative activity within an online community, it is sometimes important to have awareness of the overall progress of the activity, i.e. which steps have already been performed, which results have already been achieved, and which are possible next steps. Examples include, among others, communities that are engaged in practices that include argumentation, decision making, or learning. The results produced during such online communities' activities are usually registered in electronic documents of various forms, e.g. text, image, audio or video documents, documents including comments, forum-like or otherwise structured discussions, chat protocols, collections of simple documents, etc.

Possible solutions for organizing activities and their respective documents include records management and workflow management systems or a combination of both. These solutions might be adequate in organizational contexts where activities are well understood, structured and formalized. However, in the context of informal online communities, where practices are not formally defined, where the user-base is diverse, and where activities are less structured or evolve over time, solutions are required that allow for more flexibility, i.e. that are more likely to adapt to new requirements, that facilitate unanticipated ways of executing an activity, and that accommodate different user preferences

regarding the execution of an activity.

Solutions at the other end of the spectrum include content management systems. These allow for less formal and less structured practices. However, they often provide limited support regarding the structure of a practice or the awareness of its current state.

As a concrete example of a practice, we consider the case-based discussions within an emerging community of special education teachers. One objective of these discussions is the elaboration of so called "attendance plans" that address issues around the inclusion of students with special needs in regular classes. Another objective is to support lifelong learning concerning the work-practices of special education teachers.

A case-based discussion in this community can be characterized as being "loosely structured", i.e. there are some milestones such as case proposition, problem clarification, or attendance plan proposition, but different possible paths between certain milestones exist, and a variable number of iterations and milestone revisions is possible. The community of special education teachers is still emerging, i.e. it has a growing number of members, practices are not yet well defined or established. The user profiles are diverse with respect to domain and IT competencies.

In this paper we describe a timeline-based presentation of documents related to an ongoing case discussion in a community of special education teachers. A timeline is a presentation of events in chronological order. Timelines are used to visualize data where the temporal relationship between data points or "events" is important [116]. In addition to time, other dimensions might be used as secondary, tertiary, or n-ary ordering criteria, e.g. geographic location, artistic or architectural style, political party, etc. Different presentation modes are possible, e.g. the relation between events can be presented as text (e.g. sequential layout), graphic (e.g. spatial layout), animation (e.g. spatiotemporal layout), etc. Information can be coded using text formats, colors, shapes, etc. The events presented in a timeline can be past, present or future events. Present events usually are time intervals (regarding the granularity that is relevant to the analysis), since we can assume that a time point belongs to the past as soon as it occurred. Depending on its purpose, a timeline is constructed and used differently. For example, a timeline for analysis of historic data is constructed and remains static, but might influence future events. A timeline for planning purposes, i.e. the "analysis of future events", is constructed and adapted according to new information, whereas these events might also originate from outside the timeline, e.g. new legislation or a natural phenomenon might influence the plan for constructing a building. A timeline, be it of present/past or future events, might be used by the same or a different person or group who created it. A timeline might be created manually or automatically, and, regarding timelines of present or past events, after the event occurred or as the event occurs.

Successful applications of timeline-based presentations include examples from domains

such as history, astronomy education or medical records. Potential benefits of using a timeline-based presentation for an ongoing case discussion include: providing an overview about what has already been discussed and what results have already been achieved; enabling a flexible structure of the discussion by exploiting the graphical layout possibilities of the timeline; and facilitating the participation in the discussion by providing different forms of interacting with the timeline.

The paper is structured as follows. In the next section, we describe how findings presented in scientific literature contributed to informing the prototype design. We then discuss how empirical data gathered during participatory practices further informed design. In subsequent sessions we present the low-fidelity prototype, discuss the findings, and conclude.

5.2 Design Informed by Literature

The main areas of knowledge that are of relevance to the present work are the Pragmatic Web and Information Visualization. In this section we present work from these areas as well as design examples of timelines and other tools for supporting collaborative flexible processes that informed the design of the proposed timeline prototype.

5.2.1 Pragmatic Web

The Pragmatic Web is a research area that has been described as an extension of the Semantic Web. While the Semantic Web targets the problem of making the semantic aspects of web content accessible to machines in order to enable interoperability between computers and by that way facilitate cooperation between people in the Web [16], the Pragmatic Web strives to include pragmatic aspects of human collaboration, such as intentions, meaning negotiation, or the question of how meanings are collaboratively constructed and evolve over time [111].

Research topics in the area of the Pragmatic Web include Interaction Design [71], self-organizing communities of practice [40], or collaborative argumentation or discourse [27].

Regarding Interaction Design, in the (pre-Semantic) Web, people access web pages, contextualize and interpret the content found in a page, and navigate between pages using links. For a computer, the content in a web page is a mere string or stream of characters or binary data (e.g. a search for “Paris Hilton Hotel” would include pages about the hotel and the celebrity). In the Semantic Web, a computer is able to “recognize” representations of things or concepts (e.g. a user would be able to specify whether he wanted results about the hotel or the celebrity) and to “reason” to some extent (e.g. show alternative booking

dates with cheaper room rates). In the Semantic Web, the focus shifts from web pages and hyperlinks to data, its description and links (and their descriptions) to other data. The Pragmatic Web builds on this basis and moves the focus on what people actually do with this information, and how they construct meanings depending on the context (e.g. accept the new booking dates in the case of a holiday trip, but book a different hotel in the case of a honeymoon where the wedding date depends on family and friends). One approach to facilitate these processes is to enable people to perform actions on content with the tools (e.g. web applications) that best fit their preferences and their current situation (e.g. in order to collaboratively edit a document, two users may use different online editors that are tailored to each user's preferences), as opposed to web sites that tie content and service to a user account (e.g. in order to share photos online, two users need a user account at the same photo sharing service and have to browse the photo gallery with the same web application) [71].

Applied to the timeline described in this paper, this would mean that the timeline is only one possible form to participate in a case discussion. Contributions made to the discussion should be accessible to users of other tools if they have the required authorization, even if tool or identity provider differ from the content provider. This approach would allow for a greater flexibility of the discussion practice, since changes could be implemented more easily (e.g. the introduction of an additional tool during discussion).

In order to facilitate collaboration, online communities need a shared space and tools that support content creation, conversations and other community activities. The requirements for shared space and tools may change over time, e.g. an emerging community might require tools for getting to know each other or for brainstorming, while an already established community might require tools that support very specific and well defined activities. It cannot be assumed that all requirements can be met by a single closed system: community members often use a variety of different tools to support their activities [38]. However, even in online communities that use a less integrated set of spaces and tools, often not all requirements of all members are considered. Depending on the community organization, different community members might have different privileges and obligations regarding the selection and definition of the space and the tools the community uses as well as regarding the indication, evaluation, and implementation of change requests regarding space and tools. In order to facilitate these selection and change processes, it is crucial to also consider pragmatic aspects of space and tools. In contrast to partial approaches that consider syntactics and semantics of these processes, de Moor and van den Heuvel propose a meta-model that also includes pragmatics [40].

Although this model makes it possible to consider requirements and concerns of all members within the limits of the norms established by the community, it requires knowledge of the community members that might go well beyond the knowledge required to

exert the community's core activities. Furthermore, in an emerging community with heterogeneity regarding user competencies and intentions, it might be difficult to accommodate all requirements. Thus, we take a different approach with the timeline presented in this paper. Instead of requiring explicit selection and change processes for the used tools, the timeline is one possible visualization that facilitates a case-based discussion, but it does not prescribe or restrict the use of other tools.

A third Pragmatic Web related topic relevant to this work is Web-mediated collaborative argumentation or discourse. An argument can be seen as a "product", i.e. as a conclusion derived from a set of premises, or as a "process", i.e. a social process where individuals construct and discuss arguments. When using the word "discourse" instead of "argumentation", the research focus is also on additional speech acts such as explanations. The identifier "collaborative" is used to signify that the focus of a dialogue is not on the debate, e.g. participants need not take sides or persuade others, but may freely explore different positions or make concessions [96]. Research in this area starts from the premise that collaborative argumentation or discourse have positive effects on learning. Many tools for computer-supported discourse and argumentation require an additional effort from its users, such as manually annotating the structure of an argument [108]. One of the questions in this area is how to facilitate collaborative sense-making providing mechanisms that make the structure of conversations more explicit while allowing for flexibility and reducing the additional effort required to use these mechanisms [27].

The intended users of the timeline described in this paper are members of an emerging community of special education teachers. They possess diverse IT competencies, and little experience of the timeline as a case discussion tool and the possibilities of the system where it is hosted. Thus, initially, the only mechanism for making the structure of the discussion more explicit is providing visual cues (and textual equivalents) regarding content type and author of a contribution, phase of the discussion, and the reply structure of contributions. Future iterations, however, could explore mechanisms for making the discussion structure more explicit.

5.2.2 Information Visualization

Information Visualization is concerned with supporting users to understand and make sense of data by providing graphic representations. It is relevant to our work since the timeline described in this paper is a graphical representation of a case-based discussion and is intended to support users in understanding the current state of the discussion, what already has been discussed, what are possible next steps, etc.

Heer and Shneiderman provide a taxonomy of interactive dynamics [65] that can serve as a checklist when creating new analysis tools. They identify twelve task types for

interacting with visualization tools and group them into three categories: “data and view specification”, “view manipulation”, and “process and governance”. Although the examples given are predominantly related to large volumes of quantitative data, they also apply in principle to smaller volumes of predominantly qualitative and unstructured data. The task types from the categories “view specification” (visualize, filter, sort, derive) and “view manipulation” (select, navigate, coordinate, organize) are relevant to our timeline visualization. A task type that is less intuitive regarding the representation of a case-based discussion is “derive”. An example for this task type would be to show a list of users who participated in the discussion. Since one objective of our timeline is to support lifelong learning, the category “process and governance” with the task types “record”, “annotate”, “share”, and “guide” is relevant in principle. However, this category is out of the scope of this paper, since we focus on the support of a discussion and do not intend to demonstrate how learning might be supported by analyzing a discussion.

Regarding the question of how to concretely design a timeline-based visualization of a discussion, Aigner et al. provide a taxonomy of characteristics of time-oriented data and provide examples of different visualization methods for each characteristic [2]. Considering the two subcategories of the “time” category, our data consists of the temporal primitives “time points” (e.g. posting an attendance plan), and “time intervals” (e.g. the time between the first and last post of a forum-like discussion thread), and has a branching structure of time (e.g. posting an attendance plan might trigger various discussions). Note that “linear time” can be seen as a special case of branching time. As to the subcategories of the “data” category, our data has an abstract frame of reference (i.e. data has no spatial reference, or a spatial reference is not considered relevant for visualization), is multivariate (e.g. different media types with different types of meta-data can be posted), and is visualized as abstract data as opposed to “raw” data (e.g. instead of displaying a complete posted message in the timeline, only meta-information such as sender or message title is displayed). Finally, regarding the “representation” category, data is presented statically and in 2D, although a dynamic presentation (e.g. displaying the construction of the timeline as an animation in accelerated time to promote the understanding of the development of the discussion) or a 3D presentation are conceivable alternatives. The mapping of visualization methods to categorization in [2] reveals that there is no single visualization method that is able to visualize all time-oriented characteristics of our data. Thus, a design solution must find an acceptable compromise between existing methods.

5.2.3 Timeline Design examples

Although the taxonomies are relevant for our work, most of the visualization examples in [2] visualize concrete data as opposed to data abstractions. Furthermore, the examples are targeted at the use of the visualization as an analysis tool and not as a mediator of a collaborative process. Some examples that are closer to the proposal of this work are presented in [116]. Silva and Catarci categorize timeline based visualizations based on what they call "visualization features". These features can be mapped to elements or combinations of elements discussed in the previous paragraphs, but their nomenclature is more related to the use of the timeline in a constructive process as opposed to an analytic process. Visualization features relevant to this work and not already discussed are "snapshot view" (visualize data valid at a certain time point or interval), "complex entity" (visualize an item and its properties), "entity relations" (visualize relations between items, e.g. causal, similarity, hierarchical, etc.), "user-defined display" (let the user customize the display), and "focus+context" (visualize general and detailed information of an item).

Regarding the categorization and examples provided in [116], there is no single example that meets all of our requirements. Solutions that according to the categorization meet some requirements include: perspective wall, dynamic timelines, lifestreams, lifelines, tmviewer, timetube, and timescape. The perspective wall [86] and dynamic timelines [81] address the problem of visualizing large amounts of data. While the "perspective wall" uses a distortion technique in order to use available screen space more efficiently, "dynamic timelines" uses techniques such as infinite zoom, translucency, and animation. Lifestreams as presented in [51] has a strong emphasis on the document storage model, but does not provide much visual structure regarding the presentation of documents in a stream. Timetube [30] has a strong focus on discovering visual patterns in the data, which does not apply to our case. Timescape [106] is an example that offers multiple presentations of temporal data, e.g. a snapshot view, a calendar view, and a timeline view. Lifelines [103] and tmviewer [82] are interesting examples but do not aggregate anything new to what is relevant to this paper.

5.2.4 Timelines in Collaborative Environments

In collaborative environments, timeline visualizations are used for different kinds of data and different purposes. We can distinguish between synchronous and asynchronous collaboration. Human behavior that contributes to collaboration can be divided into communication, information sharing and coordination [105]. Table 5.1 shows examples of how the use of timelines might facilitate these different kinds of collaboration.

An example for a timeline supporting *synchronous communication* is the "Loops timeline" [48], which shows the users who are or were present in a conversation, highlights

Table 5.1: Examples of timelines for facilitating different kinds of collaboration.

	Synchronous	**Asynchronous**
Communication	Erickson et al. [48]	Smith and Fiore [119]
Information Sharing	Crow et al. [36]	Bui et al. [28]
Coordination	Crow et al. [36], Bohøj et al. [19]	Bohøj et al. [19]

when a user was speaking, and also shows time and place of speaking. It thus falls into the category of tools that promote awareness during online conversations. While we consider very important the awareness during a conversation, we will have to investigate community norms and individual values such as privacy in order to determine whether the users of our timeline would accept to keep a persistent record of their participation in conversations.

Regarding timelines for *asynchronous communication*, the "Netscan" visualization dashboard [119] provides different visualizations of Usenet newsgroup threads, including a thread's temporal and structural history, the information who posted to a thread on what day, and a sociogram that depicts who replied to whom. An application of this visualization to our example of case-based discussions would pose additional design challenges, since in our example, a discussion could contain much more than a single thread, as well as additional content types, e.g. different types of media files or text documents. Furthermore, the structure of a case-based discussion is not only defined by the structure of its containing threads or other documents, but also by the phase of the discussion these contents are associated with.

The "Timeline Interactive Multimedia Experience (TIME)" system [36] is an example of the use of a timeline for *synchronous information sharing and coordination*. The system aggregates information about social events (e.g. conferences, conventions, music festivals) posted to social networking sites. The aggregation is displayed in an on-site information kiosk in order to provide visitors of the event with information about "sub-events" (e.g. sessions, presentations) and facilitate attendance planning during the event. The act of information sharing can be explicit (i.e. a user intentionally uses a certain tag because she knows that the tag will be picked up by the aggregation) or implicit (i.e. users not aware of the aggregation could use the respective tags without knowing that their post will be displayed in the aggregation). Regarding the timeline described in this paper, there is currently no requirement for synchronous coordination. Implicit and explicit information sharing is possible, i.e. the content of a user currently engaged into a case discussion is automatically shared in the timeline, and users currently "outside" of the discussion (i.e.

navigating through other areas of the system) can explicitly post content to the timeline.

The "TimeLine" system for visualizing integrated patient records is an example of timelines for *asynchronous information sharing* [28]. The idea behind this system is to provide physicians and other health professionals with an integrated access to historical medical data of a patient. The visualization is problem-centric, i.e. data is organized around medical disease entities and conditions, and customized to information requirements of the respective user, e.g. to allow a primary care physician to access a general overview of the data, and a surgeon to access more detailed data that is only relevant to a certain surgery.

With regard to our own work, the following aspects of "TimeLine" are relevant: the non-linear spacing between events to remove gaps of inactivity and to expand periods of high activity; and the flexibility to tailor visualizations to specific user requirements and to incorporate new content types. Bui et al. discuss the problem of algorithmically constructing visualizations tailored to different information requirements [28]. Our approach to this problem is to let the users themselves customize the visualization, instead of trying to propose a visualization. This includes the possibility to share a customization of a visualization with another user. Differences to our work include the purpose of the timeline and the characteristics of collaboration. While the primary focus of the timeline of Bui et al. is to support a physician's practice (e.g. understanding medical data, formulating a hypothesis regarding the diagnosis), our goal also includes supporting the learning of practice (e.g. learning how to discuss a case or create and implement an attendance plan). Thus, in addition to mechanisms that support the actual work-practice, the timeline should also support learning-practices. Regarding collaboration, although the users of the timeline of Bui et al. share the common goal of treating a patient, it seems there is no direct interaction between users (e.g. collaborative interpretation of patient records). Since interaction is at the core of our timeline, additional mechanisms are required for our timeline, some of which already have been discussed. On the other hand, interaction affords the construction of common ground, which affords less complex content, since not everything has to be made explicit.

The "CaseLine" [19] is an example of a timeline supporting *asynchronous coordination* that also can be used for synchronous coordination and, to some extent, for asynchronous information sharing. "CaseLine" enables parents and municipal case-workers to collaboratively plan and control parental leave within the context of Danish parental leave legislation. In terms of interface design, "CaseLine" does not add to what has already been discussed in this section. However, regarding interaction design and the design process, the work of Bohøj et al. resonates well with our work. Bohøj et al. believe that the timeline metaphor is an interesting alternative to common metaphors in collaborative settings, such as the document metaphor. They see the CaseLine as a boundary

object between different stakeholders that operate in different norm and value systems. Furthermore, "CaseLine" plays different roles, which not always can be accommodated smoothly (e.g. "CaseLine" as a work application vs. a home technology, or negotiation between stakeholders with different interests). In order to better understand these roles and how collaboration can be facilitated under these circumstances, Bohøj et al. employ an iterative participatory design process.

The timeline presented in this paper acts as a boundary object between special education teachers, domain experts, and in future health professionals and other stakeholders. Our findings so far emerged from participatory practices and showed that even within a single group of stakeholders (e.g. special education teachers), different norm systems and different approaches to how to conduct a work-practice exist. The timeline also plays different roles, e.g. for teachers it is a tool to support their work in class (attend students with special needs), to learn in an informal, non-institutionalized setting (undirected learning among peers, about the domain of special education as well as the practice of discussing a case and creating/implementing attendance plans), but also a platform to meet other teachers with similar problems, to socialize, or to exchange ideas.

5.3 Design Informed by Participatory Practices

The timeline described in this paper is being designed and used within the context of the research project "Redes Sociais e Autonomia Profissional" ("Social Networks and Professional Autonomy")[2]. One of the objectives of the project is to provide an environment that facilitates continuous learning among special education teachers in Brazil's public school system. Another central objective is the facilitation of community building among special education teachers and other related professionals. To this end, an inclusive social network system (ISN) called TNR ("Todos Nós em Rede", Portuguese for "All of us networked") is being designed.

To provide an initial training for special education systems, the Brazilian Ministry of Education (MEC) created an eighteen-month distance learning course during which teachers learn to discuss a so-called "case" of a student with special needs. TNR adopts the "case discussion" as a central metaphor for its learning environment. However, in contrast to the formal learning provided by the MEC, learning in TNR is informal and non-institutionalized, i.e. there are no formally assigned tutors or supervisors, teachers will not receive diplomas or certificates, etc.

The research team that is designing TNR consists of researchers with a background in different areas, including Computer Science, Human-Computer Interaction, Pedagogy,

[2] `http://www.nied.unicamp.br/tnr`

and Education. In order to learn more about special education teachers (their work-practices, their IT competencies, how they use Web systems, how they engage in Web-mediated conversations, etc.), a survey was conducted among the participants of the distance learning course offered by the MEC, and 28 teachers from all over the country were invited to participate in the project's activities. It was explained to them that they would participate in a research project. The project's goals, as well as their role as participants, including their rights and privileges, were explained. The project has been approved by the university's ethics committee, and all participants signed a term of consent.

The first activities targeted at understanding how the participants use Web systems that afford different kinds of conversation and collaborative knowledge construction. To this end, four different available online systems were chosen: Yahoo! Answers[3], a system that affords a "one question, multiple answers" style of "conversation"; ACBP-Sakai[4], a problem-based learning environment that affords collaborative knowledge construction using artifacts from Organizational Semiotics; LeMill[5], a web community for creating and sharing educational resources that affords forum-like discussions, among others; and Vila na Rede[6], an inclusive social network system that affords a weblog-like conversation (i.e. a post with subsequent hierarchical comments), among others. Each of these four systems was used in one of four sequential scenarios. In a scenario, a case description was posted by a member of the research team. The participating teachers then were asked to discuss the case until they reached a consensus of an attendance plan or the previously scheduled end date of the scenario. A scenario lasted six weeks (with exception of the second which was extended because it coincided with the holiday period), and after each scenario, semi-structured interviews were conducted via instant messaging tools. After the data gathered during the scenarios and interviews was analyzed by the research team, six of the 28 teachers were invited to a one-day on-site workshop. During this workshop, the findings of the scenario analysis were presented and discussed, and a BrainDraw session with two parallel groups consisting of teachers and researchers was conducted. BrainDraw, a participatory practice, is a graphical round-robin brainstorming with the objective to produce candidate designs [89]. In this case, participants were asked to draw the home page of the, by then, not yet existing TNR, and a screen representing a case being discussed.

The data gathered during the scenarios and the workshop, as well as our analysis and reflections, informed the design of the timeline prototype as will be described in the remainder of this section. The topics discussed in the following are related to practice,

[3] **http://answers.yahoo.com**
[4] **http://styx.nied.unicamp.br:8082/portal**
[5] **http://lemill.net**
[6] **http://vilanarede.org.br**

i.e. the process, and to conversation. We will begin to elaborate on the practice.

In the LeMill scenario, at one point one user proposed to enter the next phase of the case discussion, the elaboration of the attendance plan. Other users expressed the concern that the problem had not yet been discussed detailedly enough and that the group might miss important points if they already started the elaboration of the attendance plan. What followed was a discussion with at least two users arguing for either side with the result that one user opened a new thread for elaborating the attendance plan (the users decided to use different threads for different stages of the discussion, but also opened threads for specific topics within a stage). Some users, including some who originally expressed concerns, began to contribute in this thread, while others remained in the clarification thread. Eventually, the group converged, but still switched between threads occasionally. This observation depicts evidence that a system that supports some kind of process should allow for some flexibility, i.e. going back and forth between process steps. We believe this is even more important in learning environments, where learners should be able to explore different alternatives and reflect about them, instead of following a predefined sequence. Thus, the timeline described in this paper allows to freely initiate and switch between phases of the discussion while only enforcing minimal rules, e.g. an attendance plan cannot be created before a case has been posted.

After analyzing the interviews and during the workshop, when researchers and teachers discussed the four scenarios, it became clear that most participants required a more explicitly defined discussion process or at least a more structured tool. In the Yahoo! Answers case the only possible structure was "one question, multiple responses". In the LeMill case, the participants structured their discussion by forum topics, however not to everybody's satisfaction. In the Vila na Rede case, the only available structure was the comment hierarchy (the participants could have created additional blog posts, but did not do so). On the other hand, the different tools that ACBP-Sakai provided, were positively received, maybe because the tools for the problem clarification that ACBP-Sakai implements from Organizational Semiotics could be mapped to a certain phase of the discussion. For our timeline, this means that the process should be easily visible (and accessible to users of assistive technologies), and not hidden, e.g. behind a link to online documentation. Furthermore, a user should be aware of where she currently is in the process and what possible next actions are.

As a related matter, some users expressed a certain dissatisfaction regarding the efficiency of the discussion. During the scenarios there existed no case owner or moderator who drove the process, i.e. who closed or initiated a certain phase of the discussion, and participants felt insecure regarding whether they could e.g. "simply open a new forum". Although there will exist a case-owner for a case discussed in TNR, since only real cases will be discussed in the system, it cannot be expected that all potential case owners are

equally comfortable with the role of the moderator who drives the discussion. On the other hand, it is not clear, whether a moderator always "emerges" from the discussion participants, or whether this is desired at all. More empirical data has to be gathered, and the community of teachers will have to articulate their values regarding this matter.

In the LeMill and the Vila na Rede cases there were conversation strands where a certain topic was discussed by the same subset of users across different threads or different comment subtrees. Sometimes these discussions were not concluded. In Vila na Rede, e.g. the composition of an young adult education class was discussed in subtrees scattered over the whole comment tree, and at the end came to nothing. The scattering makes it difficult to reconstruct the single positions. Strategies like skim-reading or using the browser's in-page search are of limited use since the topic is indicated by different terms (e.g. young adult education, YAE, special class, or versions with typos). The content organization of LeMill and Vila na Rede (emphasizing new content) might promote losing sight of unfinished discussions. For our timeline this means that not only new content should be emphasized, but also "what already has been 'said'". Furthermore it should be possible to search or apply filters to the timeline to be able to track certain topics or conversations.

Regarding the messages or other content posted to the case discussion, we could identify the following types in all four scenarios: messages strictly related to the case, messages about the work-practice of special education teachers (e.g. reflections, calls to actions, often but not always triggered by the case), messages regarding socializing (e.g. "nice to see you again in this discussion"), or messages about the tools (e.g. "could someone explain how to record audio with a webcam?"). We believe that all four message types are relevant; however, not all types have to appear in the same area of the system. In Vila na Rede, all types appeared in the comment tree, while in LeMill a dedicated thread was created, in which most, but not all, questions about LeMill were discussed. In our timeline, there should at least be a possibility to discuss questions about the tool outside the timeline. Regarding socializing messages, further investigations are required: too many messages could distract users from the discussion, but on the other hand, those messages are important for community and practice development.

5.4 A Low-Fidelity Prototype

The timeline will be embedded in TNR, which at the time of writing exists as a closed system (i.e. only open for the participants of the scenarios and the research team) with basic content management system (CMS) and social network functionalities, i.e. users already can create their profiles, share documents, comment on each others contents, "follow" users, "like" content, etc.

Figure 5.1 shows one possible wireframe of the timeline tool. In this tiled layout the timeline is embedded in the content area of the CMS and consists of three main areas: the timeline canvas, the event viewer, and the chat widget. The wireframe has been designed for screens with a resolution of 1024x768 pixels, which is a resolution with which a significant number of the target users access the site where the timeline will be deployed.

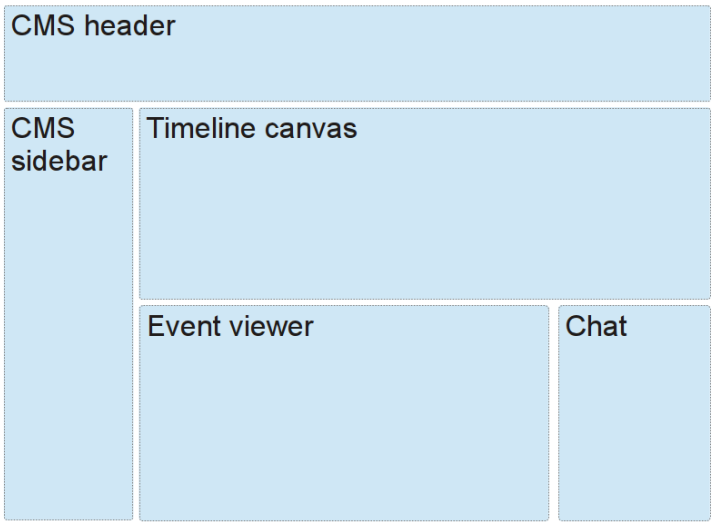

Figure 5.1: Wireframe of the timeline within the CMS.

Figure 5.2 shows a mockup of the timeline canvas in medium detail level. The timeline canvas contains different controls for exploring timeline content, such as alternative presentations in tabs (a), search (b), filter (c), zoom/detail level control (d), timeline overview (e), and a marker (f) that marks the current date. The two tabs (a) switch between a two-dimensional plot of events with event details displayed in the event viewer and time flowing from left to right to a textual representation with collapsible/expandable event details displayed inline and time flowing from top to bottom.

The content area of the timeline canvas is divided into three horizontal stripes that correspond to the stages of a case discussion (clarification, elaboration, implementation). Events are plotted in the respective stripe. Depending on the event type and detail level, events are plotted as points or intervals. For example, the posting of a case proposition is plotted as a point in time while a forum-like discussion is plotted as an interval, if the time span between the first and the last contribution to the discussion spans more than one time unit (e.g. hour, day, week) in the current detail level. The timeline starts with a case proposition by user “andreav”. This posting is followed by multiple events in the clarification stage (a forum-like discussion among multiple users, the posting of a video file, and two chats) until a “problem solution” is posted. A “problem solution” is similar

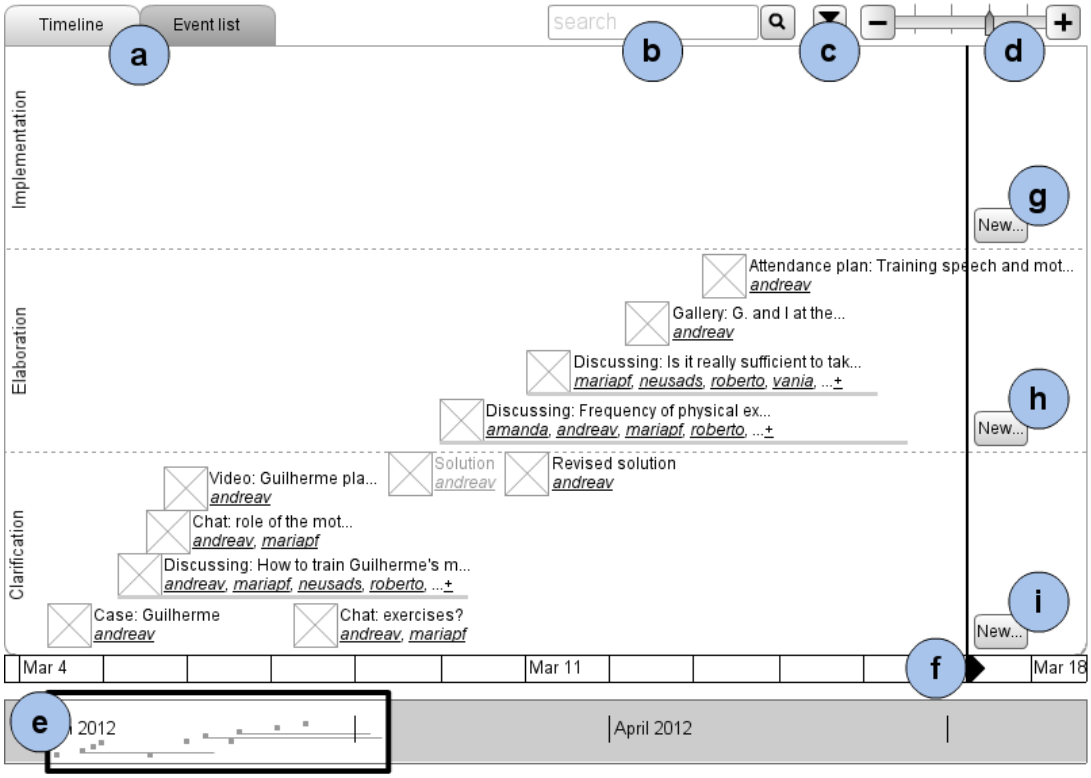

Figure 5.2: Timeline canvas.

in content to a "diagnosis". However, the term "diagnosis" has been rejected by the users as being too medical and evoking associations with terms like patient or illness. From this point in the timeline, some users start elaborating an attendance plan, while others continue the discussion. The discussion then results in a revision of the problem solution. After this all activities take part in the elaboration stage that results in a first version of an attendance plan.

The event details that are displayed in the timeline canvas depend on the event type, the detail level and the number of displayed events. Event types include the posting of text, audio or video files, invitations to a case discussion, or chat protocols. Depending on the event type, additional details are displayed as tool-tips. Related to information visualization, an important item for future work is the definition of the zoom detail levels and the kind and amount of details displayed at each level. Data gathered so far during the scenarios described in the previous section, e.g. number and length of posts, suggest that at least three discrete zoom levels will be required. The question of how to visualize events at different zoom levels also entails the question of how to aggregate event details and how to choose the most important events at each zoom level.

Apart from exploring the timeline, the canvas directly permits to engage in the case

discussion. Depending on the current state of the discussion, possible actions can be directly initiated from the respective stripe in the timeline canvas (g, h, i). For example, when a case proposition has been posted, it is possible to include a comment, to invite a person into the discussion, or to post a new revision. In the next stage, it is possible to post an attendance plan, request further clarification, post accompanying materials, etc.

When selecting an event, its complete details are displayed in the event viewer. Depending on the associated event type and the user's authorizations, the event details may be edited, creating a new event upon saving the changes, e.g. a new revision of the attendance plan. Furthermore, for each event type, different actions may be initiated directly from the content viewer, e.g. commenting, discussing, or attaching a file.

The chat widget (Figure 5.3) is case specific, i.e. it permits to engage in a conversation with the users who are currently viewing the case. Furthermore it allows to register a part of the current chat history as an event associated to the different stages of the case discussion.

Figure 5.3: Chat widget.

5.5 Discussion

The main objectives of introducing a timeline metaphor to collaborative problem solving practices was to enable flexible practices and to provide participants with an "at a glance"-

overview of what has already been achieved, what are possible next steps, and who are the main participants.

A timeline, as proposed in this paper, represents a single instance of a collaborative problem solving practice. Users initially get the "at a glance"-overview since the default zoom-level is one that displays all contents generated during the practice (documents, conversations, and other events) at the maximum detail level that still fits into the viewport of the accessing user agent (e.g. web browser). Content is displayed using different icons, colors, and other visual cues for each content type, along with information about the author and other contributors. Users interact directly with the timeline, and the user interface offers only the actions that make sense regarding the current state of the practice.

Apart from the visualization itself, i.e. the problem of how to optimally present the event data visually, an important challenge is how to design an accessible version of the timeline visualization. The current prototype makes use of various visual dimensions, e.g. two-dimensional layout, icons, or colors. A textual representation of the timeline data, e.g. in list or tabular form, would provide minimal accessibility, e.g. the possibility to access content with a screenreader or different assistive technologies. However, the main purpose of the timeline visualization is to provide users with an "at a glance"-overview of the current state of the process. An accessible timeline thus has to provide users of non-visual output methods with an equivalent overview. This is no trivial challenge: when accessing the timeline visually, a user "takes in" its content at various detail levels quasi-simultaneously, while, e.g. a screenreader user accesses the content essentially as a linear sequence.

By displaying events in the two-dimensional timeline according to time of the event and activity of the practice, users get an overview of the practice's structure, which might also benefit new users who need to learn the practice. For example, a linear process would roughly follow a line with a positive slope, while an iterative process would follow a sine wave. A totally flexible practice might yield no curve pattern at all, but cluster content in the horizontal stripes which represent the practice's activities. Furthermore, the two-dimensional display not only facilitates flexibility regarding the conduction of a practice, but also the evolution of its definition, since the inclusion or alteration of an activity corresponds to changes in the respective stage and its associated actions.

One might argue that there is a trade-off between flexibility and efficiency: a process that permits much flexibility might be less efficient because users might be unsure or indecisive. However, many problems, including the case discussions presented in this paper, require some flexibility. Without the possibility to perform a process flexibly, users might have to improvise or apply workarounds, often resorting to other tools.

The definition and instantiation of the timeline's features have been inspired by lit-

erature, as well as by requirements and ideas gathered during participatory practices. Primacy has been given to pragmatic aspects of interaction. For example: instead of using a fisheye view or a perspective wall, we decided to use a zoom metaphor that can be found in map interfaces; different types of conversations are facilitated by the chat widget, that is timeline specific instead of universal, because the participants of the project already use different instant messaging tools. In other words, although being conscious of "what is possible" (e.g. the state of the art of information visualization), the more important question is "what does support practice reasonably well", "reasonably well", because a solution is always a compromise of various factors. This pragmatist stance should not be confounded with utilitarianism: although not explicitly examined in this paper, we consider issues related to, e.g. values or aesthetics equally important. Thus, the timeline prototype proposed in this paper is one possible answer to the question of how to support a case discussion among special education teachers. This answer not only considers the task of the case discussion and how to visualize the course of the discussion, but also how and why special education teachers engage in these discussions (which might be different from other teachers and certainly is different than, e.g. how and why lawyers engage in their case discussions).

The indispensable next step is to do various iterations of participatory evaluation and design practices, e.g. using storyboards with paper prototypes, the Wizard of Oz technique, or simple pseudo-functional static HTML prototypes. These iterations will clarify, whether the timeline, in the way it is proposed, is a viable alternative for real-world problems, e.g. the case discussions of the participating teachers.

5.6 Conclusion

In this paper we presented a low-fidelity timeline prototype that is intended to address two main requirements in collaborative problem solving: enabling users to get an overview of the current state of the problem solving process (what has been achieved, what are next steps, who is participating, etc.); and permitting a flexible conduction of the problem solving practice.

Two main distinguishing characteristics to many other timeline interfaces are that our proposed timeline is used collaboratively, i.e. it is not only used to individually access and understand past data or plan future events, but as a mediator of an ongoing group process.

The design of the low-fidelity prototype was informed by literature and by participatory practices in the context of a research project about lifelong learning practices among special education teachers in Brazil's public school system.

Next steps include participatory evaluation and design practices to iteratively improve

the prototype and create and deploy an initial functional version to TNR in order to investigate how the timeline metaphor affects real collaborative problem solving and whether it contributes to lifelong learning practices of special education teachers. Another major topic for future work is how to provide users with visual impairments with an equivalent presentation of the timeline that is renderable by screen-readers and other assistive technology.

Chapter 6

Pragmatics-driven Evaluation of Web-Mediated Interaction[1]

6.1 Introduction

Evaluation is an important aspect of designing web-based systems that mediate collaborative practices of people. After all, we usually design systems with some goals and want to know whether our design contributes to achieving these goals. Evaluation has many faces: it happens during different stages of a system's lifecycle (e.g. during design, at the end of a design cycle, during use), it can be done in many different ways (e.g. by inspection, by controlled experiments, by ethnographic studies), or it may refer to different evaluation objects (e.g. accessibility, usability, learnability, degree of support for a certain practice).

As to the object of evaluation, one possible question to ask regarding collaborative system is: "How (or: in which ways) does a system facilitate the practices of its users?". Note that we did not pose the question in the form of "How well ...?" or "To what extent ...?". Asking the question the way we did implies that the purpose of this kind of evaluation is not criteria measurement oriented as in "To what extent ..."-questions. It is also not goal measurement oriented, i.e. focused on the goals of an organization. "To facilitate the practices of its users" might include practices that are important for a user but not necessarily directed towards the goals of the organization. Even for a qualitative goal-based evaluation, these practices would be out of scope.

Regarding the questions of when to evaluate and what are the roles of the evaluators, the evaluation method described in this article is part of a "continuing-design-in-use" lifecycle ([66], in [85]). Under this perspective, the evaluators become facilitators of local change processes instead of being external experts who analyze, "detect problems",

[1] **Article submitted to an international journal.**

and propose a redesign [85]. Consequently, this perspective acknowledges that there are multiple stakeholders in evaluation who might play an active or passive role and who might have different interests.

Evaluating how a system facilitates users' practices under this perspective is a complex, multi-faceted problem. Multiple points of view must be considered, and the result of the evaluation is not a set of "objective" key figures but an input for discussion and reflection. At the same time, an evaluation must produce results that are useful for the respective stakeholders, e.g. results that can inform an adaptation of the system. The complexity of this problem as well as the importance of conducting an evaluation that includes multiple stakeholders and is not goal measurement oriented becomes clearer by asking the three questions:

1. "Who are the 'users' of these systems?",

2. "Who are the stakeholders of the evaluation?", and

3. "What does it mean to 'facilitate a practice'?"

In web-based systems, a "user" often might be any person that accesses the web address of the system. Even in cases where access is restricted, such as in special purpose communities, it can be expected that the user population is diverse regarding e.g. age, gender, literacy, technology competence, or social and cultural backgrounds.

Stakeholders of evaluation comprise the designers and developers, the system "owner", the users, the beneficiaries of the practices facilitated or enabled by the system, etc. If the extensive list of evaluation stakeholders strikes some readers as odd, we argue that design and evaluation can be seen as two sides of the same coin [31], and if design considers multiple types of stakeholders so should evaluation.

As to our third question, it is clear that from a user's point of view, "to facilitate a practice" might mean different things to different users. People have different preferences and capabilities, and even if two people collaborate within one practice, they might do so with different intentions and requirements. Regarding other stakeholders, they too might have different requirements on evaluation and interpret evaluation results differently. A designer requires evaluation to produce actionable results that can be fed back into the next design iteration. The system owner might require evaluation to produce results that support her in taking business decisions. Regarding the interpretation of results, different interpretations might exist between as well as within stakeholder groups. A certain amount of non-substantial messages in a discussion board might e.g. be interpreted as a sign of social connectedness or as a sign of "noise". Furthermore the notions of "a practice" and "to facilitate a practice" might change over time.

Looking at stakeholders of systems use and evaluation and at the denotations of "to facilitate a practice", it becomes clear that an evaluation that is solely criteria or goal measurement oriented might miss important points [31]. Regarding criteria measurement oriented evaluation, one might argue that one could simply evaluate a wider variety of criteria or evaluate a criteria more comprehensively. Regarding usability evaluation, for example, why not increase the number of tasks to evaluate and explicitly include different groups of stakeholders and their perspectives on what are relevant tasks? The problem with this approach is at least twofold. First, when we talk about "groups of stakeholders", "user roles", or "personae" we simplify and categorize, and thus still might miss important points regarding people who don't fit these categories. Second, since tasks often change over time and since a technical system often enables new tasks that only emerge at a later point in time, it is very difficult to evaluate those developmental factors using criteria-based methods, since the basis or the "input parameters" are constantly changing.

As to goal measurement oriented evaluation, web-based systems are often used differently than originally intended by their designers. Often, stakeholders and their roles and influence change over time. Thus, the mix of goals to be measured and the goals themselves need to be constantly adjusted. Remembering that the aforementioned "to facilitate the practices of its users" might include important practices that are not directed towards the goals of the organization, a goal-based evaluation might miss these practices and might, for example, not detect a need to re-prioritize an organization's goals.

To be clear at this point, we strongly believe that criteria- and goal-based evaluation methods are important parts of an evaluation portfolio. However, they are not the only ones. In this article, we take a Pragmatics-driven approach to evaluation. This enables us to understand practice execution as processes of meaning negotiation and construction that involve different stakeholders. By trying to answer questions such as "How does a system facilitate the practices of its users?" in a goal-free evaluation, we can inform design by insights that might have been missed by other forms of evaluation. The article is structured as follows: Section 6.2 presents related work. Section 6.3 defines our vision of "Pragmatics-driven evaluation". Section 6.4 presents a case study where we applied this approach to evaluation. Section 6.5 discusses the results of the case study as well as the relation between the proposed approach to evaluation and design. Section 6.6 concludes.

6.2 Evaluation in HCI and related areas

Evaluation is an integral part of HCI research and practice. Scientific literature about the area is abundant, and the purpose of this section is not to give an overview of this area. Rather, we touch on some key issues of evaluation, in order to contextualize the approach described in this paper. Evaluation can be done for many reasons, e.g. in order

to show that a new system, changes to an existing system, or a new method are usable, useful, better, or valid. A first challenge which we will revisit at the end of this section is to define accepted criteria and methods for measuring "usable", "useful", "better", or "valid". Since the purpose of this article is to propose an approach to evaluation, the discussion in Section 6.5 presents evidences that the proposed method is useful by showing it provides meaningful results. This can be seen as an "existence proof" [60], i.e. a first step that requires further justification and evaluation, by e.g. using expert opinion, published results, and argumentation based thereupon, peer review, comparison with previous results, or empirical evaluation methods [47, 43].

Blandford and Green [17] classify evaluation methods along three dimensions: evaluation with or without active involvement of users, with or without a running system, and with or without a realistic context of use. The approach to evaluation presented in this article requires active involvement of the users, and uses a running system in a real (as opposed to "realistic") context of use. The approach to evaluation presented in this article is also related to evaluation in Information Systems (IS) and Computer Supported Collaborative Work (CSCW) research.

Regarding IS, Cronholm and Goldkuhl [34] distinguish six types of information systems evaluation strategies, depending on how (goal-based, goal-free, or criteria-based evaluation) and what (IT-system as such, or IT-system in use) to evaluate. The approach presented in our article falls into the category of goal-free in-use evaluation with one significant difference. Goal-free evaluation has been described as subscribing to an objectivist epistemology [57], achieving objectivity by attempting to not inform evaluators about an organization's goals and interpreting the results without specific goals in mind. We subscribe to a subjectivist epistemology and instead of claiming that it is possible to keep an evaluator completely unaware of an organization's goals and to interpret evaluation results objectively, we affirm that it is possible that the evaluator and the interpreter of the evaluation make assumptions which might have an effect on the evaluation and its results. That way, we believe it is possible to benefit from the open-endedness of a goal-free evaluation given the awareness of the influence of pre-knowledge of the evaluator and the interpreters of evaluation.

As to CSCW, based on a finding of Pinelle and Gutwin [102] that many scientific publications on groupware systems consider evaluation insufficiently, Herskovic et al. [68] present a classification of groupware evaluation strategies. They classify existing methods according to whether the evaluation is qualitative or quantitative, who participates in the evaluation, as well as when, at which place, during which time span and with which goals the evaluation is applied. Although our and their terminology differ, we can classify our proposed approach according to their criteria. Among the twelve methods they reviewed, none matches the combination of characteristics of our proposal. For example, methods

cited in [68] that use in situ observations do not evaluate collaborative aspects of practices and vice versa.

Another important aspect of the approach to evaluation presented in this article is its longitudinal character. As indicated by a recent workshop about longitudinal research in HCI [79] and a PhD thesis about the subject [53], this is still an open topic in HCI. The contributions to the workshop show that currently diverse approaches are explored. In his PhD thesis [53], Gerken proposed a taxonomy of longitudinal research methods based on types of research questions. The "in-depth why and how" type seems to be the only one compatible with the approach presented in this article. Among the 42 studies presented in [53], only five pursue this type of research questions. Of this five, one is a lab-based experiment, and two use only data gathered by interviews or surveys. Of the remaining two [59, 128], both focus on the interaction of people with technology instead of the collaboration of people mediated by technology as described in this article.

In recent years, evaluation has gained importance in scientific publishing in HCI. Many publication vehicles list evaluation as one of their review criteria. For example, at CHI 2006 almost all accepted papers included evaluation of some sort. Regarding empirical studies, an increase of qualitative approaches can be observed [14]. At the same time, there is an ongoing debate in the field regarding appropriate and valid evaluation methods, which according to Kaye and Sengers [80] is not only a methodological, but also an epistemological question. The same authors see a trend towards more open-ended methods that allow for multiple, even conflicting interpretations. Traditional methods, e.g. usability evaluation, have been criticized as being too narrow in focus and not being able to account for all relevant phenomena [31]. On the other hand, novel evaluation methods that often "borrow" from other areas, are often subject to debate regarding their relation to design and the validity within HCI evaluation. For example, Dourish [46] and Crabtree et al. [33] discuss the use of ethnographic methods in HCI. Blevis and Stolterman [18] discuss these kinds of issues related to theoretical and methodological rigor under the perspective of disciplinarity. They advocate for transdisciplinarity in HCI as opposed to multi- or interdisciplinarity, adhering to the values of rigor, openness and tolerance. They furthermore believe that "transdisciplinary rigor", i.e. giving priority to larger societal goals and understanding theories and methods as means to achieve these goals, might be a preferable notion of rigor. Rogers [107] states that HCI is moving "into the wild", i.e. that in order to solve contemporary problems, studies are more and more being created in situ instead of being created an evaluated "in the lab" and deployed afterwards. Methodologically, this means that, e.g. considering ethnographic approaches, rather than informing design by observing existing practices, new technologies are created and evaluated in situ instead. In order to succeed in this move "into the wild", Rogers [107] proposes three steps: importing theories about real-world behavior, reconceptualizing how

theories might be utilized for research and design, and developing new "wild theories". The approach presented in this article uses two "imported" frameworks that are fit to explain real-world behavior. Furthermore, the project team of the case study presented in Section 6.4 consists of researchers from different areas. Thus, we believe that our article might make a contribution to Roger's [107] second step of conceptualizing imported theories.

6.3 Characterizing "Pragmatics-Driven Evaluation"

In this article, we use the term "Pragmatics" in its semiotic sense, i.e. we investigate the relation between signs and people who use these signs. A goal of this investigation is to understand how people negotiate and construct meanings collaboratively, depending on contextual factors such as previous knowledge, intentions, or previous and future interactions. In its broadest sense, a "Pragmatics-Driven Evaluation" (PDE) of a web-based collaborative system thus evaluates how this system supports "meaning making" processes. In the remainder of this section, we first show that there is a need for pragmatics-driven systems evaluation by characterizing pragmatic aspects of web-based collaboration. We then situate PDE methodologically and theoretically, i.e. we examine how PDE is related to other types of evaluation, how PDE methods can be classified, and which theories and frameworks might inform the definition of PDE. We close this section with the investigation of how to conduct PDE.

6.3.1 Pragmatic aspects of web-based collaboration

The purpose of PDE is to evaluate how a system supports the negotiation and construction of meanings during some collaborative practice. When people are engaged in collaborative practices (with or without a computational system), they perform actions which are eventually directed towards some goal or some outcome of the practice. The outcome of the practice might be material or ideal. The actions are usually performed using materials or ideas as media or tools. These materials or ideas might be created during the practice, or existing ones created during previous practices might be adapted or reused. A practice happens within the context of previous practices – i.e. existing relationships between people, past experiences, existing materials and ideas, etc. – and might influence future or co-occurring practices. The execution of a practice is governed by implicit or explicit, and informal or formal rules or norms which define e.g. a structure of actions, roles of participants, or expected outcomes. In order for a practice to succeed, meanings have to be negotiated and constructed: the participants in a practice might have different, even conflicting intentions and in extreme cases they might come from completely different cultural, social, linguistic or other backgrounds. Meanings are usually negotiated and

constructed conversationally, i.e. by exchanging and interpreting written or spoken words or other signs.

Besides communication, mediation and representation are two important aspects of collaboration (e.g. [78]). Tools or shared workspaces are examples of mediators of collaboration. Representations also act as mediators. Examples for representations are prototypes, sketches, or notes. When collaborating "offline", collaboration can be more direct or "immediate". Although language and physical tools can already be considered as mediators, we can communicate face-to-face, experience tools physically or even use our hands or body to directly manipulate the object of collaboration. Collaboration in the web, on the other hand, is always indirect, i.e. it requires external representation. Thus, representations or mediators in general have different qualities than their offline counterparts. This imposes limitations, but, at the same time opens up new possibilities for collaboration. An example of a limitation of web-based collaboration is that, even when using synchronous video communication, we do not have access to all non-verbal clues of face-to-face communication. Examples of new possibilities that emerge in online collaboration are the relative easiness of creating and using working prototypes, manipulation, versioning, or undoing changes. More drastically, however, the web enables collaboration among large numbers of people who might be complete strangers to each other. Examples include the development of open-source software or even the writing of scientific papers [129]. When problems occur during collaboration that are related to communication, mediation or representation, we call these "semiotic barriers" in the context of this article.

Systems that facilitate the collaboration among people from different backgrounds and with different intentions thus have to support the negotiation and co-construction of meanings. Consequently, meaning negotiation and construction have to be taken into account during design and evaluation. We argue that design and evaluation of those systems should not be system-centered (e.g. as in certain flavors of usability engineering where a system's functions are designed taking into account psychological and cognitive characteristics of humans) or user-centered (e.g. user experience, accessibility), but practice-centered. We further argue that Pragmatics provides us with conceptual tools required to do practice-centered design and evaluation. Hornung and Baranauskas [73] described how Pragmatics supports the design of systems that mediate collaboration. Building on this work, in this article we examine how Pragmatics might support the evaluation of such systems, and propose a Pragmatics-driven approach to evaluation.

As a parenthesis, other authors use terms like "activity based" or "activity centered" computing or design (e.g. [13]). These are often rooted in or inspired by Activity Theory [78] or (development-)psychological approaches. Furthermore, recently the term "activity" seems to be used more and more in purely computational contexts (e.g. in the Android

OS). We prefer "practice-centered" to emphasize our focus on Pragmatics and Semiotics and that parts of the practice, or its causes or effects, may lie outside the boundaries of the facilitating computational system.

6.3.2 Situating PDE methodologically and theoretically

Before describing how to conduct PDE, we need to situate PDE in terms of its methodological and theoretical basis. Regarding methodology, we investigate how PDE is related to other evaluation types and how it can be classified according to criteria for evaluation methods used in literature. We then outline the relation of PDE to existing theories and frameworks for designing and evaluating collaborative systems.

PDE's relation to other evaluation types

Regarding PDE's relation to other evaluation types for collaborative web-based systems, we position PDE as an additional evaluation type. PDE does not strive to replace evaluation types that have been proven in theory and practice to answer the questions they were designed for (e.g. accessibility evaluation). Rather, we position PDE as an evaluation type for addressing questions that existing methods cannot answer. There are relations between PDE and other evaluation types, e.g. between PDE and accessibility or usability evaluation. PDE cannot evaluate a system's accessibility, but without accessibility, obviously a system cannot support meaning making processes. Regarding PDE's relation to usability, it is possible that a system's usability evaluation is very positive but "misses the point": if usability evaluation evaluated tasks that are not very relevant to users, no inference can be made whether the usability level affects meaning making processes. Regarding "relevance" or "usefulness", a system can be very relevant or useful (e.g. systems to create and submit an income tax declaration), but nevertheless poorly support meaning making processes due to e.g. being aligned to complex bureaucratic procedures instead to the "simple" tasks users try to achieve, etc.

An evaluation type strongly related to usefulness is actability evaluation [35]. Both actability and PDE acknowledge the socio-technical dimensions of computational systems and are inspired by theories that investigate language use and communication. Regarding the differences between PDE and actability evaluation, actability is a quality of the computational system, and always related to a specific business context and "business tasks" to be performed. Although the consideration of context is crucial in PDE as well, context in PDE is not pre-defined (e.g. by business rules) but established during collaborative practice. Actability evaluation using actability principles is a criteria based evaluation of "IT systems as such" or "IT systems in use", whereas PDE is a "goal-free evaluation" of "IT systems in use". An evaluation type that, like PDE, can be traced back to Semiotics,

is the evaluation of the meta-communication from the designer to the user based on Semiotic Engineering. The Semiotic Inspection Method is one example of a method in this category [41]. The main difference to PDE is that PDE is concerned with communication between users as opposed to communication from the designer to the user.

Classification of PDE

So far, we described PDE as an evaluation type concerned with evaluating how a system facilitates meaning negotiation and construction during collaborative practices. We stated that we position PDE as part of a "continuing-design-in-use" lifecycle. By investigating classifications of evaluation methods and discussing which characteristics are adequate for PDE, as well as by defining from which sources to gather data for evaluation, we take another step toward outlining how to actually conduct PDE.

Regarding Cronholm and Golkuhl's [34] six generic types of IS evaluation, PDE is a type of goal-free evaluation of "IT-systems in use". In order to avoid missing important, but unanticipated outcomes, as well as the danger to narrowly evaluate criteria that "miss the point", PDE does not define explicit goals or evaluation criteria. Instead, PDE is a type of interpretive evaluation that involves different stakeholders. This is also in line with critique on current evaluation within the HCI community [31].

Regarding classification criteria for collaborative software evaluation [102], PDE is placed in a naturalistic, non-experimental setting. Due to the goal-free, evaluation-in-use strategy, PDE is a type of formative as opposed to summative evaluation that is conducted periodically or continuously during use. As a parenthesis, Pinelle and Gutwin [102] distinguished between "evaluation during development" and "evaluation after implementation", but did not describe the "continuing-design-in-use" scenario. Possible foci of evaluation are the impact on work practice, the end-product produced through using the software, patterns of system use, and the user interaction while using the software.

Theoretical underpinning of PDE

In Hornung and Baranauskas [73] we illustrated how to choose theories and frameworks as frames of reference for a design project. The research project of that paper corresponds to the project of the case study presented in the next section, and we thus adopt the frameworks proposed in that paper, i.e. Organizational Semiotics [83] and Activity Theory [78]. Organizational Semiotics understands an organization as an information system where people exchange signs. A computational system is a small part of this information system, and by understanding and applying semiotic principles, computational systems can be designed that better fit user requirements. Activity Theory as applied in HCI is a framework based on developmental psychology that investigates the use of information

technology in the context of human practice. Additionally to these frameworks, we include the Pragmatic Web [111], which investigates how web-based technologies support meaning construction and negotiation processes. The Pragmatic Web is rooted in Organizational Semiotics and the Language/Action Perspective [58, 131] that, in contrast to Organizational Semiotics, focuses on linguistic instead of sign-mediated communication. For a more extensive overview of the relation between the Pragmatic Web and HCI we refer to [71]. The three frameworks are compatible with the neo-humanist paradigm of Hirschheim and Klein [69], i.e. the view that knowledge about the world is socially constructed and subject to change and conflict.

Using these frameworks as theoretical underpinning of PDE permits us to account for the following aspects that are relevant to our proposal of PDE:

- the existence of different stakeholders with different requirements and preferences who pursue different objectives/goals,
- a complex system of activities and objectives/goals with possible tensions among them,
- developmental aspects of practices, and
- the relation between a collaborative practice and its support by a computational system.

Regarding the computational system's support for practice, the chosen theoretical frame of reference particularly permits us to investigate semiotic barriers to collaboration, i.e. aspects related to communication, mediation and representation.

6.3.3 Conducting PDE

We stated that the purpose of PDE is to answer questions such as "How does a system facilitate the practices of its users?" and that "translating" this question to the perspective of pragmatics, the purpose is to evaluate how a system supports the negotiation and construction of meanings during collaborative practices. We have also already mentioned that design and evaluation can be seen as two sides of the same coin and that evaluation is a part of a continuing-design-in-use lifecycle. Furthermore, evaluation results should be of a form that permits to inform design. Since we positioned PDE as goal-free in-use evaluation, there is no fixed evaluation process that is independent from the evaluation object. Depending on the current stage of a system's lifecycle, PDE might be conducted differently in each stage. We can roughly distinguish between early design stages, when there is no system available yet, and the design-in-use part of a system's lifecycle.

During the very early stages of design, it is difficult to separate design and evaluation: when clarifying design problems, eliciting requirements and defining design goals, ideas are constantly discussed among the stakeholders. Regarding pragmatic aspects of systems use, it is crucial to critically evaluate requirements and design goals considering possible practices of possible users during the very early stages of design. Organizational Semiotics with its methods for problem and semantic analysis, and Participatory Design with its methods for stakeholder participation are two examples of frameworks that might facilitate these activities.

When conducting PDE during the "design-in-use" part of a system's lifecycle, one question that arises is whether PDE should be conducted differently during different stages of the lifecylce, e.g. whether PDE requires a different approach in the growth stage of an online community than in the saturation stage. Our position is that the practices of a system's users can constantly change during all stages of the lifecycle. It might be that change is more rapid or evident during the early stages of the lifecycle, but even in later stages of the lifecycle, changes might occur. Hence, although the input to PDE changes, and although some techniques might not be applicable in some stages of the lifecycle, the method does not change conceptually along the lifecycle.

Possible methods and techniques for conducting a PDE depend on the evaluation as well as on the theoretical and methodological frame of reference. In the previous subsection we proposed Organizational Semiotics, Activity Theory and the Pragmatic Web as frames of reference. However, other theoretical approaches are conceivable as frames of reference of a PDE. The minimum requirement for methods and techniques is that they are compatible with the neo-humanist paradigm and allow to conceptualize communication, mediation, representation, and people's practices. Furthermore, the conduction of PDE has the following minimal characteristics: deep engagement of the designer-evaluator with the system to be evaluated, involvement of relevant stakeholders in the evaluation process, observation of a real practice in situ, and a group activity for collaborative sense-making.

As to the input or possible "data sources" of goal-free in-use evaluation, Cronholm and Goldkuhl [34] list the computational system, documentation of the system, information provided by the system owner, observation of user interaction, users' perceptions of the system, as well as information about the users' IT competences as well as their "pre-knowledge". We assume that with "pre-knowledge", Cronholm and Goldkuhl mean knowledge about the organizational context, about how to use the system, and about how to "execute the tasks" the system supports. We adopt this list for PDE, clarifying that "user interaction" for PDE means "interactions between users, mediated by the system" and includes traces the users left in the system, e.g. content they posted. Although this might be included in Cronholm's and Goldkuhl's "pre-knowledge", it is worth noting that a description of the other stakeholders of the system, besides the users and the owner, as

well as a description of the actual practices, parts of which are facilitated by the system, might be relevant data sources.

In summary, PDE can be conducted as follows:

- Prerequisite: profound understanding of the practices under evaluation, e.g. by deep engagement or stakeholder participation.
- Stage 1 (practice conduction in situ):
  - Preparation: define which stakeholders to involve, which data to collect, how to collect and analyze data,
  - Execution: observe the practice in situ,
  - Analysis: articulate understanding of the results and list points that need further clarification.
- Stage 2 (group activity; ex situ, but contextualized):
  - Preparation: define which stakeholders to involve and which data to collect; define activities according to the results obtained during the analysis of stage 1,
  - Execution: conduct and observe group activities,
  - analysis: verify/adjust understanding gained during stage 1 and complement with new insights.
- Synthesis:
  - consolidate data collected during the two stages,
  - identify and discuss semiotic barriers,
  - make suggestions for (re-)design informed by semiotic barriers.

The instantiation of this method, i.e. the choice of observation and data collection methods, as well as the nature of the group activities is highly dependent on the research or design problem and on the stakeholders involved in the evaluation. In the next section, we illustrate how the method was instantiated in a concrete research and design project.

6.4 Case study: collaborative problem solving among special education teachers

In this section, we describe a case study of an evaluation-in-use adopting the PDE approach. The case study spans the period of June to September 2013 and was situated

within the research project "Redes Sociais e Autonomia Profissional – Novos Rumos para Formação Continuada à Distância de Professores de AEE"[2] (Portuguese for "Social Networks and Professional Autonomy – New Directions for Lifelong Distance Learning of AEE[3] Teachers). The research project's goals include to enable AEE teachers to socialize, exchange experiences and discuss matters of professional practices. To this end, a web-based technical system called "TNR" has been built[4] that provides some functionalities of social network systems (e.g. user profile, posting content and commenting), but also functionalities specifically aimed at supporting professional work practices of AEE teachers. One of the practices TNR aims to support is the "discussion of an AEE case". An AEE case describes:

- problems or challenges regarding the inclusion or participation of a student with special needs in daily school-related situations (the "case proposition"),
- how these problems can be overcome (the "AEE plan" or "attendance plan"), and
- feedback regarding the implementation of the "AEE plan".

In order to facilitate AEE case discussions, a tool called "Nossos Casos" (Portuguese for "Our Cases") has been made available in the TNR system [72]. In this section we describe the evaluation of the support of the case discussion by this tool, i.e. for illustration purposes and the sake of brevity we focus on a single practice, without going into details about other practices supported by the system. The evaluation took place at the time of making the "Our Cases" tool available for a small group of "key users" called "multipliers", and before making it available to all users of TNR. Before describing how the evaluation was conducted and what results were obtained, we first provide some historical background of the project and the system, and then describe how an "AEE case" can be discussed with the "Our Cases" tool. Both, historical background and the description of the tool are important to provide relevant context regarding the TNR system, its users and their practices. This context is a crucial input for the actual evaluation.

6.4.1 Previous history

All practices supported by the TNR system are aimed towards the overarching goal of supporting the inclusion of children with special needs in regular schools. Before the existence of TNR and "Our Cases" and regarding professionals who do not use TNR or "Our

[2] **http://www.nied.unicamp.br/tnr**

[3] The acronym "AEE" (Atendimento Educacional Especializado) can be roughly translated with "Specialized Educational Attendance". AEE is a special education service aimed towards the complete inclusion of students, considering their specific needs.

[4] "TNR" (**http://tnr.nied.unicamp.br**) is an acronym for "Todos Nós em Rede" which can be translated with "All of Us Networked".

Cases", activities aimed towards inclusion were and are conducted ranging from ad-hoc to more formal, and from individual to collaborative practices. Some of the education professionals work as AEE teachers ("inclusion teachers") in schools where they might be the only teacher with a formal education regarding inclusion and special education, others work in "attention centers" together with other professionals (e.g. psychologists or other AEE teachers), attending multiple schools. The formality of practices comprises individual formalisms (e.g. spreadsheets; one teacher reported to use a concept mapping technique), formalisms constructed during meetings, workshops or seminars, and a formal training in AEE case discussions offered by public universities. Collaborative practices, if occurring, were conducted via face-to-face meetings (e.g. among professionals working in the centers and teachers in school), or using communication tools such as telephone, email, or instant messaging. Regarding the formal training course, an AEE case discussion was taught as a sequence of multiple steps that led from a case proposal to an AEE plan. During each step, group discussions occurred in an online learning environment. Discussion results (e.g. the AEE plan) were posted to the respective forum. Tutors guided the discussions as well as the transitions between steps, and reviewed the posted documents.

Given this context of diverse work practices on the one hand and the formal training that reaches some but not all AEE professionals, a principal objective of the "Our Cases" tool in TNR is to provide a platform where AEE professionals can discuss their cases in order to support their work practices geared towards inclusion. "Our Cases" builds upon the common ground provided by the formal training while trying not to be limited by it.

The education professionals who participated in the evaluation described in this section are part of a group of 28 so-called "semeadoras" (Portuguese for "sowers" or "seeding group" in the sense of "multipliers"), and participate in the overarching research project since August 20101, from their local contexts in different regions of the country. This group was chosen among interested AEE professionals who completed the formal AEE case discussion training mentioned in the previous paragraph. The strategy of working with a group of multipliers was adopted because the project team considered it crucial that the future system's norms, policies and practices be established and promoted by its users instead of an "outside authority". Between October 2010 and June 2011, four consecutive AEE case discussions were conducted in four different available online systems, each of which offered a different conversation style (question-answer, forum, blog-like with comment section, and a system that used Organizational Semiotics tools for problem clarification in a problem-based learning environment). The objective was to learn whether and how those systems supported a case discussion, and how the participating education professionals discussed AEE cases without tutors and without a fixed structure.

In August 2011, six of the multipliers were invited for a one-day face-to-face workshop in our institution, during which we discussed the experiences of the case discussion

and performed participatory design practices to inform development and design of TNR. The method of performing case discussions in already existing systems, and analyzing and discussing experiences during a workshop was preferred to a more traditional requirements eliciting process for the following reasons. Discussing AEE cases online in a large scale and with different people than only direct peers was a completely new form of conducting this professional practice (and even a completely new practice for some education professionals). Thus, apart from some already known general requirements such as user management or posting and commenting content, many requirements were "moving targets": in an emerging practice, new requirements arise, the implementation of which changes the tool that mediates the practice. Changes in the tool in turn might result in changes in practice execution and thus in new requirements. Furthermore, users often have difficulties expressing their requirements directly. The four case discussions in four different conversational styles in already existing online systems [72] thus enabled us to elicit requirements indirectly while already observing some important aspects of practice conduction.

In October 2011, the initial version of the TNR system was launched. Initially, the system was only open to the multipliers as well as to the members of the research team and some invited "experts", people who do not act as education professionals in AEE, but who have expert knowledge regarding inclusive education, special needs, etc. 17 of the 28 multipliers accepted our invitation and registered during the first days of TNR. Multipliers and research team members are allowed to invite other AEE professionals, and in September 2013, the system had more than 400 registered members. Also as of September 2013, 21 of the initial 28 multipliers are members of the system, 18 of which are "active users", i.e. log in at least once per month. Until June 2013, TNR had no explicit tool for discussing AEE cases, however users posted questions related to AEE cases and made attempts to improvise AEE discussions in the comments sections of posts.

6.4.2 Case discussions with the "Our Cases" tool

In order to support AEE case discussions, the "Our Cases" tool was developed based on the activities and experiences described in the previous subsection. The conceptual basis of "Our Cases" is the metaphor of the "AEE case discussion" as taught in the formal training course. In comparison to the formal way of discussion described in the previous subsection, two substantial changes were made. First, the number of "steps" or "stages" was reduced from five to three, namely case proposition/description, elaboration of the AEE plan, and feedback of plan execution/implementation. Second, flexibility was introduced. Instead of a rigid sequential order, the three "stages" in "Our Cases" can be developed in parallel. The case description and the AEE plan are not the results of

a stage, but starting points of discussions that lead to iterative refinement. These two changes and other design decisions were informed by previous activities that indicated the need to make compromises between rigidity and flexibility, and between formality and informality. Among the overall design goals of TNR is to facilitate professional autonomy and lifelong learning. In order to support those two goals, "Our Cases" intends to promote the ability of creative problem solving while minimizing the unreflected application of ready-made "recipes". Hence, "Our Cases" tries to support flexible practice conduction, for example by permitting users to elaborate "stages" iteratively and in parallel, or by choosing free-form text fields over fixed-value fields in certain instances. On the other hand, too much flexibility sometimes might impede practice execution. Thus, "Our Cases" provides some structure, for example by making the three different stages explicit, or by separating content from discussion. The question of formality is related to the question of flexibility. Both, too much formality and informality might have a negative effect on practice execution. "Our Cases" tries to find a compromise between the two. For example, "Our Cases" does not distinguish between roles (e.g. "teacher", "expert"), but makes the "case owner" and the "discussion participants" visually explicit. Content creation and discussions are not moderated or restricted, but the case description and the AEE plan are formalized by respective input forms. Figure 6.1 shows the landing page of "Our Cases". Below a short demo video, a table of the currently discussed cases ordered by last modification date is shown. A click on a case title in the first column leads to the overview page of the respective case (Figure 6.2). A click on the three circled tabs in Figure 6.2 leads to the respective "stage" of the discussion, where logged in users can comment, and the case owner can edit the respective form.

6.4.3 The two-staged evaluation of "Our Cases"

A first evaluation of "Our Cases" was performed between the end of June 2013 and mid September 2013. The evaluation was conducted in two stages. In the first stage, participants used "Our Cases" from their usual environments, each one in her respective location. In the second stage, we conducted an activity during a face-to-face one-day workshop at our institution with some of the participants. Figure 6.3 provides an overview of the temporal sequence of the evaluation.

For the first stage, we invited 16 users (3 experts, who were part of the research team, and 13 multipliers) to use a first version of the "Our Cases" tool in order to discuss their own AEE cases. The users were chosen based on their comment and login frequency, i.e. we invited users that visit TNR and comment there frequently. Six of the 13 multipliers were users that had participated in the workshop described in the previous subsection and that continue to be the most active users in the system. An invitation was sent out

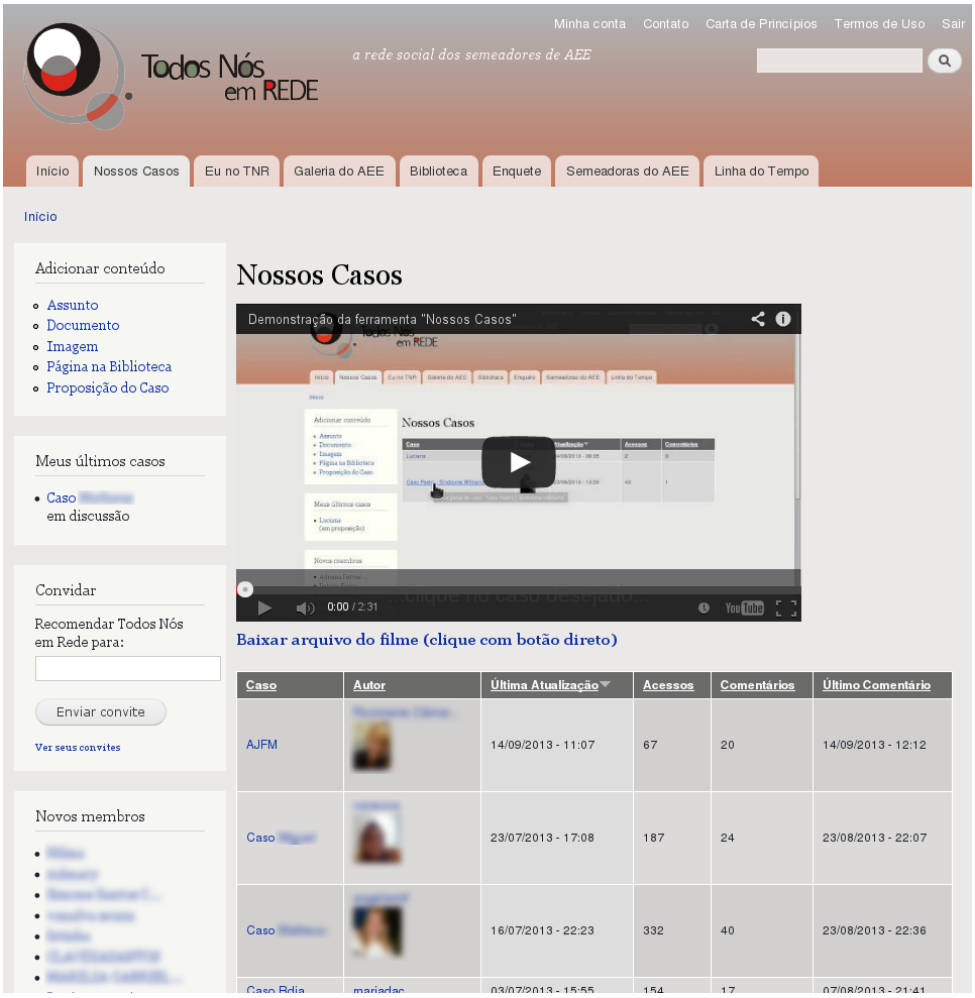

Figure 6.1: "Our Cases" landing page (texts in Portuguese).

per e-mail to all participants, explaining that in order to provide a tool to enable AEE case discussions in TNR, the project team needed their help. The participants were asked, should they accept the invitation, to explore the "Our Cases" tool in the system, and post AEE cases if they had any they wanted to discuss. Suggestions, problems or comments about the tool should be reported back via the system's contact form. The invitation was deliberately formulated in an open way, i.e. did not contain task descriptions, a time frame or require participants to post a certain number of cases, since the focus of the evaluation was on the tool's support for the process of a case discussion and not on, e.g., certain qualities of its user interface. After six weeks, follow-up interviews were conducted remotely with participants who agreed to an interview and were able to schedule a date with the interviewer of our team.

For the second stage, 7 of the 13 multipliers were invited to participate in an activity

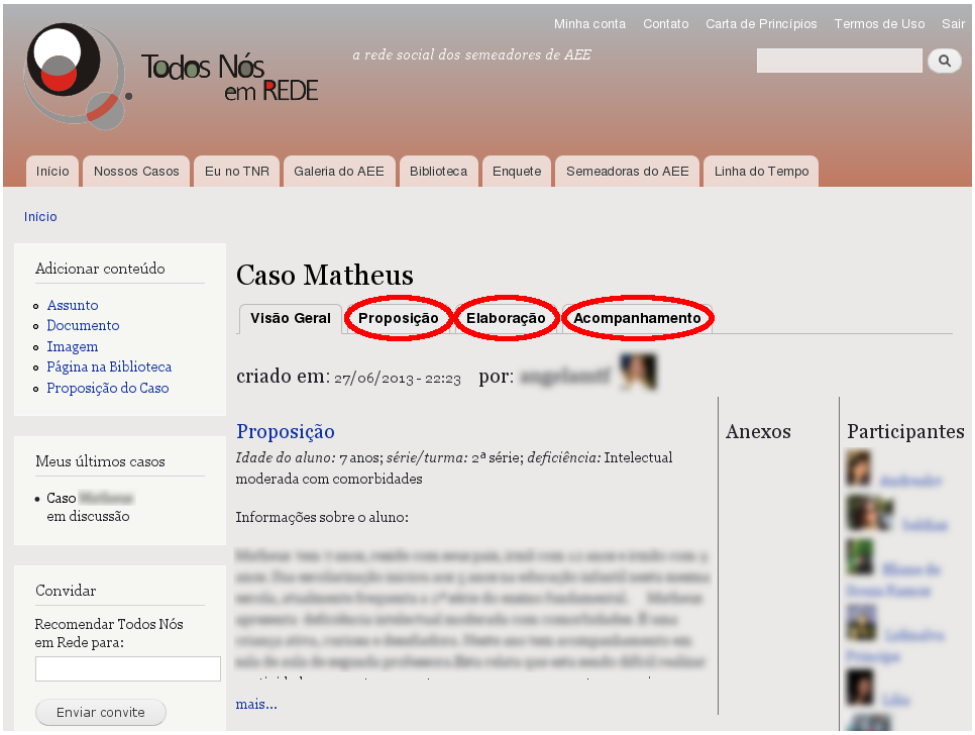

Figure 6.2: Overview of a case (texts in Portuguese).

during a one-day workshop at our institution. The activity consisted of a "controlled AEE case discussion" using "Our Cases" and a subsequent group discussion. For the controlled case discussion, we asked the participants to send a short "AEE case proposition" of approximately 300 words to the first author of this article prior to the workshop. At the workshop, we explained the activity to the participants (cf. Figure 6.4). One multiplier would be the case owner and post her case to TNR using "Our Cases" (station 1). The remaining multipliers would take turns commenting on the case using a single desktop computer on a first-come-first-served basis (station 2). The ones not commenting would observe the discussion via an LCD projector operated by a facilitator, who navigated on the discussion page on demand. In parallel, three experts would follow the discussion and

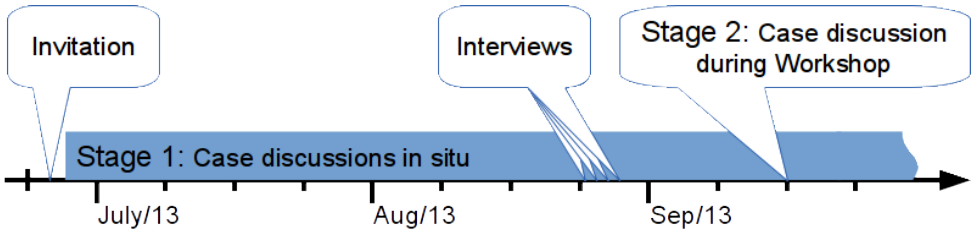

Figure 6.3: Temporal sequence of the evaluation.

leave comments at station 3. It was explained that at each station, a facilitator would take notes, prompt participants to think aloud, and that speech would be recorded. The participants in the waiting area were asked to remain silent and take notes individually on clipboards, e.g. to prepare their comments. Besides common prompts of a HCI think-aloud protocol (e.g. "please keep talking"), the facilitators were instructed to ask certain questions when a new comment was posted (e.g. to the poster: "why did you post this comment?"; to an expert: "would you post an answer? why or why not?"; to the case owner: "does this comment contribute to the discussion? how?"). Five of the seven multipliers had previously sent a case proposition, three of which were much more extensive than requested. We explained that we would like to discuss a case that had a short and potentially still incomplete description. One of the two multipliers who had supplied a short case description agreed to discuss her case. After one hour of discussing the case in "Our Cases", the participants were called to a group discussion. During this discussion, the participants' experiences using "Our Cases" during the previous weeks and at the workshop were explored.

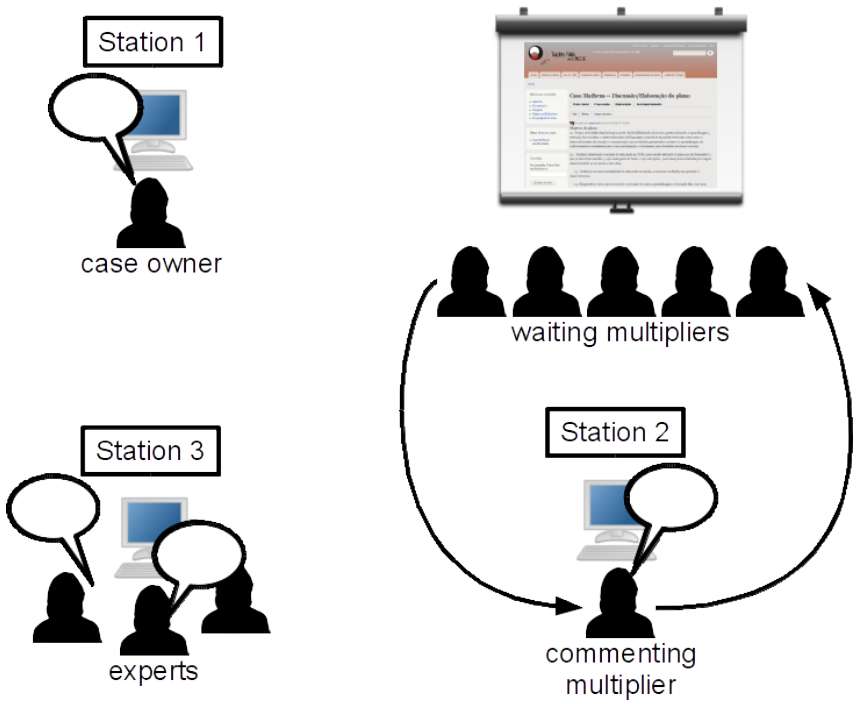

Figure 6.4: Controlled AEE case discussion.

In the following subsections we present a synthesis of the results obtained during the case study. We begin with the results of the case discussions in situ and the interviews, and end with the workshop. The in situ case discussions are still ongoing. However, we only present results up to the date of the workshop.

6.4.4 Results of the in situ case discussions

Although only two multipliers explicitly answered our request to confirm participation, 12 of 13 multipliers and all three invited experts accessed the "Our Cases" tool at least once. Three cases were posted by three different multipliers, and 81 comments were made by seven multipliers and four experts[5]. One of the cases had about 40 comments while the others had more or less 20 comments each. 36 of the 81 comments were responses to other comments, the maximum length of response chains was 5. The purpose of presenting these statistically not significant quantitative figures at this point is to support a subsequent qualitative analysis. Of special interest is the structure of the discussion, i.e. who commented, who replied to whom, what was the temporal distribution of comments, etc. Figure 6.5 shows the distribution of comments by roles and case, distinguishing the roles (case) owner, multiplier, and expert. We should mention that "role" is a term used in this analysis only to facilitate the discussion of some observed behaviors. In TNR all users except system administrators have the same authorization profile. Figure 6.5 shows that the overall number of comments made by experts was relatively high, while the number of comments made by the owners of cases 2 and 3 was relatively low.

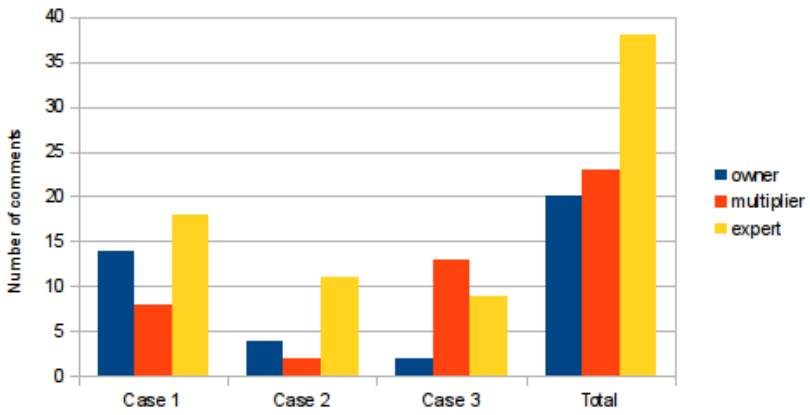

Figure 6.5: Comments by role and case.

Figure 6.6 shows the different comment flows in the case discussion regarding the different roles of participants. We considered only comments that are responses to comments, i.e. we excluded direct comments to the case documents. This analysis was solely based on the comment tree, i.e. it is possible that, e.g. due to a usability problem, a user clicked on the "reply" link of one comment while in fact replying to a different comment. However, a manual analysis of case 1 showed that comments to comments were always

[5]One expert from the research team participated without being explicitly invited.

addressed to the correct participant, although they sometimes contained a "reply to all" phrase (e.g. "hello Mary and colleagues"). Direct comments to the case documents on the other hand included amendments to the case documents made by the owner, notifications/comments directed to all participants, and some cases of comments to a specific user, in which the commenter erroneously clicked the wrong comment link. Figure 6.6a shows that aggregating all three cases, roughly a fifth of responses to comments were made by the respective case owner. A comparison between Figures 6.6b, c, and d shows that the three case discussions seemed to be quite distinct. For example, in case three, the case owner seemed not to respond to any comments from the multipliers and experts. However, a manual content analysis showed that the case owner of case 3 responded to two comments of multipliers using the comment form of the case description instead of the reply links of the respective comments.

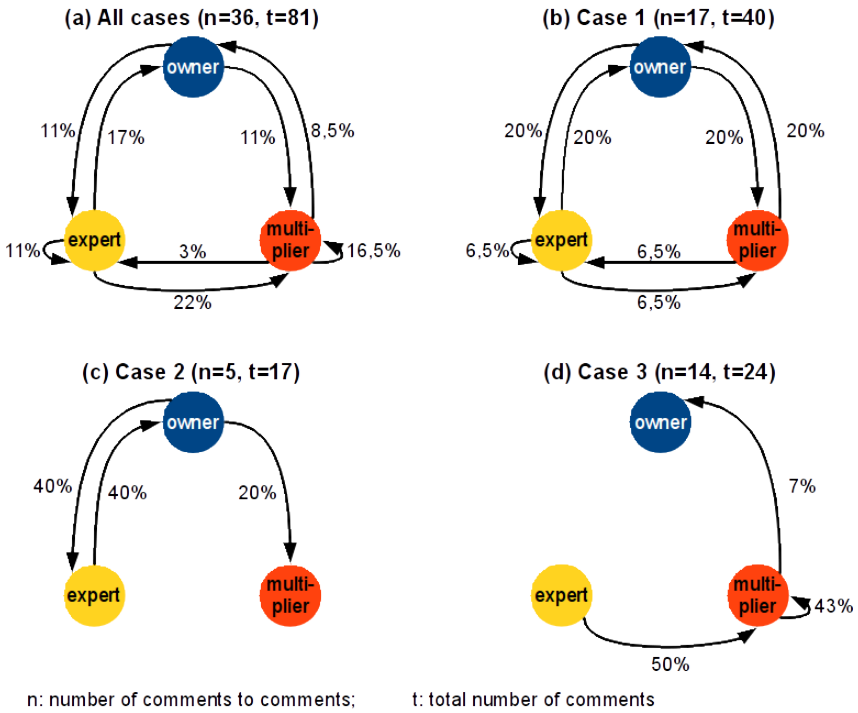

Figure 6.6: Flow between responses to comments by role.

Figure 6.7 shows another difference between the three case discussions, regarding the temporal flow of comments by different roles. While the owner of case 1 accompanied the discussion during the first month, the owner of case 2 participated much less. The owner of case 3 responded to comments and updated the case discussion after two weeks. After that, the discussion seemingly continued without her.

To complete the quantitative picture, Figure 6.8 shows the accesses of participants to

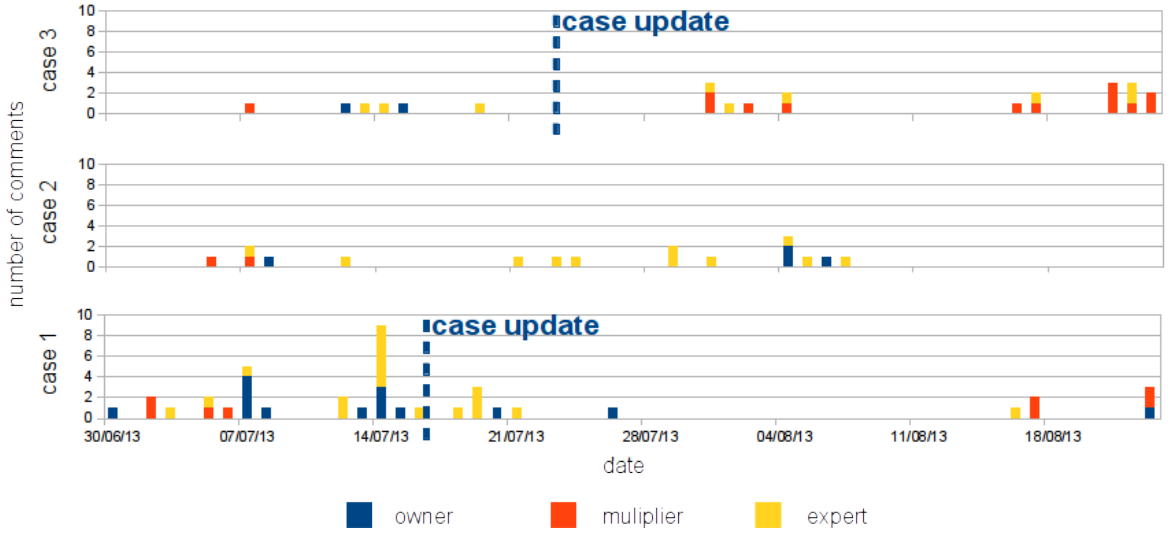

Figure 6.7: Temporal flow of all comments.

case 1. Each black rectangle corresponds to an access that would last from less than a minute to more than 30 minutes. The access graphs of the other cases are quite similar, although the respective smaller numbers of comments in cases 2 and 3 are also reflected in smaller access numbers. Apart from the researchers/designers, approximately half of the participants who accessed a case discussion also posted at least one comment.

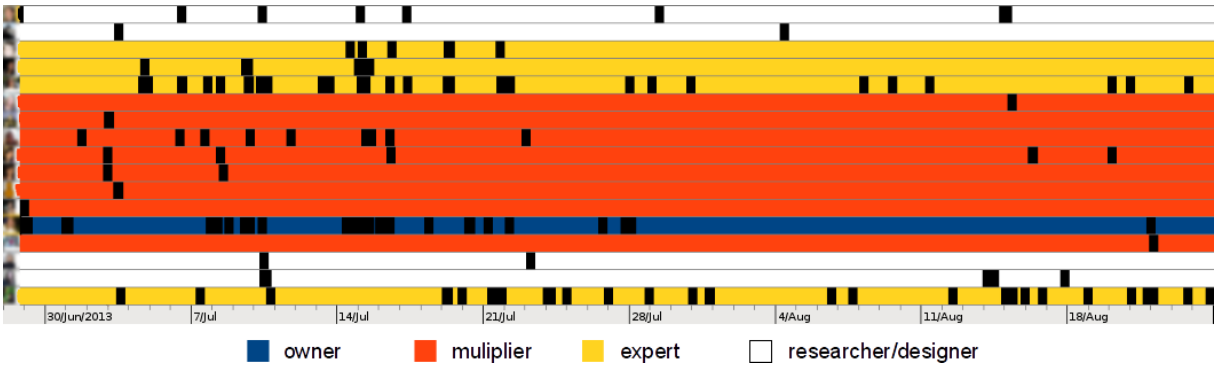

Figure 6.8: Accesses of participants to case 1.

Other quantitative data, such as comment length by role, time between comments, accesses by week day or time of day did not yield significant or peculiar results. In the remainder of the subsection, we present the qualitative results of this activity.

Regarding reading instructions and "online help", only two out of 13 invited multipliers answered our request to confirm participation. Instead of following our request to use the system's contact form for support, suggestions or critique, the participants tried to

use other channels, such as personal email messages and the comment section of a case discussion. The page with tips how to fill in the case forms was only accessed by one multiplier and one expert.

Regarding creating and updating the case forms, all three case owners started with the case proposition. The owners of cases 1 and 3 posted an AEE plan some weeks later, owner of case 1 only after being prompted by an expert and after first posting the plan as a file appendix of one of her comments. None of the three case owners started documenting the plan implementation. The owner of case 1 updated the case description when posting the first version of the AEE plan. Although she had stated to include suggestions and comments of the discussion, she only added a single phrase with information of minor importance. However, after the period of evaluation reported on in this article, she revised the case proposition substantially, including many suggestions and comments made during the discussion. The owner of case 2 did not update the case proposition. The owner of case 3 updated the formatting but not the content of the proposition when posting the AEE plan.

Regarding behavioral/social aspects of the three case discussions, two of the three case owners participated actively in the others' case discussions. Figure 5 showed that overall, the experts made approximately half of the comments of the discussion. In cases 1 and 2, most of these comments were intended to guide or control the conversation. In case 1 the experts tried to instigate the case owner to post an AEE plan. In case 2, the involvement of the case owner was very low and the experts asked her repeatedly to answer the open questions and even pondered the idea of terminating the discussion. This led to a justification and apology by the case owner when she later re-entered the discussion. Case 3 saw a more passive behavior of the experts. However, case 3 was already well elaborated when posted, and although an AEE plan was not posted initially, it was clear that the student in question had already received good attendance (one of the first commenters remarked, "I see that the process of inclusion is already happening"). The tone of the conversations was polite and amiable. Almost all comments were substantial (i.e. related to the case or related to professional practices) or to control the conversations; only six comments were solely about expressing sentiments, e.g. thanking or apologizing. Regarding comment content, experts often posed conceptual questions or provided background material, while the multipliers asked more questions that were directly related to the case. The experts were researchers from the Education field in our research team who also met each other face-to-face. This was reflected in posts that started like "we discussed this and think...". Furthermore, one of the experts is considered an authority in the area of inclusive education. This manifested itself in replies to comments of this expert, e.g. "I feel privileged to ...", and possibly had an impact on the conduction of the practice. Regarding the depth of the comment tree, the two "deepest" threads with

a depth of four and five were related to meaning construction and negotiation, e.g. the discussion of how an AEE teacher should attend a child with intellectual disability, or whether alphabetization should be worked on.

After approximately six weeks of case discussions, one member of the research team who also participated as an expert in the discussions conducted five unstructured interviews via instant messaging services. The interviewed multipliers reported that they found "Our Cases" clear and easy to use. One multiplier stated that she liked the way "Our Cases" facilitates case discussions because "in AEE it's like that ... dynamical, you need to restructure all the time". One multiplier who had not posted a case stated that she only would post a case when its description was already well elaborated and "tidied up". A multiplier who posted a case wished for an explicit role such as a moderator that would guide the discussions. Upon further inquiry, she suggested that the case owner should actually take on this role. During the interviews, some feature requests (e.g. chat, notifications) were repeated that were already made during the discussions.

6.4.5 Results of the activity during the workshop

Figure 6.9 shows the comment flow during the activity at the workshop. To give an example of how to read the figure, during the first minute of the activity, the case owner (user 6) and the experts (user 3) logged into the system. During the second minute, the owner started creating the case proposition and posted it during the fourth minute. During the fifth minute, a multiplier (user 2) started creating comment c1 as a response to the case proposition.

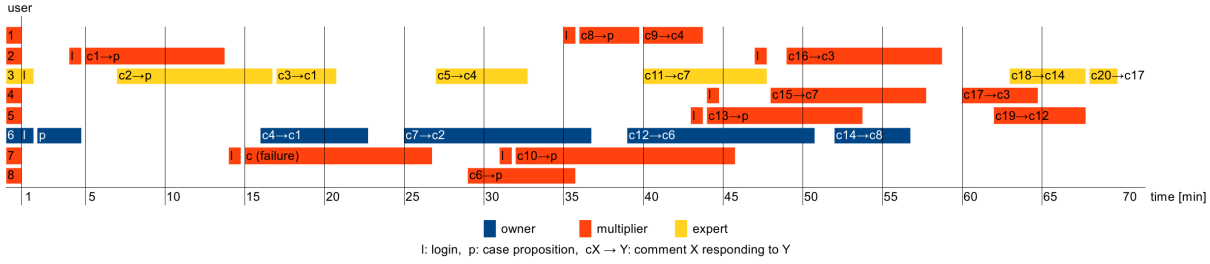

Figure 6.9: Comment flow during the activity.

The "failure" at the 15th minute refers to a usability problem that occurred when trying to post the comment. On clicking the submit button, user 7 accidentally performed a mouse gesture that navigated to the previous page in the history. Since at that time an autosave feature was not implemented yet, the comment was lost and reconstructed as comment c10. After approximately 30 minutes, the multipliers expressed the desire to use more than only one computer to comment. Thus we made two more computers

available and one observer took on the role of an additional facilitator. To give an idea of the physical setting, Figure 6.10 shows a snapshot of the case discussion scenario. The experts' table was outside the photo, but visible to all.

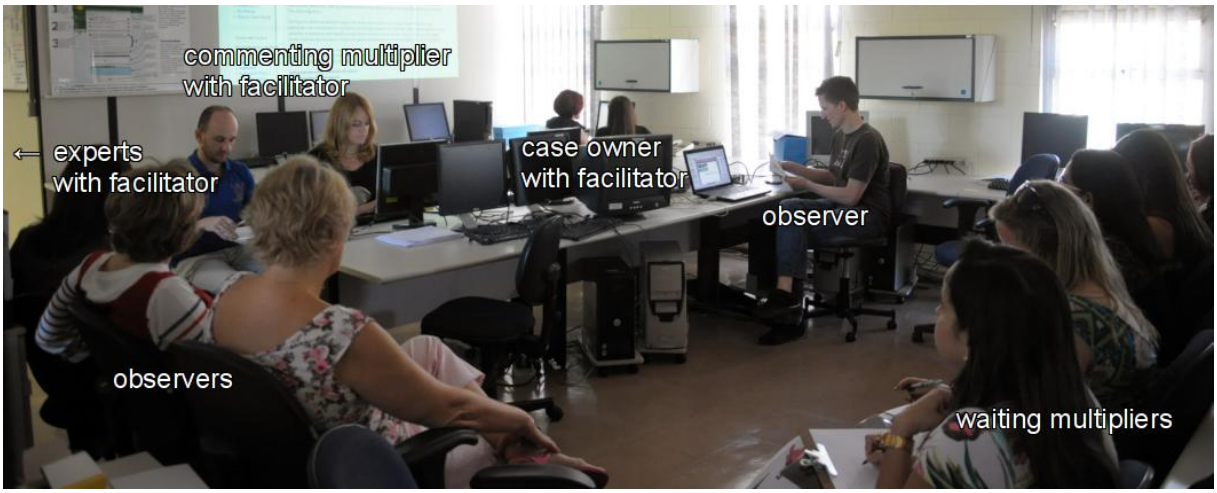

Figure 6.10: A snapshot of the case discussion.

Of the 20 comments, the owner made four, the experts six (together on one computer) and the multipliers ten. 19 comments were directly related to the case, only one comment was made to express sentiments, and no messages to control or guide the discussion were sent. Due to the parallelism introduced in the second half of the activity, some comments contained duplicate questions that were however cross-referenced by the case owner.

The case owner stated that by posting the case she would like to confirm or refute the hypothesis that the child in question was autistic. However, she only put "hypothesis autism" in the field "diagnosis" without stating her objective in the case description. She furthermore stated that her objective was not to define an attendance plan, but to clarify some questions important to the child's school. Since she worked in an attention center and not directly in a school, she felt the need to explain how she works, which she did in the comments. She affirmed that the others' comments helped her to reflect about the case. After receiving some comments she affirmed that she would have to check back with the school and then update the case description, if she was at home and had more time.

A recurring theme of the experts' think-aloud protocol was that they "restrained themselves" in order to give the multipliers a chance to comment and in order to not intimidate the other participants. They affirmed to write shorter comments, wait for answers before writing a new comment or hold comments back altogether. Although the case owner did not explicitly state that her objective was not to create an AEE plan and although the facilitator did not prompt the experts towards this question, they expressed the correct assumption that the case owner did not work towards creating an AEE plan.

However, they did not post a comment regarding this subject.

Regarding the multipliers, several affirmed that, also with regard to the other previous case discussions, the comments of participants from different backgrounds might help the case owner to see the child and the case from a different perspective. One multiplier commented that she generally reads all comments but tries to only contribute with topics that have not already been explored. All multipliers, experts and the case owner were consistent with what they "thought aloud" before posting a comment and with what they then wrote in their comments.

During the subsequent discussion we asked all participants to briefly comment on the previous activity. Although we had a list of topics that was based upon results from the in situ case discussions (e.g. regarding updating the case description or posting the AEE plan), we then let the discussion flow relatively free, directing it only from time to time towards topics from our list that had not yet emerged during the discussion or had not already been answered during the previous practice. A topic that already emerged during the activity was the different working environments of the education professionals (e.g. some come from special attendance centers, some work in schools, etc.) and consequently different forms of professional practices. There was a consensus that the different backgrounds that come together in a case discussion help to elaborate and understand a case by providing different perspectives and points of views. It was seen as positive that the written case discussion forces the professional to formalize a case and an AEE plan which helps to focus on improving the attendance of a student in order to promote inclusion (or, as one participant put it, it helps "to escape the blah blah blah"). The "focus on the student" was a recurring topic, not only in the context of the case discussion in TNR. Regarding the focus on a student, it was noted by the multipliers that there are questions that do not depend on the professionals working environment or concrete working practices (e.g. the student's communication and learning processes, or interventions by the AEE professor), and that these questions appeared in all cases discussed in TNR so far.

Regarding the question of updating the case forms and posting an AEE plan, there was a consensus that the forms should be updated as new suggestions and critiques would be made in the comments. The plan was seen as a document that is not final and always subject to changes, influenced by the exchange of ideas during the discussion in "Our Cases". As to the question of when to post an AEE plan, there seemed to be a consensus that it could be posted at the very beginning of a case, together with the case proposition, and then evolve with the discussion. However, there was evidence that, in concordance with the formal training mentioned at the beginning of this section, some participants saw the process as sequential (e.g. the AEE plan as a "consequence" of the discussion, or the "next step" after the proposition has been sufficiently discussed). Regarding the

question of whether an AEE plan and a report/feedback about its implementation should be posted at all, the participants agreed that they considered this indispensable. One participant even stated that she would explicitly demand this from a case owner and probably not participate in future discussions of a case owner who failed to post an AEE plan and the implementation feedback.

Regarding the question whether there exist factors that would inhibit someone from posting a AEE plan and expressing themselves freely, it was mentioned that by posting an AEE plan, a person exposes his- or herself, and that it thus is important to make clear that it is not the case owner who is evaluated, but that it is the plan that is discussed by the group in order to promote inclusion of a student. In this context, the owner of case 1 of the in situ discussions reported her experience that a comment from an expert on her AEE plan "pulled the rug out from under her". Nevertheless, she found this "piagetian experience of disequilibration" important to change her perspective and to eventually create an AEE plan more geared towards the inclusion of the child in question.

Finally, asked about other possible benefits of TNR and the "Our Cases" tool, participants mentioned the benefits of "being heard", "being valued", and the affirmation/ support for education professionals who do not yet know the inclusive philosophy and principles of AEE very well.

6.5 Discussion

In the first part of this section we will discuss the results of the case study from the previous section in order to illustrate what we meant by "evaluators become facilitators of local change processes instead of being external experts", and in order to demonstrate that it is possible to obtain the always-sought "implications for design" from a PDE. In the second part we discuss PDE as an approach to evaluation methods in HCI.

6.5.1 Relevance of historical background and practice description

Looking at the historical background provided in subsection 6.4.1, it becomes evident that before "Our Cases", the practice of discussing a case for many AEE professionals did not exist at all, or if it existed, it existed in a substantially different form. This is a challenge for both design and evaluation. Regarding design, the requirements for a new tool that enables a previously non-existent practice, or a practice with divergent modes of execution, are moving targets. Furthermore, when introducing the tool and thus enabling the new form of practice execution, new requirements are likely to emerge and old might become obsolete. As a consequence, the introduction of a new tool often

changes practices. A purely quantitative evaluation or a goal- or criteria-based evaluation can thus only deliver an incomplete picture.

The second half of the historical background shows that "Our Cases" has not been designed in a complete vacuum or only based on the formal training course or descriptions of the diverse practices that existed before TNR and "Our Cases". The multipliers used TNR for collaborative practices for about two years and where engaged in other practices for another year before that. They already used TNR for discussing topics related to AEE cases and even tried to improvise case discussions using the means available before "Our Cases". Consequently, although reporting on a ten-week evaluation of a new tool, the evaluation presented in the previous section should not be seen as an initial snapshot, but as an evaluation of a work practice that is evolving for at least two years. Subsection 6.4.2 provided the description of how "Our Cases" enables case discussions, as well as the explanation of the design goals (promote professional autonomy and lifelong learning) and of the design principles believed to achieve these goals (compromises between rigidity and flexibility, and between formality and informality). This serves to provide necessary context for interpreting the evaluation results. Remembering that the principal question of the evaluation was "How does 'Our Cases' facilitate case discussions among AEE professionals?", with the secondary question of "How does 'Our Cases' support collaborative meaning negotiation and construction processes?", the evaluation results also have to be interpreted with respect to flexibility and formality, and regarding evidences of promoting professional autonomy and lifelong learning.

6.5.2 On the validity of the evaluation results

Before discussing and interpreting the results of the evaluation, we must discuss the expressiveness and validity of the evaluation results from the previous section. To this end, we discuss how the evaluation was designed and conducted (cf. subsection 6.4.3). Stage 1 of the evaluation was designed to be an in situ observation of AEE professionals discussing real AEE cases in their usual environment. A factor that introduced some artificiality was the limitation of this stage to only 16 participants. The explicit invitation should not have introduced additional artificiality, since all participants are accustomed to receiving news about the system periodically. Furthermore they already were accustomed to participate in different online activities in the system, e.g. the discussion of the "Terms of Use" and the collaborative elaboration of a "Charter of Principles". Evidence that stage 1 constituted a relatively natural activity includes the facts that not all invited multipliers participated actively in the discussion and that only three multipliers posted a case, i.e. nobody seemed to feel forced or obligated to participate. Regarding the behavior of the education experts from the research team of trying to "drive" the discussion, we did not

instruct them how to behave during the activity. Thus we interpret this as a result of the evaluation and not as a factor that introduced artificiality.

The purpose of the case discussion during the first part of stage 2 was to establish common ground, since not all participants of stage 2 participated actively during stage 1. Consequently, we will not claim that observations during this stage will occur exactly the same way in "real-world" usage. Furthermore, the participants might have felt excited, intimidated, or otherwise, which might have biased their behavior and their contributions to the discussion. For example, the inclusive education authority was also present during the activity. These effects were probably mitigated by the fact that six of the invited multipliers had already participated in a previous workshop and already knew most of the research team "face-to-face." We tried to further minimize these effects by making the participants feel at ease and by preferring observation and discussion of actions instead of direct to-the-point questions. During the activity (cf. Figure 6.4), instead of letting the multipliers comment in a fixed order in station 2, we used a first-come-first-served order to avoid the anxiousness before one's turn. The fact that the multipliers asked to use two more computers during the "controlled AEE case discussion" and the rather mundane fact that the subsequent group discussion had to be terminated to not miss out on lunch provide evidence that the multipliers where in fact at ease and engaged in the activities.

6.5.3 Implications for design informed by semiotic barriers

From the topics that emerged during both stages of the evaluation, the following were the most important: behavior of the experts and the case owners, as well as updating the case proposition and posting the AEE plan. We can discuss these topics under the perspective of semiotic barriers.

Semiotic barriers of interaction with experts

The experts who participated in the case study had a very active attitude, and sometimes tried to drive the discussion requesting answers to their comments or requesting the posting of an AEE plan. At one point, they even gave a case owner an ultimatum, stating that the case would be "closed" should the owner not respond before a certain date. Regarding their behavior, the experts themselves stated that they probably pushed the participants too hard, and that they even felt that some participants might have felt intimidated and withdrew from the discussion. During the workshop activity, the experts did not try to drive the discussion or "push" the multipliers. We interpret this behavior as part of the process of constituting a collaborative practice. Although some attempts had been made to informally discuss cases in TNR before the launch of "Our Cases", the case discussions described in the previous section were the first ones to be discussed in a

dedicated space and in a more formalized way. Thus, many norms did not yet exist, e.g. implicit informal norms regarding the expected response time for a comment or regarding notifying other participants of one's absence. Although the experts from the case study are now aware of this problem and already seem to have adjusted their behavior, the problem remains relevant. An "expert" in TNR is no role but an informal status according to the concept of "cognitive authority" [100], i.e. due to the behavior in TNR, a person P might implicitly become an expert in area A to person Q, but possibly not to person R and possibly not in area B. Thus, design solutions that presume a formally defined "expert" role are not applicable.

The phenomena observed here regarding the behavior of experts can be understood in terms of semiotic barriers. Due to mediation and representation, the experts did not know if the case owner had read their comment at all or if she simply ignored it. In the case of a "trickier" comment from an expert, the case owner would "expose" herself: during face-to-face communication one can gloss over not knowing an answer or giving a wrong answer, while during written online communication, the answers are visible to the expert and many others. Furthermore, communication partners might subscribe to different communication styles and norms, or simply not have ubiquitous access to the system, which was the case in the discussion with the ultimatum. In this context, it is important to remember that many users of TNR are not accustomed to this kind of conversation and thus might try to apply their expectations from face-to-face, e-mail or instant message communication.

There are different possibilities for redesign. Some of these possibilities can be based on simply obtainable statistic information, such as number of comments per user and case, mean time between comment and response, or the number of comments between pairs of users. In the list of case participants in the case overview (Figure 6.2), the number of comments per participant could be shown in a bar chart in order to give each user the possibility to compare how many comments each participant made. Regarding different response time norms, when commenting or displaying a not responded comment, based on a statistical analysis, an indicator such as "X usually responds a comment within Y days" could be made available. As to different qualities of relationships among users, information concerning certain users could be displayed differently, e.g. using the "following-followed" relation in TNR or the frequency of comment exchanges between two users. Besides these non-interactive possibilities based on statistical data, also solutions that require some interaction from the user are possible. For example, in the sender's view, a comment could be augmented with a "seen by addressee" indicator. Conversely, in the addressee's view, unseen comments could be highlighted, and be marked "seen" manually, or automatically when hovering with the mouse over the comment for a certain amount of time. Another design solution that already works on the pragmatic level of

making intentions and expectations more explicit would be an optional set of form fields for the comment form where the expert or any commenter could indicate if she expects a response from the addressee and if she thinks the response is difficult or time-intensive, or if the commenter considers herself an expert in the area of the comment.

Semiotic barriers of interaction with case owners

Parts of the discussion in the previous subsection apply symmetrically to the case owners, e.g. the way they do or do not respond to comments. Depending on which solutions of the previous subsection would be implemented, it is also possible to show this by type of commenter relation, or to show or send respective notifications.

We observed that the case owners did not update the case discussions, even if they provided various pieces of additional information in the discussion thread. Thus, for example, a participant who only joined the discussion later would have to read the whole thread to construct the case description. On the one hand this is not too bad, since that way the participant would also reconstruct the development of the discussion. On the other hand this is highly inefficient for lengthy case discussions. Moreover, the case owner might gain a better understanding of her own case when rewriting or amending the case description, and important points might get lost if not doing so. Apart from not updating the case description, the case owners seemed also reluctant to post an AEE plan. We already observed this during previous activities where we used existing systems to discuss fictitious cases, but at that time attributed it to the fact that the cases were fictitious and had no case owner. The main reason for not posting the AEE plan might be related to the feeling of being exposed or under scrutiny. Another possible reason might be that some participants got too accustomed with the moderated discussion process from the formal training mentioned in subsection 6.4.1. Evidence for this emerged during the group discussion when one multiplier remarked that the plan is the consequence of the case discussion.

In terms of semiotic barriers, we can understand the phenomena of the previous paragraph as follows. From the point of view of a participant, the construction of the not updated case description by sifting through all comments corresponds to the pragmatic pattern of a "scattered conversation" that we identified in previous work [74]. The various pieces of information that complement the case description are scattered throughout the discussion thread, and even unresolved contradictions might be encountered in different subtrees of the thread. From the point of view of the multipliers, we believe the main semiotic barrier is related to the textual representation and the formality of the case discussion. First of all, the multipliers value authorship and attribution greatly. In previous activities they rejected collaborative writing because it was not clear which parts of a text could be attributed to which author. Second, during the interviews of stage 1, as well as

during the activity and group discussion of stage 2, it became clear that they take great care before posting a comment or a document. From this, we conclude that they have a strong sense of accountability in the sense of having to account for what they posted. A similar barrier might occur in the case of not posting an AEE plan. The impression of being under scrutiny might arise due to the sense of accountability and the possible sensation that a once posted AEE plan is "set in stone", although it can be edited at any time. Under this perspective, we can interpret the desire for an online chat as an attempt to avoid formality. Another semiotic barrier might be directly related to semiosis, i.e. the sign process of interpreting a representation of an object. When posting a case description, the respective child is usually already in attendance. However, it seems that the AEE plan posted in "Our Cases" might not be seen as a representation of the incomplete and constantly evolving plan that the professional is already executing, but as an idealized version of how the professional would like to attend the child. And finally, a simple representational barrier might the visual representation of the plan as a tab to the right of the description (cf. Figure 6.2), which might contribute to understanding the plan as a consequence or a next step after the case proposition.

As to possibilities for redesign, regarding the problem of promoting updates of the case description, one possibility is to highlight comments from the case owner that were posted after the last update of a case description. Other possibilities include making the case owner aware of not yet responded comments by multipliers and of the number of comments the owner made after the last update, e.g. in a dedicated area of the case as some form of notification. Another option would be to implement in-place editing as a replacement of the separate edit mode. This would also alleviate the possible sensation of the AEE plan being "set in stone". Regarding the possible semiotic barrier of not associating the AEE plan posted in "Our Cases" with the plan being implemented in school, a possible solution could be to include more suggestive descriptions that focus on the actual execution of the plan, e.g. "what is the current attendance schedule?" or "what objectives have you already achieved?". Regarding the possible problem of understanding the AEE plan as a consequence of the discussion, design solutions would be to invert the order of the tabs or to display the case proposition and the plan together in the same view.

Semiotic barriers of interaction with multipliers

Apart from the barriers related to experts and case owners, there also might exist semiotic barriers of interaction with multipliers. During the case discussions and during the workshop, the only barriers that became evident were those related to different work contexts. This resulted sometimes in comments or suggestions that a case owner deemed to not be feasible in her particular work context. However, during the group discussion, it

became clear that the participants were well aware of these different contexts. The consensus among the participants was that these different contexts enrich the case discussions and thus contribute to learning of the multipliers. These differences also contribute to a better understanding of the case by allowing the case owner to get input from different perspectives and requiring her to explain and thus evaluate her own perspective. Thus, this barrier actually has a positive effect on the case discussions. However, this barrier needs to be evaluated continuously. At the moment, there are various possibilities for a user of TNR to gain awareness of different work contexts of others, e.g. the individual user profile pages, or discussions in other areas of TNR. Considering the potential increase of the number of TNR users, it might become necessary to make different contexts more explicit by e.g. displaying a user's city, state, work-place and position together; at the moment only a profile picture appears.

Stakeholder values and goals

So far, the evaluation resulted in a better understanding of the occurring semiotic barriers. This enabled us to propose design solutions that are based on a shared understanding among the most important stakeholders of TNR, i.e. AEE professionals, designers/developers, researchers, case owners, multipliers, and experts (one person might be in multiple stakeholder groups). Although our evaluation was "goal-free", resulting design proposals that will be implemented must still be aligned with the stakeholders' goals. The main goals of TNR and thus of "Our Cases" are to facilitate professional autonomy and lifelong learning. These goals originate from the researchers, but are shared by the designers and probably by the case owners, multipliers, and experts. It is possible that not all AEE professionals share these goals, e.g. some might want to use "Our Cases" to get seemingly "ready-made" solutions. However, designers, researchers, case owners, multipliers and experts agree that the goals of professional autonomy and lifelong learning take primacy over possible conflicting goals.

Although there is still much room for improvement, as the semiotic barriers discussed in the previous subsections have shown, the evaluation provided evidence that "Our Cases" in fact contributes to autonomy and learning. The participants were quite engaged in the case discussions during the first stage of evaluation, and during the workshop activity it became clear that the multipliers, who are all AEE professionals, mutually benefit from discussing with others who come from different backgrounds. Furthermore, the evaluation provided evidence that the compromises between flexibility and rigidity and between formality and informality have been chosen sensibly.

Among the goals of the experts and multipliers (each of which can already be seen as an expert in TNR in some area) is to be the curators of domain and practice knowledge. This goal in principle works towards the overall goals of learning. However, we have seen

that it might have negative effects if it results in "driving the conversation" or "feeling under scrutiny". In future, it is thus important to evaluate how experts contribute to case discussions and also how open they are to admit new and adapt existing knowledge and practices.

The third case discussion during stage 1 of the evaluation has shown that a possible goal of AEE professionals might be to "show off" their work. Although the project's researchers prefer elaborating over presenting solutions, posting well described, apparently successful cases might at least contribute to "learning by example". However, "showing off" might have a demotivating effect on some AEE professionals, and thus is something that needs to be evaluated in future. Another potential source of conflict is the one of being exposed during the formal, written discussion versus not being able to effectively elaborate the AEE case due to too much informality. Although it is important that the feeling of being exposed is minimized, the stakeholder representatives seem to agree that it is a necessary part of the process of gaining autonomy and learning. Design solutions can evoke the right direction; however, the degree of feeling exposed ultimately depends also on the behavior of TNR's members.

Finally, the designers/developers have goals such as usability, accessibility, robustness, performance, etc., that have not been object of this evaluation. These goals are positively correlated to the goals of professional autonomy and lifelong learning in the sense that they are prerequisites of the usage of TNR and "Our Cases". Due to being deeply engaged with TNR and having an intimate knowledge of TNR's goals and the goals of its stakeholders, the designers/developers can align their goals with the overall goals, avoiding thus to push solutions because they are technologically possible and not because the make sense for practice execution.

6.5.4 On PDE

The discussion in the previous subsections has shown that PDE as proposed in this article in fact can make important contributions to a continuing design-in-use lifecycle of TNR. PDE helped us to gain a deeper understanding of the "case discussion" practice. By involving different stakeholder representatives, we were able to identify different semiotic barriers and their positive or negative effects. Identifying positive effects and being able to reflect about why these effects occur and how they might be stabilized or even increased is already a difference to many evaluation methods that only focus on detecting problems. By discussing the semiotic barriers, the relation of different stakeholders to these barriers, as well as relevant stakeholder goals that are possibly in conflict with each other, we were able to formulate and discuss possible design solutions and even generate objectives for future complementary criteria- or goal-based evaluations (e.g. regarding the participation

of the case owner and the experts in the discussion). We were also able to trace these discussions back to the project's overall design goals.

We proposed Organizational Semiotics, Activity Theory and the Pragmatic Web as theoretical and methodological frames of reference for PDE. We think it is possible to choose other frames of reference; however, we postulate that a frame of reference has to subscribe to the neo-humanist paradigm at least, and be able to conceptualize communication, mediation, representation, and practice.

Regarding the actual conduction of PDE, we stated that this always depends on the object of the evaluation. We defined the following minimal set of characteristics of PDE: deep engagement of the designer-evaluator with the system to be evaluated, involvement of relevant stakeholders in the evaluation process, observation of a real practice in situ, and a group activity for collaborative sense-making. The discussion in the previous subsections has shown that many results we obtained could probably not have been obtained without our deep engagement with the system. Furthermore, involving stakeholders was crucial for planning, conducting and analyzing the evaluation. The group activity during the workshop was important because it contributed to contextualize the observations made during stage 1 of the evaluation. Some important results could not have been obtained by e.g. individual interviews. These include discussing the contradictions between actual practice and idealized conceptualization, as well as the juxtaposition of the different professional backgrounds of the multipliers. Other forms of group activities for stage 2 are conceivable, e.g. video conferences. For the group activity of the evaluation method presented in this article we chose a face-to-face meeting. Not all participants had Internet connections at their homes that allow a sufficient video and audio quality. More importantly, the personal contact during the face-to-face meeting enabled much deeper and personal interactions than a video conference, as well as longer activities than a video conference that gets tiresome after some time. Furthermore, the social contact among the whole group was essential to strengthen the genuine sense of sharing ideas towards constructing TNR together.

The in situ observation of stage 1 of the conducted evaluation might resemble some ethnographic methods in HCI. However, stage 1 was certainly not an ethnographic study as performed by trained ethnographers. A commonality between stage 1 and an ethnographic study is the open-ended focus on understanding of phenomena. This sets PDE apart from "discount ethnography" that often has a narrower focus such as gathering requirements in the early stages of a system's lifecycle [46]. At the same time, in terms of "costs", PDE is much closer to "discount ethnography" than full-fledged ethnography.

A limitation of this article is that it is based on a single research and design project in a single domain. Thus, the description of how to conduct PDE (cf. Subsection 6.3.3) is rather generic. We stated that an instantiation always depends on the concrete re-

search and design project. An investigation of PDE in different problem domains might yield further insights on invariants of the method and a more detailed description of its conduction. Regarding possible limitations of the presented evaluation method, PDE can only work when subscribing to the continuing design-in-use model and when involving relevant stakeholder representatives since the early stages of a project. The deep engagement of the designers and developers takes time and effort which might be a problem for projects on a tight schedule or with a small budget. Furthermore, PDE acknowledges the interdependence of design and evaluation and thus requires openness to continuously questioning and redesigning aspects of the technical system. The acknowledgement of this interdependence might pose a barrier to contexts where it is e.g. preferred to train users to learn the practice that the system supports instead of (re-)designing the system to better support or enhance its users' practices.

6.6 Conclusion

In this article we situated evaluation of web-based collaborative systems as an integral part of a continuous design-in-use system lifecycle. We argued that criteria or goal measurement oriented evaluation methods might miss important points and particularly are not able to answer open-ended questions such as "How does a system facilitate the practices of its users?" We proposed Pragmatics-Driven Evaluation as a goal-free approach to evaluation that is rooted in the neo-humanist paradigm and that focuses on pragmatic aspects of web-based collaboration, i.e. on meaning construction and negotiation processes among different people or groups. Thus, we acknowledge that evaluation is a multi-faceted problem that has different stakeholders with different, possibly conflicting goals.

To illustrate how PDE can be conducted and what kind of results can be obtained, we then presented a case study of a PDE using Organizational Semiotics, Activity Theory and the Pragmatic Web as theoretical and methodological frames of reference. The chosen frames of reference allowed us to investigate semiotic barriers of collaboration, i.e. barriers related to communication, mediation and representation.

We characterized PDE as an approach to evaluation that requires the deep engagement of the designer-evaluator, the participation of relevant stakeholders, the observation of a real practice in situ, as well as a group activity for collaborative sense-making. The case study presented in Section 6.4 was conducted accordingly considering AEE professionals, experts, multipliers, designers, developers, and researchers as relevant stakeholders. The case study was situated in a research project in the domain of inclusive education. The object of evaluation was "Our Cases", a tool for discussing "AEE cases", i.e. problems or challenges the education professionals face related to the inclusion of a specific child in a regular school. "Our Cases" is part of TNR, a system for AEE professionals which is

being designed with the goals of promoting professional autonomy and lifelong learning.

The analysis of the case study showed that each of PDE's single characteristics contributed to the conducted evaluation and that we therefore can consider these characteristics as a minimal set. The discussion of semiotic barriers helped to understand the different goals of the different stakeholders and the possible positive or negative tensions between these goals. Instead of being focused on "detecting problems", the discussion of semiotic barriers also uncovered positive elements. It thus informed design and redesign in order to alleviate problems or elaborate positive elements. The PDE as presented in the case study also informed further evaluation, including criteria- or goal-measurement-oriented evaluation. We conclude that we provided evidence that PDE can make a valuable contribution to the evaluation portfolio for web-based collaborative systems. By providing a detailed discussion of the conducted evaluation and the provided method, we have contributed to Roger's [107] "conceptualizing of theories imported to HCI". Regarding future work, we need to apply PDE in more contexts, including different kinds of collaborative systems, in order to gather more experience and insights on PDE's weaknesses and strengths.

Chapter 7

Conclusions

The problem treated in this PhD thesis addressed how to reduce semiotic barriers that occur during web-mediated collaboration. The reduction of these semiotic barriers related to communication, representation and mediation concerns the important objective in HCI of designing meaningful systems. The notion of "meaningful" and the question to what meaningful actually relates have changed over the years. At a time where users used computers to perform well-defined tasks individually within a well-defined context, it was enough to consider the meaningfulness of the "user interface" on the syntactic and semantic levels. On a semantic level, users needed to know what an interface element "meant", e.g. that a "button submits a form". On a syntactic level, they needed to know which interface elements to manipulate in which order to achieve their tasks. Important theories and frameworks to inform the design of such interfaces came from Ergonomics and Cognitive Psychology. An example of a prevalent design approach is system-centered design with its view of the person as a "human factor". Later, people started to use computers to work in groups. The use context expanded from an individual using a single computer to groups working collaboratively on different tasks. Although this context was still relatively well-defined and static, i.e. group members often came from the same working domain or company, it became clear that it was not enough for users to "make sense" of the user interface. Focus thus shifted from the interface to the interaction among users, from "human factors" to "human actors" [8]. "Meaningful" on a syntactic level now meant to understand the processes, i.e. knowing which users needed to perform which actions in order to achieve a common objective. On a semantic level, it was important for users e.g. to understand the conditions under which actions could be performed, and which actions had been performed or needed to be performed by whom. A prevalent design approach was user-centered design, and the theories and frameworks that arose to inform this kind of design have been called "post-cognitivist". Today, digital technology has permeated all aspects of life. People use devices of a wide variety of form factors in a wide variety

of contexts or situations. When designing an application or a system, the definitions of "user" and "task" often become moving targets. Although the aforementioned types of theories and frameworks are still important, they cannot answer all relevant questions. Many researchers have traced this development and made calls to action to search for adaptation or creation of theories, frameworks and approaches to design.[1]

This PhD thesis is our answer to these calls to action, and the root of our answer is Pragmatics. The starting point of our work was the perceived gap between the syntax and semantics of interaction on the one hand, and the "social" on the other. Admittedly, probably only researchers or practitioners who use semiotic or linguistic approaches to design would talk of "syntax and semantics of interaction", but this does not make the gap disappear. Adopting Stamper's [122] semiotic "ladder", it becomes clear that pragmatics is the missing link between semantics and the social layer. The "social" is appearing nowadays in guises such as "social Web", "social software", "social computing", etc., and it often asks "why" questions that are related to people's intentions and thus to pragmatics, e.g. "why do people engage in social networks". However, answers to these questions are often focused on the, nevertheless important, motivational aspects, and in the best case on people's values. We perceived that Pragmatics was an underexplored area. Our approach in this work was thus to propose a pragmatics-driven perspective for the question of what it means to "design meaningful systems". "Meaningful" on a pragmatic level is about understanding each other's intentions, as well as the expectations, commitments and social consequences that result from conveying these intentions. Hence, our argument is that we need to understand the pragmatics of interaction and their implications for design in order to design systems that enable meaningful interaction among people.

In the following, we will synthesize the contributions of this work, provide a critical reflection, and indicate future work.

7.1 Contributions

The main contribution of this work is the pragmatics-driven approach to design of collaborative web-based systems presented in Chapter 4. Based on Organizational Semiotics (OS) and Activity Theory, that chapter defines our vision of "Interaction Design in the Pragmatic Web". The objective of the proposed approach is to reduce semiotic barriers that occur during web-mediated collaboration, i.e. barriers related to communication, mediation and representation. Adopting a research and design cycle consisting of five stages – understand, study, design, build, and evaluate –, we show how pragmatic aspects of interaction play a crucial role and inform the choice and use of methods and techniques

[1] This paragraph is a result of our "pragmatics-driven" reading of Grudin, Bødker, Harrison et al., Bannon, and Rogers [61, 29, 64, 9, 107].

at each stage. The basic premises of the proposed approach are the subscription to neo-humanism and the primacy of human practices. As a consequence, the proposed approach requires stakeholder involvement in all stages, in order to form a continuous design-use feedback cycle. Design solutions shape the use, i.e. the practices mediated by the system, and vice versa. A practice is the minimal unit of analysis in this approach and comprises, besides the actual collaborative actions and objects of collaboration, the people, their beliefs, norms and values, as well as the situational, historical and developmental context of the interaction. We provided validation to the proposed approach by showing how the five stages of a design cycle were materialized within parts of the TNR project (cf. Chapters 5 and 6, and Appendix C).

As another contribution, we proposed a pragmatics-driven approach to evaluation called PDE in Chapter 6 that is based on the proposed approach to design from Chapter 4. We conceptualized design and evaluation as two sides of the same coin and situated the proposed approach to evaluation within a continuing design-in-use cycle. The minimal set of characteristics of PDE comprises the immersion of the designer-evaluator in the system to be evaluated, the involvement of relevant stakeholders in the evaluation process, the observation of a real practice in situ, and a group activity for collaborative sense-making. On the example of the evaluation of a tool for case discussions in the TNR system, we illustrated how PDE can be conducted and that the obtained results informed design and redesign, and lead to a deeper understanding of the research and design problem. Furthermore, it showed the usefulness of the concept of "semiotic barriers". The concept of "semiotic barriers" can be seen as an additional contribution, since it has shown to be valuable for discussing issues related to design and evaluation.

The contributions of this PhD thesis are foremost contributions to theory development in HCI, although we also touched related areas such as Information Systems research, CSCW, and Web Science. Furthermore, we think to have contributed to the advancement of the Pragmatic Web research area by providing an example of transforming Pragmatic Web theory into practice.

7.2 Critical Reflection

In the introduction of this PhD thesis, we formulated the main objective of this work as to "investigate semiotic barriers to web-mediated collaboration and propose an approach to Interaction Design that reduces these barriers". Our first step in Chapter 2 led us, among others, to the concept of "affordances". We presented how the concept of affordances is used in different contexts (e.g. HCI and OS) and how its use has changed over time (e.g. Norman's reconceptualization from "perceived affordances" to "social signifiers"). Since affordances are a prominent topic in HCI, one possible consequence of Chapter 2 could

have been to conceptualize barriers to collaboration in terms of affordances. However, Chapter 2 has shown that there exist too many understandings of the concept, even among researchers from the same area. Thus, we decided that it would be counterproductive to our objectives to use such a polemic and ambiguous concept, even more so as we chose OS as a frame of reference, where "affordance" has a meaning very different from its meaning in HCI. This eventually led us to the conceptualization of problems during web-mediated interaction as related to semiotic barriers.

The elaboration of the problem and objectives, and the determination of the Pragmatic Web as a research perspective in Chapters 2 and 3 made clear that the Pragmatic Web provided a promising theoretic approach, but that it still lacked examples of practical applications. As a result, the following was defined as a secondary overall objective of this work: to "demonstrate that it is possible to define an Interaction Design method that can be carried out using respective techniques, and that results in a decrease of aforementioned barriers". Chapter 4 then outlined how pragmatics-driven design can be instantiated in the stages understand, study, design, build and evaluate of an Interaction Design cycle. Chapter 4 and Appendix A made clear that the proposed approach and its theoretical and methodological frames of references already were well suited for the stages understand and study, but required additional investigations regarding the stages design, build and evaluate. Chapter 5 and Appendix C showed how the stages design and build could be instantiated within pragmatics-driven design. Chapter 6 finally provided a detailed account of an evaluation method within the proposed approach.

Regarding the Pragmatic Web, as discussed in Chapter 4, the area is still emerging and has a relatively small number of researchers and events such as conferences or workshops. Although the Semantic Web is a relatively more mature area, it is also dynamically evolving. As a consequence, the boundary between the two areas is not a clear cut one, and some topics that would have been considered core Pragmatic Web topics have been taken up by the Semantic Web community, although often with different foci and different theoretical or methodological approaches. Regarding Interaction Design in the Pragmatic Web, the emergence of the area and the small number of researchers offered opportunities and posed challenges at the same time. An opportunity was to be able to actively define and shape concepts in this area. Challenges included the difficulty to discuss our work with colleagues, which we tried to overcome by publishing our work in different related areas, e.g. HCI (Chapters 3 and 5), Information Systems (Appendix A), Web (Appendix B), and the Syntactic/Pragmatic Web (Chapter 2, which was submitted to the Pragmatic Web track of a Semantic Web conference).

Although based on experiences from previous research projects, e.g. the e-Cidadania project, the principal research and design activities reported on in this work have been carried out within the context of the TNR project. This might be seen as a limitation

of this work, e.g. regarding the generalizability of the results to other contexts. In fact, we propose to apply pragmatics-driven design and evaluation to other contexts and also by other researchers and designers. On the other hand, the focus on TNR as the single research and design project permitted us to get a profound knowledge of TNR's problem domain and its stakeholders. That way, instead of studying possibly recurring pragmatic aspects of collaboration in different contexts in a rather superficial matter, we were able to study the pragmatic aspects relevant to TNR in a much greater depth.

The focus on a single research and design project and our practice-centered approach (as opposed to a system-, technology-, or user-centered approach) also had other consequences for this work. Although the Pragmatic Web has been described as an extension of the Semantic Web, we did not explore the implementation of Semantic Web technologies as a basis for our design solutions. These technologies are useful e.g. for integrating content from various different data sources. However, for the practices of TNR's stakeholders this was not relevant and thus not explored during our work. For the same reason, we did explore themes that appeared within Chapters 2 and 3 in less depth, such as flexibility of means of access (e.g. customization/adaptation).

Regarding the context of current HCI research, semiotic and linguistic frameworks have been used in HCI at least since the 1980s. Although these frameworks never entered or did not yet enter the "limelight" of HCI research and practice, they have continuously brought contributions to the area. Considering the current efforts of the area to explore new directions for theoretical and methodological approaches, it remains important to maintain the discussion and show how semiotic approaches can contribute to HCI research and practice.

7.3 Future Work

The results of this work open up a rich space for future work regarding further validation and refinement of the approach to pragmatics-driven design and evaluation, an extension exploring other pragmatics related concepts and methods, an articulation with other topics in HCI, as well as a proposal of approaches that go beyond what has been investigated in this PhD thesis.

In order to further validate and refine the approach to design and evaluation presented in this PhD thesis, we propose the following:

- to implement the design and redesign suggestions to "Our Cases" proposed in Chapter 6 and perform further design-evaluation cycles,
- to deploy the timeline representation prototype presented in Chapter 5 and Appendix C, and perform necessary design-evaluation cycles,

- to conduct pragmatics-driven design and evaluation in other problem domains of collaborative practices, and
- to further disseminate pragmatics-driven design and evaluation, e.g. in meetings or workshops, in order to motivate other groups of researchers and practitioners to apply the approach.

Regarding an extension of this PhD thesis, the following topics could be further explored:

- the potential to use concepts and methods from Organizational Semiotics and from Activity Theory in a more integrated conceptual and methodological framework, as indicated in [73],
- the use of the analysis of illocutions in design and evaluation, as indicated in [24, 23], as well as an exploration of whether and how the resulting perlocutionary effects might influence design, and
- the exploration of pragmatic patterns of collaborative problem solving, started in [74].

Besides a further validation and an extension of the work presented in this PhD thesis, it is important to articulate our work with other topics in HCI. We see potential in the following topics:

- Design Rationale: our work has shown that different stakeholders might have different requirements and capabilities and experience different semiotic barriers. An interesting question is whether there are benefits to make more explicit the relations between design problems, alternatives and decisions on the one hand, and semiotic barriers as well as stakeholder goals, requirements and capabilities on the other hand, and how to create such design rationales.
- Universal Design: recognizing that people have different intentions and goals is another perspective on Universal Design which usually presumes different user requirements and capabilities. The conceptual model in Chapter 3 touches briefly on these questions. A possibility for future work is thus to explore the relation of Pragmatics-Driven Design to Universal Design.
- Embodied Interaction: phenomenological accounts of interaction and the concept of embodiment have gained importance in HCI in recent years (e.g. [45]). O'Neill [97] provides an account of the Semiotics of Embodied Interaction within the context of Interactive Media. A possible future work is to elaborate this account within the context of web-mediated collaboration.

Finally, considering going beyond the work presented in this PhD thesis, so far we focused on the pragmatic aspects of interaction and adopted a Pragmatic Web perspective in order to design systems that enable meaning construction and negotiation during collaboration. We already introduced the concept of semiotic barriers. A next possible step is to extend our investigation to the Semantic Web in the one and to the Social Web in the other direction. Regarding the Semantic Web, the question of how to leverage Semantic Web techniques in order to build systems that facilitate collaboration among people in the sense presented in this work remains underexplored. A reason for this might be different theoretical and methodological approaches in the Semantic and Pragmatic Web, even regarding to ontology and epistemology. A concrete starting point is the investigation of how to integrate these different, in some aspects seemingly incompatible, approaches, possibly inspired by Blevis' and Stolterman's [18] "transdisciplinarity". Furthermore, we can explore whether and how Semantic Web techniques and technologies affect semiotic barriers.

The Social Web can be defined in many ways, e.g. in technical terms as the "set of relationships that links together people over the Web" [7], or in terms of lists of functionalities and characteristics of web sites that are considered core examples of the Social Web. Answers to important questions such as why certain Social Web sites or mechanisms succeed or fail depend on these definitions. For example, a technical view on the Social Web might yield answers related to network effects or critical mass, while a psychological view might yield answers related to motivation. If we adopt a semiotic view, we are able to understand the Social Web by means of expectations and commitments that result from people's actions and that are influenced by beliefs, values and the fields of norms in which people act, building on our understanding of how meanings are constructed and negotiated, and how intentions are expressed and understood. A possible area of future work is thus to consider the Semantic, Pragmatic and Social Web in an integrated manner, yielding a Semiotic Web. Core HCI-related questions in the Semiotic Web continue to be related to designing meaningful interactions, but understand "meaningful" on the social level, i.e. relating it to the fields of norms of participating people and the effects of actions in the social world. Thus, building on this PhD thesis, the Semiotic Web would provide a theoretical and methodological framework to designing systems relevant for society.

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Appendix A

Conceptual Frameworks for Interaction Design: Analysing Activity Theory and Organizational Semiotics Contributions[1]

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Conceptual Frameworks for Interaction Design:
Analysing Activity Theory and Organizational Semiotics Contributions

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Abstract: Designing systems to mediate actions of people involves knowledge in areas such as Computer-Supported Cooperative Work, Information Systems, Human Computer Interaction, to name a few. Each of these areas provides its own conceptual frameworks, informed by other areas, such as Sociology, Psychology, Computer Science, etc. It is not always straightforward to choose an adequate conceptual framework to work on problems in which collaboration, work and learning are joint foci of interest. Starting from a concrete research and system design problem for supporting the work of special education teachers in their lifelong learning process, this paper investigates the potential of two theories – Activity Theory (AT) and Organizational Semiotics (OS) – for supporting the different stages of design. Our findings show that, while they are well suited for clarifying the design problem and informing a solution, they provide limited support for the stages of system interaction design and evaluation. In consequence, additional frameworks or an investigation regarding the extensibility of AT and OS are required.

1. INTRODUCTION

Different approaches have been suggested in order to accommodate new requirements induced by the shift from individual computer use by specialists in workplace settings to the use of digital artefacts in different situations (individual/collaborative, workplace/leisure, expert/non-expert etc.). Many approaches at different levels of maturity, abstraction and complexity exist, i.e. single methods or tools, guidelines, models, theories, etc., some of them inspired by or adopted from theories and frameworks from other disciplines such as psychology, sociology, etc.

Every theory or framework has to be seen in the context of its underlying paradigm, i.e. the set of assumptions about the world shared by a scientific, professional or other community. When choosing a theory or framework as an approach to a research problem, researchers have to evaluate if they can subscribe to its underlying paradigm and if this paradigm is appropriate for the context of the research problem.

In this paper, we will refer to a concrete research problem from the domain of Interaction Design (IxD) for a lifelong learning system design. The Project that serves as background and motivation for this investigation involves supporting lifelong learning for special education teachers in Brazil's public school system, with the overall goal to improve the attendance of students with special needs by enabling these teachers (and later, possibly, other teachers, family members, and other stakeholders), who are geographically spread all over the country, to share experiences, clarify issues, and discuss problems with respect to the school-life of students with special needs. These system mediated activities are intended to promote a collaborative sharing of case discussions situated in their day-by-day work practice, and will be part of their lifelong learning process.

The formal professional as well as the informal lifelong learning practices of these teachers evolve and change over time, and breakdowns and conflicts may occur during the execution of a practice. Apart from the diversity of possible users and use contexts, an approach to understanding this problem and to informing the design of a possible system solution thus needs to be able to deal with change, conflicts, and breakdowns in practices.

A solution will be one that computationally mediates purposeful actions. Although the actions are directed towards purposes related to the teachers' workplace, some characteristics of such an open

online system might differ substantially from more formal institutional or corporate workplace settings. For example, social norms are different, and there do not necessarily exist any hierarchical relationships, e.g. between superior and subordinate. Formal rules, if existent at all, are not imposed by a work contract, but mutually agreed upon by the participants. Furthermore, the digital artefacts that mediate interaction are merely a means towards an end, i.e. the teachers do not use the digital artefact as a primary tool at work.

Given this research scenario, our focus is thus on theories and frameworks for understanding, informing, designing, and evaluating system solutions that enable informal (non-institutional) purposeful mediated interaction. Since the problem comprises many socio-technical questions, a candidate theory or framework should put a strong emphasis to computationally mediated human practice and support a subjectivist view, i.e. the notion that reality is socially constructed. As two frameworks that fit these criteria, we chose Activity Theory (AT) and Organizational Semiotics (OS), since both support the conceptualization of socio-technical questions regarding computationally mediated human practice, and both address different aspects of a design problem. This paper then explores commonalities and differences of these two frameworks with respect to the support of the IxD of system solutions in the considered domain.

The next section sets the background to this work. The subsequent section motivates and justifies why we chose AT and OS for our investigations and gives a brief overview of the two frameworks. The fourth section investigates how AT and OS support the different stages of the IxD The last section concludes.

2. BACKGROUND SCENARIO

In order to provide the context that is necessary to follow the remainder of this paper, we will now briefly describe the country context, special education in Brazil, the work-practice of special education teachers, and our research team's pedagogic rationale regarding lifelong learning.

Brazil is a country of continental dimensions, showing a large diversity regarding socio-economic aspects, culture, and access to information and communication technology (CETIC.br, 2011; IBGE, 2010). A poll among the tutors of a training course for special education teachers in Brazil conducted by the project team revealed a great diversity regarding the use or non-use of ICT and web applications (Cavalcante, 2010). Consequently, a system solution for the design problem will have to accommodate a wide variety of preferences and competencies regarding the use of digital artefacts.

Regarding education, in Brazil children have the right to go to regular public schools, regardless of any special needs (Dutra et al., 2008). Public schools in turn have to provide the necessary infrastructure and means (e.g. physical access for children with physical or visual impairments, sign language interpreter for deaf children) and to guarantee the participation of students in a regular class. As to the educational issues, special education teachers are employed by the schools. These teachers work in collaboration with the teacher in class to support children with special needs or perform additional activities outside regular lessons, either with individual students or with small groups. Usually the teacher elaborates an individual educational action plan (henceforth "a plan") for these students, which also considers extra-curricular activities, and involves the relevant stakeholders, e.g. therapists or family members.

The principal goal of special education in Brazil is to enable students with special needs to learn together with other students and to participate in regular classes as opposed to segregated classes only for students with special needs. Important values are to focus on the students capabilities instead of their impairments and to consider each student as an individual instead of trying to apply off-the-shelf solutions, e.g. for a "10-12 year old girl with a severe visual impairment".

In order to propagate this goal and these values, and in order to provide teachers with the required methods and tools, the Brazilian Ministry of Education has devised a formal training for special education teachers. The principal method that is taught is a so called "case discussion", the main tools are the "a hypothetical case description", which is elaborated and discussed and which eventually results in the aforementioned "plan".

The case discussion may follow a suggested structure, which starts with the case proposition by the teacher of the student in question, followed by different collaborative activities among the teachers, such as problem analysis, or a discussion of possible goals of a plan. The actual plan is the last step in this procedure. During the training course, the teachers conduct face-to-face meetings and use a distance learning system where they post documents and conduct discussions in an online forum. The elaboration and discussion of a plan based on the

proposition of a case would thus constitute integral parts of the ideal work-practice of a special education teacher. At the time of writing this paper there does not yet exist enough data to evaluate to what extent the contents taught in the course have been adopted in practice, but according to personal communications and the fact that teachers participated in the elaboration of the course, it is safe to say that practice varies from something similar to what is taught in the course to ad-hoc and on-demand activities.

As to pedagogic issues that are relevant for the scope of this work, it is sufficient to state that the following assumptions have been adopted: *knowledge and practice are interdependent*, i.e. knowledge should have a practical relevance, and practice and experience augment knowledge; *learning is a collaborative effort*, i.e. learners engage in collaborative activities and learn from the process and the outcome of these activities; *diversity improves learning*, i.e. less experienced learners learn from the contributions of more experienced learners, more experienced learners benefit from clarifying and presenting their knowledge to less experienced learners; *learning happens from real-life problems*, i.e. the learning process is improved when the learner has to solve a real problem.

Thus, given the background context of the research problem, and AT and OS as the selected conceptual frameworks, this work addresses the following question: What are the strong and weak points of each framework (a) regarding the characteristics of the design problem (i.e. the domain of informal lifelong learning, diversity of users, evolving and potentially conflicting practices), and (b) regarding the different stages (understand, inform, design, evaluate) of Systems IxD?

3. SITUATING AT AND OS

In this section we provide a rationale why we selected AT and OS. We then give short overviews of the two frameworks and show that they are aligned with our research Project, i.e. that they provide support for its key characteristics and are compatible with its pedagogic principles.

3.1 Rationale for selecting AT and OS

The background scenario of technology mediating interaction of people described in the previous section is a socio-technical one. Thus, a criterion for choosing a framework was its support for the notion of the significant role of technology in human life, and the acknowledgement that important aspects of the problem cannot be expressed as variables in a formal model. This ruled out frameworks that are purely positivist, e.g. cognitive approaches in Human-Computer Interaction.

Another criterion was the relationship between people and technology. In concordance with the context of the design problem, the chosen frameworks acknowledge the agency of people and reject the notion of computers as responsible actors. This e.g. ruled out Actor-Network Theory. An example where assuming a certain symmetry of humans and machines would be adequate is the context of maritime work and technology (Andersen, 2006). There, computers and machinery "act" – albeit within the limits of algorithms programmed by people – based on e.g. sensor input, a plotted autopilot course, etc., and people need to interpret these actions and react accordingly. In the context of our design problem and our research questions, however, we are primarily interested in the role of the computer system as the enabler and mediator of human collaboration over space and time.

The third criterion was the framework's emphasis on intentional interaction within the context of practice. This criterion was introduced because of the authors' interest in investigating how people establish and develop practices within the context of the design problem described in the previous section. This criterion ruled out frameworks that e.g. solely focus on aspects such as user experience, emotion, and affection – aspects that the authors nevertheless consider important and complementary.

The frameworks that resulted from this filtering have roots in disciplines such as psychology, semiotics, phenomenology, or sociology. It is worth noting that within the context of this paper we use the term "framework", although the selected and filtered out "frameworks" might differ significantly in scope, i.e. some aspire to be(come) a complete theoretical foundation of their respective core discipline while others try to prescribe a research perspective and try to provide methods or tools that support this perspective.

Due to space restrictions, the investigations in this paper had to be limited to AT and OS, using authoritative references by main proponents of the respective frameworks, namely: AT as presented by Kaptelinin and Nardi (2006), and OS as presented by Liu (2000). These references have been chosen because they represent a reasonable trade-off

between a comprehensive, an authoritative and an up-to-date account of the respective frameworks.

Among the frameworks that had to be omitted are the Language/Action Perspective (Goldkuhl and Lyytinen, 1982; Winograd and Flores, 1987), and Phenomenology contextualized for Human-Computer Interaction (HCI; Dourish, 2001). These have been compared to OS and AT in literature, although in different contexts. However, we are not aware of a juxtaposition of AT and OS.

3.2 AT in a Nutshell

Activity Theory (AT) is an "approach to the investigation of information technologies in the context of human practice" (Kaptelinin and Nardi, 2006; p. 3). It has its origins in cultural-historic psychology of the Russia of the 1920s and 1930s. Its two main underlying ideas are "the unity of consciousness and activity, and the social nature of the mind" (Kaptelinin and Nardi, 2006; p. 65). That is, the human mind comes to exist and can be understood only within the context of purposeful interaction between people and the world. Furthermore, human beings as well as the people and artefacts they interact with are fundamentally social.

AT's basic principles are object-orientedness, the hierarchical structure of activity, internalization and externalization, mediation, and development.

Object-orientedness, i.e. the direction of human activities toward their objects, implies that for understanding individually or collectively acting people, the analysis of the objects is a necessary requirement.

Activities are the basic unit of analysis in AT and are composed of actions which are composed of operations. Activities in AT are seen as subject-object relationships. An activity is oriented toward a motive, which is the objective, and which stimulates the subject. Actions are goal-oriented conscious processes. Operations are automatic processes which correspond to the way an activity is actually carried out within the limits of the conditions of the current situation. This three-level hierarchy is not fixed, e.g. an action can become an activity or an operation.

Internalization and externalization refer to the relation of the mind with its social and cultural environment. AT differentiates between internal and external activities, which cannot be understood in isolation. Tool mediation is a central concept in AT. Tools, or artefacts, reflect the experience of people who created or modified them, i.e. people who have faced similar problems, and thus transmit social and cultural knowledge during use. The relationship between the key components of mediation – subject, objects and tools – can change over time and can only be completely understood when including developmental aspects.

Apart from the form of AT presented so far, another common variant is Engeström's activity system model (Engeström, 1987) that explicitly considers collective activity. To this end the additional concept "community" is added to the subject-object relationship. Besides the known tools or instruments as mediators in the subject-object relationship, the following additional means of mediation are introduced: rules for the subject-community relationship, and division of labour for the community-object relationship. Furthermore, the outcome of the activity system, i.e. the transformation of the object by the activity, is included. The outcome can be used in other activities which would result in a network of different activity systems.

Activity systems are constantly developing, driven by contradictions that can arise on different levels in an activity network (Engeström, 1987).

In AT, a practice is the result of "certain historical developments under certain conditions" (Kaptelinin and Nardi, 2006; p. 71). Hence, AT requires the use of research methods that are able to capture and analyze developmental changes, and that are able to influence the process of development.

In HCI, AT has been used to understand, inform, evaluate and design interactions. An example of a tool is the Activity Checklist (Kaptelinin et al., 1999); an example for approaches to design informed by AT is Activity Based Computing (e.g. (Bardram, 2009)). Quek and Shah (2004) compare five activity-based methods for information systems development. They conclude that the examined methods either only consider a limited set of AT principles or only support a small set of development phases and that "further empirical research is necessary in order to validate the methods" (Quek and Shah, 2004; p. 228).

AT explicitly acknowledges the diversity of people by asserting that people need not only be seen in the social or collective context, but also as individuals. Related concepts for dealing with diversity are internalization/externalization and development, which build on AT's psychological base concepts such as Vygotsky's zone of proximal development (Vygotsky, 1978). Regarding evolving practices, a key premise of AT is that activities change over time, and that in order to understand an activity it has to be seen in the whole context of its historical development. As to conflict, AT provides different approaches, e.g. one that sees conflict under the aspect of "fissures" that are part of the change of technology due to creativity, reflexivity and resistance (Kaptelinin and Nardi, 2006), or one

that uses Engeström's (1987) taxonomy of conflicts. AT's concept of mediation corresponds to our Project's premise of an IT artefact being an enabler of practice and not the main purpose of interaction.

3.3 OS in a Nutshell

Organizational Semiotics (OS) is the study of organizations using the concepts and methods of Semiotics (Liu, 2000; p. 19), i.e. an organization is seen as a social system of people who employ signs to perform purposeful actions governed by norms. OS has its roots in the Semiotics of Peirce, Morris and others, and thus builds on basic semiotic concepts like the sign and semiosis.

OS subscribes to a radical subjectivist paradigm (Liu, 2000) that has also been described as "actualism" (Stamper, 2005), i.e. reality is seen as socially constructed by the behaviour of people (agents). Its basic ideas have been formulated as "there is no knowledge without a knower, and there is no knowing without action" (Liu, 2000; p. 26). People share patterns of behaviour that are governed by systems of norms. "Knowing" something is explicitly linked to the responsible knowing agent. As people interact, the (knowledge about the) world is constantly changing, which in turn changes the system of norms.

The semiotic framework of OS extends the traditional division of semiotics (syntactics, semantics, and pragmatics) by including physics, empirics and the social world. Physics is concerned with physical aspects of signs (e.g. signals and marks). Empirics is concerned with statistical properties of signs (e.g. patterns, noise, capacity with respect to different physical media and devices). The Social World is concerned with the effects of the use of signs.

In OS, an organization is understood as a layered information system consisting of an informal, a formal and a technical layer. The informal layer is that of meanings, intentions, beliefs, commitments, and responsibilities. The formal layer is that of bureaucracy, where parts of the organizational functions can be formalized by rules. The computer-based system in the technical layer is the relatively small part of the organization that can be automated.

Apart from agents (entities, who are either individuals or groups of people and who always act responsibly), key concepts in OS are affordances, norms and ontological dependency. The concept of affordance in OS is derived from the concept of the same name introduced by Gibson (1979). In the context of OS, the concept refers to invariants of social behaviour (see (O'Neill, 2009) for other uses of the concept relevant to HCI). An agent can be seen as a special type of affordance, namely one that can be attributed with responsibility. The type of relationships between affordances is one of ontological dependency, i.e. an ontological dependent affordance can be possible only if certain other affordances are available. Variable social behaviour is represented by norms. A norm is usually attached to an affordance and has a defined starting and ending time.

OS provides methods for understanding, informing, evaluating and designing information systems. Apart from the domain of Information Systems (cf. (Liu, 2000) for examples of methods) it has also been used by HCI researchers (e.g. (Bonacin et al., 2005)).

OS mainly acknowledges the diversity of people by subscribing to a subjectivist paradigm, in which conflicts regarding language, language use, communication, etc. occur. Regarding the emphasis of the individual, although agents and affordances usually refer to universal patterns of behaviour, it is also possible to consider a particular instance. Regarding evolving practices, the more dynamic or volatile aspects of the socially constructed reality are defined by norms, which in OS are always associated with an affordance and which have a start and end date. Thus, a change in a practice would mean that certain norms would be replaced by new ones. OS offers two approaches to dealing with conflict. The first is to adopt an information field view, as opposed to the more common information flow view. This means that organizational change, and hence the potential for conflict, is interpreted as the consequence of the influence of various information fields consisting of agents acting under the respectively same set of norms. The other approach is to require that all meaning is socially constructed by all involved stakeholders, which is e.g. reflected by the Problem Articulation Method (PAM), which has a dedicated step for the stakeholder analysis. Our premise of the IT artefact as an enabler of interaction corresponds to the notion of the organization as a layered information system in OS, whereas the technical information system is only a relatively small part of norms and procedures that can be automated.

4. AT AND OS IN THE DESIGN CYCLE

In this section, we investigate how AT and OS support the different stages of the IxD cycle. Since there are many IxD process models and since the purpose of this paper is not to review or prescribe

process models, we assume in this section a cyclic model that consists of the stages of understanding, informing, conducting and evaluating design. Cyclic models with these or similar stages are often used in HCI research or design projects (Harper et al., 2007). In the following subsections we first consider AT and OS separately and then investigate possibilities of using both frameworks together.

4.1 AT as a framework for IxD

Regarding AT, one possibility to understand, inform, execute and evaluate design using AT is directly applying its principles. A comparison of methods and tools that support the different stages of understanding, informing, executing and evaluating design can be found in (Quek and Shah, 2004). Apart from these general purpose tools, researchers or designers frequently create tools that are customized for a concrete problem (e.g. (Bertelsen and Bødker, 2003)).

In order to better understand our problem, it could be analyzed under the perspective of the core principles of AT. Regarding our design problem, for example, the overall motive or objective towards which all activities are directed could be described as "to better attend students with special needs in integrated classrooms". Teachers are not necessarily conscious of this objective when they are engaged in activities during their work. Examples of activities that could be mediated or supported by digital artefacts are the elaboration, implementation and follow-up of plans. Consequently, a possible goal, which still could be further organized into subgoals, could be the creation of a plan, which involves actions like describing, discussing and clarifying problems encountered by a student in class, which could be further decomposed into making comments, writing a problem description, etc. Possible examples of operations, which are on the lowest level of the hierarchy, are submitting forms, posting a file, etc. Depending on breakdowns, the conditions of the environment, and externalization/ internalization, operations might become actions and vice versa.

An example method for informing design is the approach to requirements elicitation by Martins and Daltrini (1999). However, their approach (as well as other approaches we found in HCI-related literature) considers only a limited subset of AT principles. Thus, an alternative would be to directly apply AT's core principles or Engeström's activity system model and taxonomy of conflicts. This would, for example, lead to an investigation of potential conflicts regarding goals facilitated by the system to be designed and goals of other activities. One possible result of this investigation could be the detection of a conflict between the goal of fostering community development realized during face-to-face meetings on the one hand, and the electronic mediation of case discussions and plan elaboration that would limit the need for face-to-face meetings on the other hand. In order to resolve this conflict, the system should for example enable teachers to socialize online, to plan "offline" activities, and to register the results of those activities (e.g. photos, accounts written by participants).

An example of a tool that guides a designer in applying AT's principles is the Activity Checklist (Kaptelinin et al., 1999). This checklist is intended to be used at early stages of design or during evaluation. When used for design, Kaptelinin et al. propose to apply the checklist in a breadth-first manner, in order to identify the relevant areas of interest, and to subsequently examine specific issues as required. Furthermore, Kaptelinin et al. (1999) state that the checklist is best used together with other tools and techniques. Although the "design version" of the Activity Checklist has been proposed to support design activities, in our view, the items on this list are of a rather conceptual nature and are better suited for clarifying or informing design. In our understanding, if a theory or framework not only informs design, but actually can be used to conduct design, it should provide methods or tools that reflect the theory's or framework's key concepts. In the case of AT, to our knowledge non-existent examples would be Computer-Aided Software Engineering tools such as code generation from an activity hierarchy, or a domain-specific modelling language with constructs that support the externalization of operations.

Regarding the evaluation of a design, Kaptelinin et al. (1999) propose the "evaluation version" of the Activity Checklist as a support tool. The checklist would for example uncover if the system is lacking support for required actions, if there exist conflicts between goals, if the system is consistent with and relevant to people's practices and integrated with other tools, if it supports dealing with breakdowns, if it is effectively oriented toward the object, or what effect the system has on the development of people's practices.

4.2 OS as a framework for IxD

OS offers a variety of methods and tools that can be applied during different stages of the life cycle of an information system. Regarding the understanding of our design problem, OS offers the PAM, the objective of which is to construct a shared understanding of a problem among all involved

stakeholders. One of the steps of the PAM is the stakeholder analysis, during which all stakeholders and their involvement in the problem are identified. This includes stakeholders who might not even be users of the technical system, but who might influence its design or use. Considering our design problem, the stakeholder analysis would identify the special education teachers as one of the main stakeholders with the most involvement. It would also identify health professionals, students' family members, students with special needs and their classmates, school administration and other staff, municipal, state and federal education secretaries, etc. In order to consider all stakeholders and their concerns adequately, the stakeholder analysis should be performed with collaboration of involved stakeholders. That way, it is ensured that concerns of all identified stakeholders are considered and that the language and terms used are those of the stakeholders and not of an external analyst. For example, depending on the identified stakeholders, "students' family members" could appear as a finer grained list of "father, mother, brother, sister, etc." or "parents, siblings, etc." The stakeholder analysis would also clarify the issue of whether and to what extent the different stakeholders should be considered during design and as users of the technical system.

The PAM as one of the phases of MEASUR ("Method for Eliciting, Analyzing and specifying Users Requirements"; (Stamper et al., 1988)) can be also used for requirements elicitation and thus contributes to informing the design. For example, the application of the semiotic framework might reveal that Internet access for some of the teachers is slow and unreliable, and that some teachers only have access to the Internet from within the school. This might generate the requirements that the core or all functionalities should be accessible with low bandwidth connections, that a central server component for buffering synchronous communication might be required, or that videos should per default be played with low volume or muted audio in order not to disturb other teachers in the teachers' lounge. Examples of other relevant MEASUR phases that inform design are the Semantic Analysis Method (SAM) and the Norm Analysis Method (NAM). The SAM identifies agents and affordances and their ontological dependencies, and thus the invariant aspects of the information system. Apart from universals (e.g. "school"), also relevant particulars (e.g. "Springfield Elementary School") can be considered. For example, the affordance "to discuss" is ontologically dependent on the affordance "case" and the agent "person", i.e. in order to discuss a case, a person and a case must exist. The result of the NAM is a specification of relevant norms that are valid for an agent or an affordance at a given point in time. For example, different norms of the affordance "discuss" would specify who may discuss a case under what conditions.

As to conducting actual design, core OS supports some important qualities of a solution to our design problem, such as facilitating change and conflict resolution by using norms and concepts like the semantic temporal database, which facilitates the execution of the technical information system in concordance with the currently valid norms as well as the documentation of the evolution of practices and resolution of conflicts by maintaining a historic record of all norms. However, regarding tool support or the question of how an interaction designer should design the system, OS offers not much. Approaches by some researchers to use OS concepts such as ontology charts and norms for supporting the design of qualities like adaptability (e.g. (Neris and Baranauskas, 2009)), or code generation from ontology charts (dos Santos et al., 2008) are relatively recent and require additional work until being able to be used by designers.

Regarding the evaluation of the design, OS offers relatively little. The requirements and other documents resulting from MEASUR can be compared with the actual results of the design in order to verify whether all requirements have been considered. However, this is only one part of an evaluation that does not completely cover HCI-related aspects such as how easy a change regarding a practice can be performed, or how well users adopt a changed practice. OS can be used to inform e.g. the definition of an evaluation tool, but no ready methods, principles or guidelines exist.

4.3 Juxtaposing AT and OS

We have shown how AT and OS put different foci on different aspects of a design problem. Both frameworks subscribe to the notion that reality is constructed and understood through social action. While AT emphasizes tool mediation of actions and the context in which mediated action occurs, OS emphasizes sign mediation and the conceptualization of the semantic aspects of mediation.

One issue frequently discussed in literature is the dual, i.e. material/instrumental and symbolic/ semiotic, nature of activities. Remembering that an activity in AT is the mediated relationship between a subject and an object, the subject can be seen as corresponding to an agent in OS. Although Bødker and Andersen (2005) map the activity's object to the object in the triadic semiotic sign, this mapping is not bi-directional: while the object of an activity

may be conceptualized as the object of a sign, the object of a sign is not necessarily the object of an activity. The object of an activity is made explicit during an AT-informed analysis. However, while being engaged in an activity, a person is not necessarily conscious of its object. Analogously, for a successful semiotic action, the person inevitably needs to perceive and interpret the representation, but not necessarily the object.

Bødker and Andersen (2005; p. 366) map mediators to representations (Figure 1): "A Subject applies a Mediator to transform an Object but the activity is reflexive and is always interpreted; the Mediator is taken as a Representation of the actual or intended state of the Object under a certain habit of interpretation given by the Interpretation." Using one of Bødker's and Andersen's recurring examples, a "command" does not always represent an "actual or intended state", i.e. the outcome when the command is obeyed and carried out without breakdowns. E.g. depending on the characteristics of a ship and a landing place, and depending on the skills of the captain, when docking a ship (intended state), a series of commands might be necessary (reverse, forward, left, right) that do not always represent an "actual or intended state".

If we see a command as a sign, and not as a representation, considering the context, i.e. AT's environment and OS's information field, the command affords obeying and execution. Thus, additionally to investigating the material-semiotic dichotomy on the sign level, we think that it might be also fruitful to investigate it considering OS's affordances and norms, as well as Engeström's activity system model.

Regarding our design problem, most actions mediated by the system are predominantly symbolic, e.g. the elaboration and discussion of a case description. An example of actions that have a strong instrumental character is the implementation of the plan. Possible mediators of the implementation are the plan and the functionality of giving and discussing feedback of the plan's implementation. Taking only the plan as an example to illustrate implications for design regarding the dual nature of actions, AT contributes with the concept of internalization/externalization. The plan is an instrument that can be used to externalize actions, i.e. to enable collaboration between teachers, health professionals and other stakeholders. In addition, AT facilitates to conceptualize the system of actions and goals defined by the plan, and thus enables to define who needs which information or tools in order to best implement that plan. OS on the other hand serves to identify semantic and pragmatic aspects of the plan implementation. It supports the identification of the stakeholders and the definition of the system of norms in which they act, i.e. the definition of who may or has to act under which conditions.

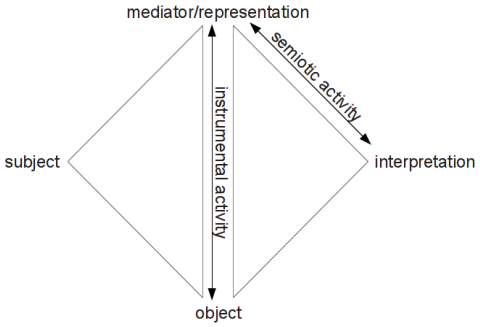

Figure 1. Instrumental and semiotic activity (adapted from (Bødker and Andersen, 2005; p. 367)).

Another central concept in AT is "development". Although AT supports capturing and analyzing the development of people's practices and thus implies that a system, which mediates people's practices, has to facilitate practice development, it is not always clear how to implement this requirement. OS offers the concept of norms that have a defined start and end date, i.e. the development of practice can be implemented by expiring old norms and putting into effect new ones. Although change and development are supported by OS, the change or development process generally is not made explicit to the users of the resulting information system. AT thus could bring affordances that emphasize developmental characteristics to the attention of semantic analysis. An example for our design problem would be a gallery of case discussions that reflects how the discussion practice has evolved over time.

We argued that AT and OS are adequate for understanding and informing design but that they show some gaps regarding the actual design activities and design evaluation. Few general AT- or OS-influenced design or evaluation methods exist. Often researchers or designers adapt existing methods to a specific problem. Regarding OS, methods and formalisms exist that are independent of the problem domain, but that are not straightforward to apply to design and evaluation. On the other hand, AT is strong in defining complex hierarchies of activities including systems of objects and goals but lacks more general formalisms that are easy to transform into implementations. Thus, we argue that AT can benefit from investigating how activities and objects are related to affordances and norms, while OS might narrow the gap to design when investigating how its semantic models relate to possible user's activities, actions and operations.

Regarding our design problem, AT and OS also have their limitations. Important aspects of our design problem include questions such as how a community can constitute itself, how its members can be motivated to continuously engage themselves and develop the community, or how to deal with newly arising usage scenarios, i.e. if users don't use the system to elaborate plans as originally intended by the designers but as a repository of "ready-made solutions". These questions have intersections with areas such as Ethnomethodology, Experience Design or Persuasive Design. Although AT and OS provide some pointers, additional research is required to determine whether AT and OS might be extended accordingly or whether additional frameworks need to be employed to address these questions.

Regarding a "comparison" of AT and OS, both frameworks subscribe to similar ontological and epistemological assumptions and do not prescribe a priori which methods to use, how to employ tools, etc. However, empirical methods targeting at eliciting concrete differences of applications of AT and OS such as trying to solve the same design problem twice, once with AT and once with SO as theoretical frame of reference, are impractical.

There exists a substantial body of scientific literature about both frameworks and some successful cases of adoption by practitioners. However, neither AT nor OS have reached a greater degree of practice adoption. There are a number of possible reasons for this. The basic assumptions that these frameworks make might seem too radical for practitioners. The adoption of AT or OS in their current forms requires a significant amount of time and effort in order to understand each framework. When applying AT or OS, the interdependency between design (or the design principles) and the design problem is acknowledged, i.e. the design affects how the involved stakeholders perceive the design problem, and the design problem affects how design is performed. AT explains this with the interdependency of activity and object/outcome, and OS with the information field paradigm. Thus, instead of providing the designer with a large set of general tools, guidelines or principles, the frameworks require the creation or adaption of methods to the context of the current problem.

A complementary use of both frameworks as hinted to in this paper would not contribute to a higher adoption in practice, since the combination of both would add further complexity. In order to promote the adoption by practitioners, further work is required to investigate if and how a combination of both frameworks could lead to more generally applicable methods and techniques that require less theoretical knowledge than today.

5. CONCLUSION

When having to choose a conceptual framework for guiding the different stages of a design process, it is often not clear which are adequate frameworks and how the choice of a framework affects the different stages of design. Based on a real-world background scenario, we have shown how the socio-technical context (teachers in the public school system of a country of continental dimensions; large diversity regarding socio-economic aspects, culture, and access to information and communication technology) as well as the experiences, attitudes and skills of the involved people (previous projects, multidisciplinary mix, stance towards ontological, epistemological and pedagogic questions) provide filters for the choice of a framework.

We have then given an overview of AT and OS and illustrated commonalities as well as how each of the two frameworks differently addresses certain aspects of our design problem. Both frameworks are highly reflective in nature and provide a comprehensive account of the context of a design problem. The account provided by OS is arguably more comprehensive since also stakeholders who do not participate in any activity are explicitly considered. Although providing different approaches, AT and OS consider the diversity of users as well as evolving practices that might be subject to conflicts. Both frameworks support the stages of understanding a problem and informing the design of a possible solution adequately but have some shortcomings regarding the actual IxD and its evaluation, especially regarding tool support for interaction designers.

Although the purpose of this paper was not to propose a synthesis or integration of AT and OS, we have found evidence that the frameworks might complement each other regarding certain aspects of a design problem. However, further work is required to investigate an extension or complementation by additional frameworks.

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Appendix B

Identifying Pragmatic Patterns of Collaborative Problem Solving[1]

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IDENTIFYING PRAGMATIC PATTERNS OF COLLABORATIVE PROBLEM SOLVING

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ABSTRACT

Collaborative Web applications for problem solving are not restricted to well-defined organizational environments, where people know each other and might use additional communication mechanisms, such as face-to-face meetings. In the Web, users of different cultures and with different educational and professional backgrounds communicate with each other independently of location and time. This might result in problems during users' interaction regarding communication and understanding, as well as interpretation of contents. Consequently, when designing Web applications that support communication and collaboration, it is crucial to take into account the influence of pragmatic aspects in addition to syntactic and semantic ones. In this paper, we consider four case studies of Web application usage for collaborative problem solving in the domain of special education. Based on these case studies, we propose pragmatic patterns of collaborative problem solving in the Web. These patterns are recurring situations of use which might require design of solutions that facilitate, promote, or avoid the manifestation of the pattern. The patterns aim mainly at promoting the consideration of pragmatic aspects, such as interpretation or intention, during design of collaborative Web applications.

KEYWORDS

Pragmatic Web, Design Patterns, Intentions and Communication, Interaction Design, Organizational Semiotics

1. INTRODUCTION

With the massification of the Web, people with different cultural, social, and individual backgrounds interact with each other via Web-based applications, sharing problems and solutions related to both professional and personal life. Consequently, computational systems for collaborative problem solving are no longer restricted to specific organizational contexts. These systems are ever more present in people's lives and provide opportunities regarding lifelong learning and professional development. However, due to the diversity and comprehensiveness of the Web, communication becomes more and more complex and entails various design challenges. Hence, it has become crucial to consider aspects of human communication during the Interaction Design (IxD) of these systems.

A key element of human communication is the inherent ability to express and interpret intentions. Intentions determine the purpose of human communication and are an essential part of it. During face-to-face communication, people use a variety of mechanisms, such as facial expressions, gestures, inflection, etc. These are determined by linguistic, social, cultural, and other aspects which delimit the participants' behavior and provide common ground. However, these mechanisms related to Pragmatics are not always available (or visible) during written or computer-mediated communication.

According to Morris, Pragmatics is concerned with "the origin, uses and effects of signs within the behavior in which they occur" (Liu 2000, p.13), with aspects such as intentions, communication, conversations, negotiations,

etc. Also, Pragmatics is a field of study in various areas related to Human-Computer Interaction (HCI), including Linguistics, Semiotics, Philosophy, and Sociology.

In a Web-based system, the interpretation of content constructed during a collaborative problem solving process (e.g., messages, discussions, documents) depends on the analysis of the participants' intentions. An interpretation might, among others, have an impact on the further solution process as well as on information retrieval and the reuse of solutions in future problems. Although there exist design solutions that enable users to explicitly express their intentions (e.g., by marking messages with images that express intentions), few works explicitly investigate the impact of pragmatic aspects in the IxD of Web applications for collaborative problem solving.

In this paper, we investigate how pragmatic aspects present in text messages exchanged between users or read by observers influence the use of a system for collaborative problem solving. We identified "pragmatic patterns" that may support the design of collaborative Web applications for problem solving. Our work has foundations in the Pragmatic Web field, which can be understood as a Web concerned with the problem of augmenting human collaboration by appropriate technologies (Schoop et al. 2006). Proposed as an extension or complement to the Semantic Web (Berners-Lee et al. 2001), the Pragmatic Web is concerned with topics such as context and negotiation of meanings in the Web (Singh 2002, Schoop et al. 2006).

The empirical data for the present paper was collected during activities of the "*Redes Sociais e Autonomia Profissional*" (Portuguese for "Social Networks and Professional Autonomy")[1] Project, a project in the context of computer-mediated lifelong learning of special education teachers. Four case studies in different Web applications were analyzed. Based on the case studies, we extracted "pragmatic patterns", inspired by the Design Patterns of Software Engineering (Gamma et al. 1994). The proposed patterns represent recurring situations in which Pragmatics potentially have an influence on the use of these applications, and indicate potential difficulties of users that demand specific design solutions.

This paper is structured as follows: the second section presents the theoretical and methodological foundations, i.e., Organizational Semiotics and the Pragmatic Web, including related work; the third section presents the identified patterns; the fourth section discusses the results and concludes.

2. FOUNDATIONS AND RELATED WORK

In this section, we describe the theoretical and methodological foundations of this paper, i.e., Organizational Semiotics and the Pragmatic Web. Furthermore, we present related work.

Semiotics can be described as the theory of signs. In Peircean Semiotics, "a sign is something […] which denotes some fact or object […] to some interpretant thought" (Peirce 1931-1935, vol. 1, par. 346), and which involves a signifier (or representamen), a signified (or object), and an interpretant. Organizational Semiotics (OS) is a branch of Semiotics that understands and investigates organizations as systems of signs. OS studies the nature, characteristics, functions and effects of information and communication in organizational contexts. An organization is considered a social system in which people behave in an organized manner, and in which organizational behavior is shaped by a system of norms as well as by people's individual or joint communication and interpretation of signs (Liu 2000). Hence, we understand the context of a Web-based system for collaborative problem solving as an organization in which certain rules apply that define, for example, communication among participants or expected behaviors.

The concept of Pragmatics in OS is understood as the relations between the intentional use of a sign and its effects on people in a social context (Liu 2000). According to Liu (2000), communication is successful when a meaningful sign is used with an appropriate intention between the speaker and the listener. In pragmatic analysis of human communication, a communication act is the minimal unit of analysis. A communication act is a structure consisting of three components: the speaker, the listener (the addressee or an observer), and the message. A message has two parts: the content and the function. The content manifests the meaning, while the function specifies the illocution, which reflects the intention of the speaker. Liu (2000) groups illocutions into three dimensions: time, invention, and mode. Besides of illocutions, also the effects they produce on a listener have to be considered, which are called perlocutionary effects.

The Pragmatic Web investigates topics related to context and meaning negotiation in the Web (Singh 2002, Schoop et al. 2006). The concept emerged to address some critical issues of the Semantic Web, e.g., the

[1] http://www.nied.unicamp.br/tnr

complexity of content creation and maintenance (McCool 2005), and the underestimated consideration of context (Singh 2002). In this paper, we apply the concept of the Pragmatic Web under the perspective of IxD (Hornung and Baranauskas 2011), under which interaction among people is based on intentions that are materialized by Web-mediated communication acts. Additionally, interaction is supported by collaborative practices.

The Pragmatic Web is directly related to the question of how knowledge is constructed and how it evolves during Web-mediated collaboration. The focus of investigation is on the interaction among people and not on the mediating artifact (the Web) or on the interaction of the people with the artifact.

Although the consideration of pragmatic aspects in systems design has been explored in recent literature (Hornung and Baranauskas 2011), there is still need to define how these aspects can be utilized to concretely inform the design and to support the use of systems. This paper investigates the concept of pragmatic patterns of interaction as a means to consider pragmatic aspects during systems design and use.

The concept of pragmatic patterns has been investigated in Pragmatic Web literature. De Moor (2005) proposed the concept in order to operationalize processes of meaning negotiation and evolution. In his approach, patterns are related to different types of individual and common contexts in communities, and defined upon various parameters. The concept has been applied in the domain of clinical knowledge management: Falkman et al. (2007) present a study regarding the identification, modeling and use of pragmatic patterns for clarifying contextual factors and communication activities in the domain of professional health care. Besides the area of the Pragmatic Web, pragmatic patterns also have been investigated in Linguistics. For example, Dam-Jensen and Zethsen (2007) conducted a linguistic corpus analysis considering pragmatic aspects via patterns. They investigated the relations between lexical meaning and the context where these meanings are inserted.

Despite improvements pointed out by these investigations, the use of the concept of pragmatic patterns in the area of the Pragmatic Web so far is on a rather conceptual level, while in Linguistics, the concept is not applied to the design and use of collaborative Web applications.

3. PRAGMATIC PATTERNS OF COLLABORATIVE PROBLEM SOLVING

In this section, we propose pragmatic patterns and illustrate their impact on the design and use of Web applications for collaborative problem solving. Section 3.1 presents four case studies and how the data collected during these case studies was analyzed. Section 3.2 describes the identified pragmatic patterns.

3.1 Case Studies

The case studies are situated in the context of lifelong learning of Brazilian special education teachers. In Brazil, inclusive education policy established the Special Education Service (SES), in which teachers work in classes equipped with specialized resources to support different types of special needs of students.

Aiming to capacitate the SES teachers, the Ministry of Education provided an 18-month distance-education course for them. During this course, teachers learn to discuss so-called “cases” of students with special needs to propose an educational action plan for them. In Brazil, special needs are divided into seven categories: visual, auditory, motor, intellectual impairment, intellectual giftedness, pervasive developmental disorder, and multiple impairments. During the course, teachers discuss cases related to each type of special need, and try to elaborate educational action plans for each case in a collaborative way. After concluding the course, however, they generally have no adequate support for solving their own cases collaboratively, and often act in isolation in their respective work-places.

Motivated by this context, one of the objectives of the “Social Networks and Professional Autonomy” research project is to create an inclusive social network for supporting collaborative case discussions. The project team adopts participatory methods and consists of researchers from the areas of Education and Computer Science, as well as of 28 SES teachers from all five geographic regions of Brazil, namely four specialists of each type of special needs.

The first stage of the project comprised the exploration of different Web-based systems in order to analyze how already existing solutions could support the collaborative discussion of SES cases. To this end, four different case studies were conducted in sequence, and in each of them, a different system was utilized for discussing a different case. All 28 participating teachers had concluded the distance-education course prior to the four case

studies. The four utilized systems were[2]: 1. *Yahoo! Answers*®, a system that affords a "one question, multiple answers" style of "conversation"; 2. *ACBP-Sakai*, a problem-based learning environment that affords collaborative knowledge construction using artifacts from Organizational Semiotics; 3. *LeMill*®, a Web community for creating and sharing educational resources that affords forum-like discussions, among others; and 4. *Vila na Rede*, an inclusive social network system that affords a weblog-like conversation (i.e., posts with subsequent hierarchical comments), among others.

Afterwards, messages produced in the four systems were analyzed in three steps. As presented by Bonacin et al. (2012), the *first step* concerned the analysis of interaction including quantitative aspects. The interactions (e.g., comments, questions, answers) among users during the problem solving were enumerated and analyzed in a temporal order, resulting in an interaction graph. The activity of the network was also observed. An expected result of this analysis was, e.g., that due to the simple question-answer style in *Yahoo! Answers*®, there were much less interactions between users than, e.g., in *LeMill*® or *Vila na Rede*, and single messages in *Yahoo! Answers*® were much longer. Comparing *LeMill*® and *Vila na Rede*, conversations in *Vila na Rede* were longer, i.e., involved a larger number of message exchanges between users, probably due to the nested comment structure in *Vila na Rede* versus the linear threads in *LeMill*®. The *second step* involved the examination of the communication based on the pragmatic analysis presented in Liu (2000). We proposed the use of this technique since it provides a structured way to analyze pragmatic aspects in messages. In this step, the different illocutions in each posted message were analyzed manually, i.e., for each message, the illocutionary acts (propositional contents carrying intentions) where identified and illocutionary types assigned, i.e., we analyzed whether the illocution was predominantly a proposal, an inducement, a forecast, a wish, a palinode, a contrition, an assertion, or a valuation. The *third step* synthesized the results of step one and two. Graphs showing the evolution of the illocutionary acts were produced to facilitate the analysis. In this step, we could visualize, e.g., that in *Yahoo! Answers*®, large phases of the "case discussion" were predominated by "proposals" (i.e., direct answers to the posted question), while there was a much larger variety of illocution types in *LeMill*®, which indicates a more engaged discussion.

After the analysis presented by Bonacin et al. (2012), five HCI specialists conducted a collaborative analysis and identified interaction problems regarding pragmatic aspects. The goal of this analysis was to explore, whether "interaction problems" could be traced back to or explained with pragmatic aspects such as illocution types. The analysis was conducted in two directions, i.e., from a textual analysis to the analysis of the illocution types and vice versa. During the textual analysis, we took the role of a user that observed the case discussions after they happened and identified peculiarities, e.g., breakdowns, aborted discussions, unclear arguments, etc. These were linked back to the analysis of illocution types in Bonacin et al. (2012). In the opposite direction, we identified distinctive features of the illocution analysis, e.g., long sequences of same illocution types or blocks with many different illocution types, and analyzed the corresponding moments in the discussion. Each identified interaction problem was documented in the following format: title, examples (i.e., sequences of users' posts), summary (stating why it is considered an interaction problem from the pragmatic point of view), and comments (discussions with other specialists).

Based on impacts and recurrence, eight patterns were identified and discussed. Due to space restrictions, only four pragmatic patterns are presented in the next section: "incentive or reputation mechanism", "coordination of practice", "consolidation of a scattered conversation", and "conversation about the use of the computational system". The patterns not presented in this paper are "non-substantial messages", "contrition and palinodes in the problem solution process", "conversation about best practices", and "synthesis of discussion results". The pattern "non-substantial messages" refers to messages like greetings, praise or other messages with the purpose of socialization. These messages are important to foster community cohesion, but might introduce "noise" if they occur very frequently. The pattern "contrition and palinodes in the problem solution process" refers to situations where a user retracts a previous statement and regrets that he/she made a mistake. Making, detecting and correcting mistakes are important in the contexts of lifelong learning and professional development. At the same time, these can generate awkward situations for the user who made the mistake. The pattern "conversation about best practices" refers to situations in which participants reflect about what are best practices, e.g. how to best discuss a case. The pattern "synthesis of discussion results" refers to situations where the various strands of a discussion require conclusion and synthesis. The four patterns presented in this paper were chosen because they present four distinctive classes of interaction problems. The patterns omitted from presentation share some overlapping parts with the presented patterns. Furthermore, experiences from previous research projects the

[2] 1. http://br.answers.yahoo.com; 2. http://styx.nied.unicamp.br:8082/portal; 3. http://lemill.net; 4. http://www.vilanarede.org.br.

authors participated in suggest that the four presented patterns also apply to other collaborative contexts than that presented in this paper.

3.2 Identified pragmatic patterns

The concept of design patterns originated in Architecture (Alexander 1977). In Computer Science it was first applied in the area of Software Engineering (Gamma et al. 1994). A pattern is a description of a recurring solution to a common problem. Generally, it is not a ready-made solution that can be directly transformed into a design or code, but a description of how to solve a problem in different situations. The concept of patterns is also present in HCI, e.g., as "user interface patterns" (e.g., Tidwell 2011). An important function of a pattern is its use as a means of communication between designers and other stakeholders.

In the context of this paper, a "pragmatic pattern" refers to pragmatic aspects of Web-mediated interaction, i.e., relevant aspects include, among others, illocutions (which reflect the intention of the speaker), and perlocutionary effects (the effect of a communication act on a listener). The pragmatic patterns proposed in this paper differ from the previous use of this concept in Linguistics or in the Pragmatic Web. Differently from Linguistics, the patterns described in this paper do not only describe pure linguistic phenomena, but also consider their relation to IxD. Regarding patterns for the Pragmatic Web, as described, e.g., by de Moor (2005), the patterns proposed here are of a lower level of abstraction, i.e., they are oriented towards more concrete and more specific problems, which we expect to facilitate their application in the domain of IxD.

We adopted the following structure to describe the pragmatic patterns: a descriptive *pattern name*, that facilitates communication between designers and other stakeholders; a short *pattern description*; a *rationale*, i.e., an explanation of why the pattern is relevant; the *relevant pragmatic context* for identifying and understanding the problem, as well as for applying the solution; a *problem description*, using techniques such as scenarios and a language style that can be understood by all involved stakeholders; *problem examples* to illustrate the problem; a proposal of a *solution approach*, or identification of open research problems; and a *comments* section for discussing the problem, the occurrences of the pattern, etc.

Differently from design patterns, pragmatic patterns depend on factors of the pragmatic context. The pragmatic context comprises, but is not limited to the participants in a communication act, the illocutions and perlocutionary effects, shared pragmatic information (e.g., cultural or social background), theme, time, location, and psychological states. It is worth noting that the description of a pragmatic pattern cannot include a general solution that applies to any context, but only examples of the problem and approaches to a possible solution that have to be tailored to the respective context. In order to promote the use of patterns in different project contexts, or in participatory design activities, the patterns might have to be re-written using a language that can be understood by the respective stakeholders. Due to space restrictions, we omit the comments in our pattern descriptions. Identified patterns are shown and discussed as follows.

Pattern name: Incentive or reputation mechanism

Pattern description: the system offers an incentive or reputation mechanism to promote a certain user behavior (e.g., substantial/pertinent participation, offering help to other users, etc.). The mechanism should be built in a way that avoids manipulation by users.
Rationale: the mechanism can promote the goals of a virtual community (e.g., conduction of successful practices). Manipulation of the mechanism by users might hinder practices and de-motivate or disturb other users.
Relevant pragmatic context: relations between users (e.g., hierarchies, authority), illocution sequences.
Problem description: one objective of providing incentive or reputation mechanisms is to promote engagement or a specific user behavior. Research challenges include the questions of how to actually promote a desired behavior (Fogg 2009) and how to avoid manipulation. For both questions, the consideration of the pragmatic context is necessary. For instance, in the case of virtual communities, community goals have to be aligned with individual intentions. Defining incentive or reputation mechanisms based on quantitative approaches, e.g., based on syntactic (e.g., number of comments), semantic (e.g., number of posts clustered by posting type and content), or "pseudo-social" aspects (e.g., number of recommendations from other users, which might include fake accounts, recommendation by reciprocity or courtesy, etc.) are potentially subject to manipulations.
Problem example(s): in *Yahoo! Answers*®, a user gets "points" and advances levels by posting a reply to a question, or when his or her post is voted the "best answer". The case discussed by the teachers was posted as a "question", and thus open to any user registered at the service. A user from outside of the group of participants (SES teachers) answered "interesting" in three of the four identical questions and did not leave any substantial or

pertinent comment (since *Yahoo! Answers*® has a time limit for responding to a question, the same question was posted consecutively four times in order to match the duration of the scenario). The same user also pasted an "answer" that he copied from another website that discussed problems from the same domain, and that, in fact, was not an answer at all. Nevertheless, his post was voted the "best answer" with a single vote (the SES teachers did not vote, since it was not an objective of the activity).
Solution approach: a definition of an incentive or reputation mechanism depends on the characteristics of the pragmatic context. For example, in small communities, or in communities with authority relations (e.g., without a moderator or coordinator role) or high cohesion between members (e.g., closed communities of interest), simple mechanisms might be sufficient (e.g., "vote for the best case of the month"). In order to discover manipulations, an analysis of the illocution sequences could be an indicator: often the illocution type of the manipulator is not compatible with the expected perlocutionary effect of the referring locution. For instance, in a sincere conversation a request (illocution type "proposal") often is followed by a response (illocution type "proposal") or a request for additional details. If it was followed by an appreciation (the "interesting" in the example; illocution type "valuation"), this could be evidence of an attempt to manipulate the reputation mechanism.

Pattern name: Coordination of practice

Pattern description: when collaborating, people need to negotiate or coordinate the start, interruption, continuation, or conclusion of different parts of a practice.
Rationale: a community's practices should permit adaptation to different situations. In communities that have no absolute leader who determines the conduction of a practice, this has to be coordinated among the participants.
Relevant pragmatic context: relations between users, description of the practice and the object of collaboration (e.g., the problem, in the case of collaborative problem solving), participants' illocutions.
Problem description: a community's practices are often complex, i.e., they consist of different parts (e.g., steps) with different relations (e.g., sequences), and permit a certain flexibility of conduction. Depending on the object of collaboration and participants, it is not always clear how to conduct the practice, e.g., when to advance to the next step. Depending on the practice and the community's norms, there might exist various understandings among the participants regarding when to advance or even which alternative way to choose. The participants need to be able to recognize when there exist different understandings regarding the conduction of the practice, be aware about possible alternatives, and coordinate how to proceed. Depending on community norms, it might even be possible or desired to permit a certain divergence among participants and a later consolidation. In learning environments, for example, flexibility and divergence are often desired, because participants may want to learn or improve the conduction of a practice.
Problem example(s): in *LeMill*®, we observed a discussion among various users about beginning the next phase of the practice. The practice in this case was divided into the sequential phases "case proposal", "discussion", "solution", "elaboration", "plan proposal". Some users wanted to start the phase "elaboration", while others preferred to continue the phase "solution". After some message exchanges with arguments for and against each position, some users started the "elaboration", while others remained in the "solution" phase. Later, the two subgroups converged and continued together in the next phases.
Solution approach: regarding the question of recognizing alternative ways of practice conduction, independently of other characteristics of the pragmatic context, users should have access to a description of the practice and the collaboration object. For example, there could be a graphical overview of the steps of a process. Flexibility of practice conduction could be made possible via respective process structures. Regarding the identification of different understandings about practice conduction, these situations are characterized by "communication messages" (instead of "substantial messages") with sequences of proposals and counter-proposals.

Pattern name: Consolidation of a scattered conversation

Pattern description: conversations between people might be scattered throughout different areas of a system, e.g., two users might converse about a single subject in two different threads of a forum. This pattern targets the consolidation of scattered conversations.
Rationale: consolidating a scattered conversation might facilitate the understanding of its contents, and, consequently, participation (e.g., argumentation) for both users new to the conversation and already existing participants (e.g., when the conversation stretches over a period of time).
Relevant pragmatic context: the conversation topic, participants and their shared pragmatic information, elements of the conversation and their pragmatic function (e.g., proposal, argument for or against).

Problem description: during written conversation in online systems, interruptions frequently occur. Examples of synchronous conversation are instant messengers (when two users talk about multiple subjects "at the same time") or chat rooms (when various users have various simultaneous conversations). Examples of asynchronous conversations are discussion forums, when a user takes up the conversation responding in a thread different from the originating one. As a consequence, participants and observers sometimes are unable to follow the conversation, even more so in conversations with the objective of reaching consensus or debating a topic.
Problem example(s): in *Vila na Rede*, some users discussed the specific characteristics of a "young adult education (YAE) class". There were diverging opinions regarding advantages and disadvantages of YAE and regarding whether the student of the case under discussion should participate in this kind of class. The message exchanges were scattered over different sub-trees of a discussion thread, and in the end, the discussion suddenly terminated without a consistent conclusion. For an external observer, it was not clear why the discussion terminated, if the participants did not continue because they no longer thought the question was relevant to the case solution, or if they maybe were no longer able to (re-)construct the scattered chains of arguments.
Solution approach: a possible solution is to present the scattered messages in a consolidated way. In order to be able to do so, elements of a scattered conversation need to be identified. Various research challenges exist for this task, some, e.g., related to Natural Language Processing (NLP) and Social Network Analysis (SNA). For example, regarding NLP, conversation topics and messages belonging to respective topics have to be identified. Once identified, it has to be determined which messages about a certain topic really belong to the same conversation. SNA might contribute to the solution of this problem by providing knowledge about, e.g., identifying clusters of users (i.e., subgroups that are engaged in conversations among themselves) or users who build bridges between clusters (e.g., moderators, tutors, etc.). Regarding the actual consolidation, various challenges exist, e.g., relevant information might get lost when extracting scattered messages from their original context. Furthermore, it is not clear how to determine the best structural organization of the consolidated messages (e.g., temporal sequence of single messages, temporal sequence of roots of message trees).

Pattern name: Conversation about the use of the computational system

Pattern description: users frequently have difficulties when using a computational system. It might be desirable to allow users to share usage problems and corresponding solutions in an organized way.
Rationale: sharing usage problems and possible solutions is important for enabling and encouraging users to explore the available functionalities. Thus, the system should support the sharing of such information, but at the same time provide possibilities to present it differently from substantial conversations.
Relevant pragmatic context: the conversation topic, participants and their shared pragmatic information, illocution types.
Problem description: when collaborating online, users might encounter difficulties regarding the use of the computational system. Some users might want to send messages with the intention to share usage problems or solutions, while others might only be interested in messages about the collaboration object. Designers might want to use information about usage problems for evaluation purposes, and support staff might want to retrieve this information to help users. Some systems offer dedicated communication channels for this purpose, but do not promote the exchange of this knowledge. Other systems, e.g., systems where users are also the "owners" of the system, as in the case of an online community that uses its own content management system, promote sharing, but might not provide means to separate these messages from substantial messages, which might create considerable noise.
Problem example(s): in the *Vila na Rede* case, almost 10% of the messages in a substantial discussion thread where about the usage of the computational resources, although the system offers a dedicated channel for reporting and solving technical problems. The SES teachers had never used *Vila na Rede* before the case study. Once they discovered the possibility to directly record audio and video from within the system, some participants had the intention to make use of this resource to support the discussion. They notified others about the possibilities, who became very enthusiastic and wanted to try it themselves. This resulted in a series of messages (e.g., "I tried to use audio, but couldn't hear my recording. Can you help?"). It was not always clear if a message was about the tool or a substantial contribution to the discussion, and for these messages, a syntactic or semantic analysis did not provide clarity. For example, only analyzing syntactic or semantic aspects, it is not possible to tell if "Your audio is great!!" is about the quality of the audio file or the quality of the recorded message.
Solution approach: one approach would be to identify this kind of messages in order to be able to search or filter them, and to present them in a way that differs from the presentation of substantial messages. As in the case of

"scattered conversations", the task of automatically identifying messages entails challenges regarding NLP and SNA, as well as regarding a pragmatic analysis.

4. DISCUSSION AND CONCLUSION

Systems for collaborative problem solving often try to support discussion and other forms of communication among participants. The support of communication in these systems could benefit from the consideration of pragmatic aspects, especially of users' intentions. Although the Pragmatic Web represents an evolution of the Web and considers aspects like context and meaning negotiation, the influence of Pragmatics on Interaction Design of Web applications has not yet been investigated extensively in HCI literature. The concept of pragmatic patterns of collaborative problem solving could provide a possible approach.

In this paper, we proposed a set of pragmatic patterns of the use of online systems for collaborative problem solving. These patterns were identified in four case studies that analyzed problem solving activities of a community of special education teachers in four different Web-based systems over a period of nine months. The patterns illustrate recurring problematic situations and indicate possible design-related solutions that tend to take advantage of the explicit consideration of people's intentions during communication and problem solving.

Although the patterns were illustrated with examples from the context of collaborative problem solving in a community of SES teachers, we believe they also apply to other domains than special education and other types of online communities. We have shown that the pragmatic context is a key factor for the identification of problems and the proposal of solution approaches. The pragmatic patterns are not only important during initial design, but also for future design iterations and redesign, since communities and their goals constantly evolve. Although problematic situations can be detected as outlined in the previous section, designers and other involved stakeholders have to decide on a case-by-case basis if the "problem" is really a critical situation. For example, the pattern "conversation about the use of the computational system" might require no action at all, if the respective type of messages is not considered disturbing. In fact, up to a certain point, the behavior of posting messages of usage problems in the middle of a substantial discussion might even be desired, since encountered problems and found solutions appear in the context of the current state of the practice. An analysis of the community's values might be fruitful for understanding and deciding when a detected pattern requires action, and what actions would be suitable (Pereira and Baranauskas 2012).

Regarding the pragmatic patterns identified in this paper and potential future patterns, we observed that there are relations between the presented patterns and "candidate patterns" not presented due to space restrictions. For example, the pattern "consolidation of a scattered conversation" and the candidate "synthesis of discussion results" are both related to the organization and structure of a conversation. The pattern "conversation about the use of the computational system" is related to meta-communication and participant support. Another conceivable pattern in this category is "conversation about best practices". Instead of proposing patterns such as "conversation structure" or "meta-communication" we opted for proposing the more concrete instantiations, i.e., we favored easier applicability to concrete situations over generality.

Future work involves an analysis of how the values of community members, designers and other stakeholders influence the assessment of the problem severity of a pattern and the choice of alternative solution designs.

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Appendix C

Implementing the Timeline Representation in TNR

In this text we present how the timeline prototype presented in Chapter 5 was implemented in TNR. The timeline is part of "Nossos Casos" (or "Our Cases" in English), the tool for discussing AEE cases in TNR. The general idea of the timeline metaphor as an alternative representation of the AEE case discussion is to promote a more flexible conduction of the case discussion and to provide an "at a glance" overview of the current state of the discussion, enabling participants to "get an idea" of what already has been discussed and what are possible next steps.

This text is structured as follows. We start by briefly repeating the main characteristics of the prototype described in Chapter 5. After that, be describe the differences between the prototype and the actual implementation and discuss some implementation details. In the last part of this document we describe the use of the timeline and possible topics for further design and evaluation.

C.1 Main prototype characteristics

The prototype represented events in a timeline by date of event creation and by stage of the case discussion (clarification, elaboration, implementation), whereas events could be posts to the case discussion of different types, i.e. documents or videos, discussion threads, etc. The prototype had the following characteristics (cf. Figure C.1):

a) choice between alternative representations, i.e. a two-dimensional timeline or textual event list,

b) search within the case,

c) filter of events, e.g. by author or event type,

d) zoom for showing more details for the rendered events,

e) miniature overview of the timeline,

f) marker for the current date, and

g, h, i) controls for posting new content to the case discussion.

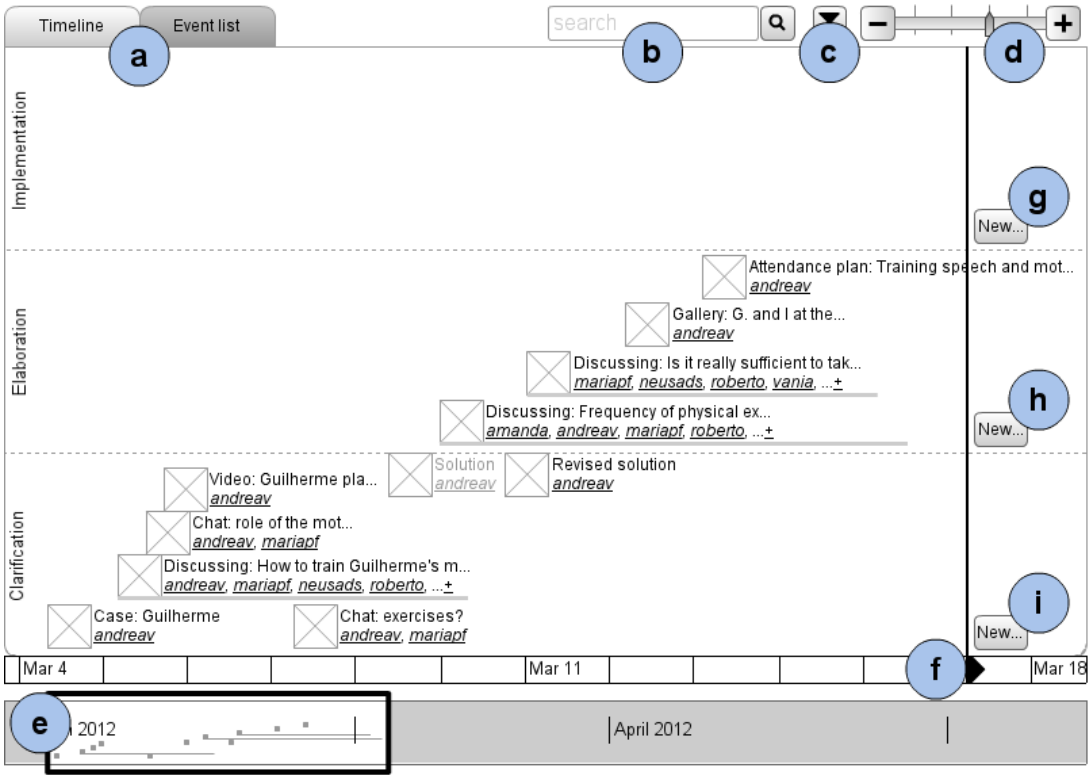

Figure C.1: The timeline prototype.

C.2 Differences between prototype and implementation

"Our Cases" and the timeline were developed in parallel. The initial version of "Our Cases" was deployed to TNR in late June 2013 (cf. Chapter 6). In comparison to the way of case discussion that was the basis for the timeline prototype in Figure C.1, some simplifications had been made to the way of discussion in "Our Cases". The purpose

of these simplification was to increase ease of use to the education professionals without limiting or restricting the case discussions. Furthermore, it was decided to integrate the timeline into the underlying Content Management System (CMS) in order use resources already available there. Thus, the timeline implementation differs from the prototype in the following points:

- the possible event types have been reduced to:
  - post or update of the case proposition,
  - post or update of the attendance plan,
  - post or update of the plan implementation feedback,
  - posts of comments to the former three documents ("case documents"); comments may contain file attachments;
- the alternative textual representation (item a) in Figure C.1) has been dropped, since the CMS already provides a textual representation of comments to case documents;
- the search (b) has been dropped since the CMS already provides this functionality (although currently the search is not case specific);
- only an "author" filter (c) has been implemented; since current discussions have shown that the amount of data in a case is currently less than expected, since the possible event types have been reduced in the initial version, additional filters were not yet necessary;
- the miniature view (e) has not been implemented, again because the actual volume of data in a time discussion makes this seem unnecessary; instead a simple horizontal scroll bar is provided;
- the "current date" marker (f) has not been implemented, since the plan implementation currently does not include planning activities; hence the current date is always at the rightmost point in the timeline, i.e. when the scroll bar hits the right-hand end;
- the controls for posting new content (g, h, i) have not been implemented since case discussants other than the case owner only post or reply to comments.

Additionally to the functionalities in the prototype, the following functionalities have been added:

- a full-screen view of the timeline in order to benefit users with smaller screens;

- a highlighting function that visually highlights all comments in a thread upon hovering with the mouse over a comment in the timeline;
- a visual highlight of comments made by the case owner;
- an overview of when participants accessed the case discussion.

These functionalities will be explained in more detail after describing some relevant implementation details.

C.3 Implementation details

TNR has been implemented in Drupal™(`http://drupal.org`), a PHP-based CMS. "Our Cases" has been implemented as a Drupal module. Since the timeline depends on "Our Cases", this module is a submodule of the "Our Cases" module. The implementation uses MySQL® (`http://www.mysql.com`), PHP© (`http://php.net`), HTML, CSS, and JavaScript. In order to facilitate front-end development, the following JavaScript libraries have been used:

- jQuery (`http://jquery.com`) for HTML document traversal and manipulation, and event handling,
- jQuery UI (`http://jqueryui.com`) for user interface widgets, effects and theming,
- Bootstrap (`http://getbootstrap.com`) for additional user interface widgets, and
- jQuery.fullscreen (`https://github.com/private-face/jquery.fullscreen`) for the full-screen functionality.

The use of jQuery facilitated development by e.g. simplifying cross-browser development. Since Drupal internally also uses jQuery and jQuery UI, the use of these libraries resulted in no overhead.

The entire implementation has been done without AJAX (Asynchronous JavaScript and XML) or similar asynchronous web-development techniques. Analyzing the user's accesses to case discussions, it became clear that accesses to a case discussion were made at a rate that at the time of writing this document did not require real-time updates in between manual page loads.

In order to implement the functionality for visualizing participants' accesses to case discussions, an additional database table was created in Drupal's database schema. This table is filled by a periodic cron job which extracts user access records from a Drupal table and calculates some derived values, such as aggregations of single accesses to user

sessions. The additional table was necessary due to performance and maintenance reasons. The corresponding Drupal table usually grows quite big and might also be subject to maintenance tasks such as periodic truncation, that way losing historic information about case accesses.

When visualizing a case discussion in the timeline, events, participating users, as well as the information about accesses to the case are extracted from the database and stored in the resulting HTML document using the JSON (JavaScript Object Notation) format. As an example, consider he following excerpt, which represents a comment by the user with the ID 82:

```
var events = {
  ...
  "comment757": {
    "authorid": 82,
    "authorname": "angelamtf",
    "eventid": "comment757",
    "entitytype": "comment",
    "entityid": 757,
    "step": 3,   // step 1: proposition, step 2: plan, step 3: feedback
    "node": 168,
    "parent": 0, // id of parent comment or "0" if parent is a "node"
    "level": 0,  // level in the comment tree
    "title": "Complementar o Relato?",
    "body": "<p>Colegas, se precisarem de mais informações
       estou a disposição.<\/p>\r\n\r\n<p>Abraços, Angela<\/p>\r\n",
    "timestamp": 1372630029000, // timestamp of entity creation
    "ts_changed": 1372630029000, // timestamp of entity update
  },
  ...
};
```

Storing data in the resulting HTML document facilitates processing by JavaScript. A possible disadvantage is an increase in size of the resulting HTML document and thus an increase in document loading time. At the time of writing this document, this had no negative effect on loading times, in fact, the page sizes of the timelines of the observed case discussions were smaller than the corresponding case description pages. However, a possible point for future development might be to load access data asynchronously and to use the browser's local storage for historic data to reduce page sizes and load times.

Regarding the time scale, two alternatives have been implemented, the default "temporal" scale that renders events according to their creation date, and an "equidistant" scale that renders two consecutive events in a uniform distance, independently of the creation

date. The two different modes have been implemented since in the highest zoom level, which displays two days in the user's view port, the timeline might be quite sparse if few comments were posted during two consecutive days. Conversely, in the lowest zoom level, which displays ten weeks, it might be difficult to visualize comments that were posted during a short time period. An equidistant spacing enables a more compact timeline while allowing to visualize all events. On the downside, the notion of time gets lost. Thus the default scale at the time of writing this document is the temporal scale. An additional option that might be explored in future is to change the scaling dynamically, i.e. to use a finer time scale during periods of high activity. A challenge here is to use a design that allows users to perceive the different time scales.

C.4 Using the timeline

Figure C.2 shows the timeline representation integrated in "Our Cases" and some user interface elements:

1. the timeline ("Linha de Tempo") is a separate tab besides the overview ("Visão Geral"), the case description ("Proposição"), the attendance plan ("Elaboração"), and the case feedback ("Acompanhamento"),
2. the zoom level, with two buttons and one slider, currently set on the default level,
3. the button for switching to full-screen mode,
4. the time scale currently showing the events within three weeks,
5. the horizontal slider, for visualizing different regions of the timeline,
6. the button for expanding the view of participants' accesses to the case, and
7. the documents posted by the case owner, displayed in a fixed position on the screen, i.e. not moving when navigating the timeline; in Figure two, only the case description and the attendance plan have been posted.

Single events, i.e. comments and updates to the case documents are displayed as rounded boxes. At the zoom level in Figure C.2, an event box contains the photo of the event author (e.g. the commenter), the beginning of the event title (e.g. the comment title), and the author's user name. When decreasing or increasing the zoom level, less or more details might be displayed for each event.

Due to the chosen zoom level and the frequency of comments during the case discussion, some events in Figure C.2 are covered by other events and thus barely visible.

Figure C.2: The initial view of a case discussion's timeline representation.

Figure C.3 shows the timeline of the same case discussion at the highest zoom level. Note that only two days of events are displayed and that the horizontal slider decreased in size accordingly. In Figure C.3, the mouse pointer is hovering above an event, and more details of the event are displayed in a popover box. The event in Figure C.3 is a comment, and consequently, all comments within the same comment thread are highlighted.

Clicking on the event shows the complete event details, i.e. in this case the complete comment, within its context, i.e. in this case together with the other comments in the same thread (Figure C.4).

Figure C.5 shows when participants accessed the case discussion, after clicking button the button with the label "Mostrar usuários que visitaram o caso" (Portuguese for "show

Figure C.3: Hovering with the mouse pointer above a comment.

users who visited the case"). Each line below the timeline corresponds to a user who accessed the case discussion, and each solid rectangle in a line marks an access. Figure C.5 also shows the "author" filter. When clicking in a line below the timeline, only that participant's events are shown in the timeline. When clicking again, all comments are shown again. When hovering with the mouse over a line, the corresponding participant's name and the number of comments he contributed are shown.

The visualization of case accesses could be a topic for future evaluations. The registration of when a participant accessed a case could conflict with the participants' privacy preferences or contribute negatively to the feeling of being exposed, as discussed in Chapter 6. On the other hand, making explicit that usually more participants access the case than post comments could also have positive effects, e.g. increase the feeling of belonging to a community, or show that a case is interesting.

Figure C.4: Comment details in context.

C.5 Topics for evaluation and further design

At the time of writing, the timeline representation had not undergone formal evaluation yet. One of the evaluations that should be performed is a usability evaluation, which could include the evaluation of different time scales. This is all the more important since the timeline representation is a rather uncommon type of content representation regarding web applications in general and collaborative systems in specific, and since the case timeline in TNR has some interface widgets that do not appear in other areas of TNR.

At the time of writing this document, the timeline representation was only made available to the researchers of the project team. No formal evaluation had been performed.

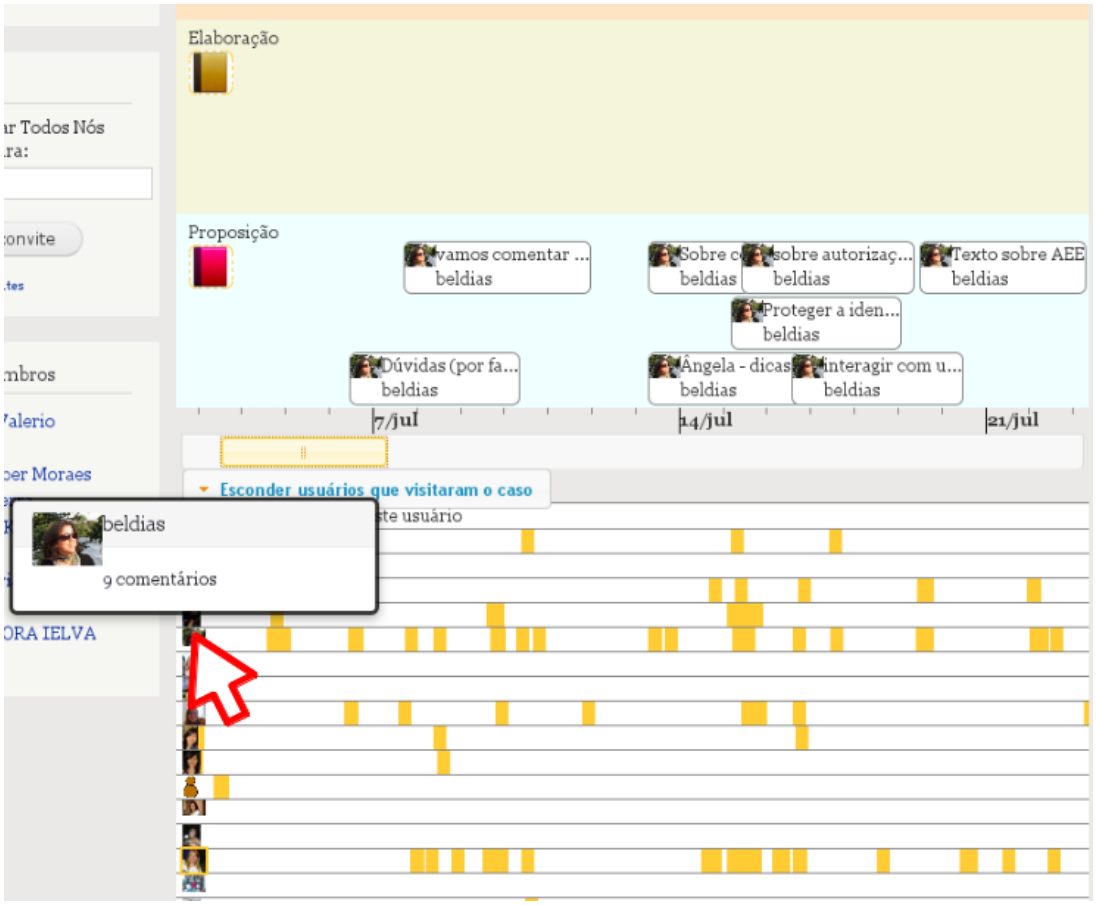

Figure C.5: Accesses to the case discussion and author filter.

As an unanticipated side-effect, the timeline representation has been proven very useful for our analysis of case discussions, e.g. for analyzing the temporal flow of comments and the accesses to a case discussion (cf. Fig 6.7 and 6.8 of Chapter 6). Thus we propose to conduct a pragmatics-driven evaluation following the approach proposed in Chapter 6 in order to investigate in which ways the timeline representation facilitates working with case discussions for which stakeholders. Furthermore, a criteria measurement oriented evaluation could evaluate the acceptance of the visualization of accesses to the case by participants.

Regarding further design, we can envision the following:

- providing real-time functionalities, e.g. asynchronous loading of comments that are posted while a user browses the timeline,
- storing timeline data in the browser's local storage in order to decrease document loading times,

- evaluating the possibility to substitute the case overview with the timeline and/or to display the timeline together with the case description, plan and feedback instead of using a separate tab,
- annotation of the timeline, e.g. to mark interesting, controversial or other moments of the discussion, and sharing of annotations with other participants in order to promote collaborative sense-making.

Finally, another point for future investigations regarding design and evaluation is the accessibility of the timeline representation for people with different special needs.

Appendix D

Approval Certificate of the Ethical Review Board

FACULDADE DE CIÊNCIAS MÉDICAS
COMITÊ DE ÉTICA EM PESQUISA

www.fcm.unicamp.br/fcm/pesquisa

CEP, 30/09/11
(Grupo III)

PARECER CEP: N° 724/2011 (Este n° deve ser citado nas correspondências referente a este projeto).
CAAE: 0647.0.146.000-11

I - IDENTIFICAÇÃO:

PROJETO: **"REDES SOCIAIS E AUTONOMIA PROFISSIONAL: NOVOS RUMOS PARA FORMAÇÃO CONTINUADA A DISTÂNCIA DE PROFESSORES DE AEE".**
PESQUISADOR RESPONSÁVEL: Maria Cecília Calani Baranauskas
INSTITUIÇÃO: Instituto de Computação/UNICAMP
APRESENTAÇÃO AO CEP: 13/07/2011
APRESENTAR RELATÓRIO EM: 30/09/12 (O formulário encontra-se no *site* acima).

II – OBJETIVOS.

Formação de uma rede social (Rede Social Online - RSO) que proporcione contato entre professores que trabalham com Atendimento Educacional Especializado (AEE) visando intercambio das experiências profissionais nos moldes da formação continuada

III – SUMÁRIO.

O projeto contempla as seguintes linhas de pesquisa: educação especial na perspectiva da educação inclusiva; formação continuada de professores para atendimento educacional especializado (AEE); desenvolvimento de ambientes e aplicações Web para a constituição de redes sociais inclusivas; teorias e mecanismos para atribuição de autoridade profissional em redes sociais

IV - COMENTÁRIOS DOS RELATORES.

Após respostas às pendências, o projeto encontra-se adequadamente redigido e de acordo com a Resolução CNS/MS 196/96 e suas complementares, bem como o Termo de Consentimento Livre e Esclarecido.

V - PARECER DO CEP.

O Comitê de Ética em Pesquisa da Faculdade de Ciências Médicas da UNICAMP, após acatar os pareceres dos membros-relatores previamente designados para o presente caso e atendendo todos os dispositivos das Resoluções 196/96 e complementares, resolve aprovar sem restrições o Protocolo de Pesquisa, bem como ter aprovado o Termo do Consentimento Livre e Esclarecido, assim como todos os anexos incluídos na Pesquisa supracitada.

O conteúdo e as conclusões aqui apresentados são de responsabilidade exclusiva do CEP/FCM/UNICAMP e não representam a opinião da Universidade Estadual de Campinas nem a comprometem.

Comitê de Ética em Pesquisa - UNICAMP
Rua: Tessália Vieira de Camargo, 126
Caixa Postal 6111
13083-887 Campinas - SP

FONE (019) 3521-8936
FAX (019) 3521-7187
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COMITÊ DE ÉTICA EM PESQUISA

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VI - INFORMAÇÕES COMPLEMENTARES.

O sujeito da pesquisa tem a liberdade de recusar-se a participar ou de retirar seu consentimento em qualquer fase da pesquisa, sem penalização alguma e sem prejuízo ao seu cuidado (Res. CNS 196/96 – Item IV.1.f) e deve receber uma cópia do Termo de Consentimento Livre e Esclarecido, na íntegra, por ele assinado (Item IV.2.d).

Pesquisador deve desenvolver a pesquisa conforme delineada no protocolo aprovado e descontinuar o estudo somente após análise das razões da descontinuidade pelo CEP que o aprovou (Res. CNS Item III.1.z), exceto quando perceber risco ou dano não previsto ao sujeito participante ou quando constatar a superioridade do regime oferecido a um dos grupos de pesquisa (Item V.3.).

O CEP deve ser informado de todos os efeitos adversos ou fatos relevantes que alterem o curso normal do estudo (Res. CNS Item V.4.). É papel do pesquisador assegurar medidas imediatas adequadas frente a evento adverso grave ocorrido (mesmo que tenha sido em outro centro) e enviar notificação ao CEP e à Agência Nacional de Vigilância Sanitária – ANVISA – junto com seu posicionamento.

Eventuais modificações ou emendas ao protocolo devem ser apresentadas ao CEP de forma clara e sucinta, identificando a parte do protocolo a ser modificada e suas justificativas. Em caso de projeto do Grupo I ou II apresentados anteriormente à ANVISA, o pesquisador ou patrocinador deve enviá-las também à mesma junto com o parecer aprovatório do CEP, para serem juntadas ao protocolo inicial (Res. 251/97, Item III.2.e)

Relatórios parciais e final devem ser apresentados ao CEP, de acordo com os prazos estabelecidos na Resolução CNS-MS 196/96.

VII- DATA DA REUNIÃO.

Homologado na VIII Reunião Ordinária do CEP/FCM, em 23 de agosto de 2011.

Prof. Dr. Carlos Eduardo Steiner
PRESIDENTE do COMITÊ DE ÉTICA EM PESQUISA
FCM / UNICAMP

Appendix E

Permissions from Publishers

From: Pellegrini Tassilo <Tassilo.Pellegrini@fhstp.ac.at>
To: Dana Kaiser <dkaiser@iicm.tu-graz.ac.at>, Stefanie Lindstaedt <slind@know-center.at>, Nina Simon <nsimon@know-center.at>, "heix@gmx.com" <heix@gmx.com>
Subject: RE: Subject: Request to use published paper in my PhD thesis
Date: Wed, 2 Oct 2013 06:46:10 +0000

---

sure! no problem from my side.

br,
tassilo

With kind regards,
Mit freundlichen Grüßen,

Prof. (FH) Dr. Tassilo Pellegrini

Department of Media Economics
Department Medienwirtschaft

St. Pölten University of Applied Sciences /
Fachhochschule St. Pölten GmbH
Matthias Corvinus-Straße 15, A-3100 St. Pölten
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E: tassilo.pellegrini@fhstp.ac.at
I: www.fhstp.ac.at

FN 146616m, LG St. Pölten, DVR 1028669F

From: Dana Kaiser [dkaiser@iicm.tu-graz.ac.at]
Sent: Monday, September 30, 2013 2:13 PM
To: Stefanie Lindstaedt; Nina Simon; Pellegrini Tassilo; heix@gmx.com
Subject: Fwd: Subject: Request to use published paper in my PhD thesis

Dear all,

I have just received a request from Heiko Hornung regarding a permisison to include the article

Hornung, H. and Baranauskas, M. C. C. (2009). An Interaction Design Perspective on the Pragmatic Web: Preliminary Thoughts. In Paschke, A., Weigand, H., Behrendt, W., Tochtermann, K., and Pellegrini, T., editors, I-SEMANTICS'09: Proceedings of the 5th International Conference on Semantic Systems, 2–4 September 2009, Graz, Austria, page 695–705.

in the PhD thesis of one of the authors. As far as J.UCS is concerned, this permission is granted provided the article is referenced as stated above.

@Stefanie, Nina and Tassilo: please contact Heiko Hornung if you have objections agains the permission.

Best regards,

Dana

-------- Original-Nachricht --------
Betreff: Subject: Request to use published paper in my PhD thesis
Datum: Mon, 30 Sep 2013 08:48:35 -0300
Von: Heiko Hornung <heix@gmx.com>
An: dkaiser@iicm.tu-graz.ac.at

Dear Dana,

I hope you are the right person to handle my request. If not, could you please indicate to whom I should address my request?

I would like to request permission to include a paper of mine that appeared in the I-SEMANTICS'09 conference proceedings published in the J.UCS Conference Proceedings Series as a chapter of my PhD thesis. The paper would be included completely, without alterations, except formatting (e.g. text formatting, reference format), and the full reference to the paper would be made explicit on the chapter's initial page.

The full reference of the paper is:
Hornung, H. and Baranauskas, M. C. C. (2009). An Interaction Design Perspective on the Pragmatic Web: Preliminary Thoughts. In Paschke, A., Weigand, H., Behrendt, W., Tochtermann, K., and Pellegrini, T., editors, I-SEMANTICS'09: Proceedings of the 5th International Conference on Semantic Systems, 2–4 September 2009, Graz, Austria, page 695–705.

Best Regards,
Heiko Hornung
Institute of Computing – University of Campinas (UNICAMP)

--
Dana Kaiser, assistant editor
Journal of Universal Computer Science
www.jucs.org
ISSN 0948-695-x
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Consent to Publish

Lecture Notes in Computer Science

Springer

Title of the Book or Conference Name: HCI International 2011 Conference

Volume Editor(s):

Title of the Contribution: Towards a Conceptual Framework for Interaction Design in the Pragmatic Web

Author(s) Name(s): Heiko Hornung, M. Cecília C. Baranauskas

Corresponding Author's Name, Address, Affiliation and Email: Heiko Hornung, Instituto de Computação, Universidade Estadual de Campinas, Av. Albert Einstein, 1251, Cidade Universitária, 13084-971, Campinas - SP, Brasil, heiko@ic.unicamp.br

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DO OBJETO

TÍTULO DO ARTIGO (doravante denominado "a obra"): Timelines as mediators of lifelonglearning processes

NOME DA PUBLICAÇÃO: XI Simpósio Brasileiro sobre Fatores Humanos em Sistemas Computacionais

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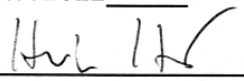
Signature(s): 

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