

Meaning Construction and Evolution: A Case Study of the Design-in-Use of a System for Inclusive Education Teachers

Heiko Hornung^{1(✉)}, Roberto Pereira²,
and M. Cecilia C. Baranauskas¹

¹ Institute of Computing, University of Campinas, Av. Albert Einstein,
1251 Cidade Universitária, Campinas, SP 13083-852, Brazil
{heiko, cecilia}@ic.unicamp.br

² Department of Computer Science, Federal University of Paraná, R. Cel.
Francisco H. dos Santos, 100 Centro Politécnico, Curitiba, PR 81531-980, Brazil
rpereira@inf.ufpr.br

Abstract. Evolution in the digital technologies has changed the way people interact with others mediated by those devices. In this paper, we argue that systems design needs to go beyond the meaningful interaction of people with computational systems, and include meaningful interaction among people that is mediated by computational artefacts, by rules and norms that guide people's actions, as well as by culture, values, and intentions. This paper presents a case study of design-in-use of a system for inclusive education teachers. The design process for the system is participatory and based on Organisational Semiotics, i.e., explicitly considers collaborative meaning construction and negotiation. We illustrate and discuss examples of meaning construction and evolution from the perspective of interface and interaction design.

Keywords: Meaning construction · Meaning evolution · Pragmatics · Human-Computer Interaction · Interaction design

1 Introduction

There are different theoretical and methodological frames of reference for understanding, studying and designing for “meaningfulness”. The notion of what constitutes “meaningful interaction” in a system, as well as what constitutes the “system” in which this interaction happens, and what or who takes part in this interaction have changed over the years. Consequently, the notion of how a system mediates interaction has also changed, making the subject even more relevant to research about Information Systems (IS) and Human-Computer Interaction (HCI).

Digital technology has permeated all aspects of life [3]. People use devices of a wide variety of forms in a wide variety of contexts or situations. When designing an application or a system, the traditional definitions of “user” and “task” do not hold up anymore. “Users” today have diverse characteristics and diverse motives for using applications, consequently “tasks” can no longer be seen in a singular context. For instance, a simple app for managing a to-do list might be used by a team of professional

software developers for project managing or by a single user for creating a shopping list. “Meaningfulness” in this case relates to people’s practices, and design needs to focus on facilitating these practices. Systems design then needs to go beyond the meaningful interaction of people with computational systems, and include meaningful interaction with people, i.e., interaction mediated by computational artefacts, by rules and norms that guide people’s actions, as well as by people’s culture, values, and intentions.

In this paper, we present the case of a system that is being designed-in-use with its users and other stakeholders since 2010. After briefly describing the context in which this system is being created, we present and discuss examples of meaning construction and evolution from the perspective of Pragmatics [6] and Values [11].

2 Todos Nós em Rede (TNR; English: “All of Us Networked”)

In the last decade, the Brazilian public policies for inclusion of disabled students in regular schools created the Specialized Educational Services (SES). The SES services regulate and provide support for teachers’ activities with students in multifunctional resources rooms, i.e., special rooms in regular schools equipped with specialized resources [10]. In order to qualify professionals in this field, teachers from all over the country started specialization courses through e-learning environments. These courses had a limited period of duration and, after them, teachers are alone in their places for accomplishing their daily activities.

The case study presented in this paper is situated within the context of the research and design project named “*Redes Sociais e Autonomia Profissional*¹” (English: “Social Networks and Professional Autonomy”). This project investigates how to facilitate continuing learning of teachers in the field of inclusive education in Brazil’s public school system and how to support them in their professional activities. Within the project, TNR² (“Todos Nós em Rede”, English: “All of Us Networked”) is a system where inclusive education teachers can socialize, share experiences and discuss matters related to work practices. As of February 2016, the TNR system has more than 800 registered users. More than 1400 contents (articles, documents, questions, pictures) were shared by teachers and received around 4000 comments. TNR is being designed according to the socially-aware process outlined in [1]. Cornerstones of this process are stakeholder participation during all stages of design and semio-participatory practices that are informed by Organisational Semiotics [9] and Participatory Design [12]. During these practices, stakeholders construct and negotiate meanings [1].

The core research and design team comprises professors, researchers and PhD/MSc students from Unicamp’s Faculty of Education and Institute of Computing, as well as inclusive education teachers from different parts of the country. For some activities, people with necessary skills are temporarily brought into the project, e.g., the team

¹ <http://www.nied.unicamp.br/tnr>.

² <http://tnr.nied.unicamp.br>.

already collaborated with a journalist, a lawyer, and a Web developer. When the project started in 2010, inclusive education teachers were recruited by sending a questionnaire to a list of registered special education teachers. From the about 300 respondents, 28 have been invited. One selection criterion was the access to and use of technology (computer, smartphone, etc.) and software such as e-mail, social networks, or other online communication systems. All 28 teachers, who are geographically dispersed all over Brazil, accepted the invitation. One reason for the selection criterion was that access and use of computers and online systems was deemed the most viable option for participatory activities. Given the continental dimensions of Brazil, bringing in all members to regular face-to-face meetings is not practical. Another reason for the selection criterion was that digital inclusion was not the focus of the project.

The project started without limiting possible outcomes, i.e., at the beginning, it was not clear that the computational system that is part of TNR would be developed. The main guiding principle was the objective to promote professional autonomy of inclusive education teachers by creating a system for socializing, sharing experiences and discussing matters related to inclusive education work practices. The main input for understanding teachers' work practices was given by a university course offered by the Ministry of Education where a 5-step process was taught, and by the diverse local practices of inclusive education teachers, which varied from ad-hoc processes using no or low-tech tools to custom-structured processes using e.g., electronic spreadsheets or mind maps. All participating teachers had attended the course offered by the Ministry of Education.

Along the first 4 years of the project, we conducted various synchronous and asynchronous online activities as well as two face-to-face one-day workshops. Details of the project and the process have been described in [11]. In the following, we present aspects related to meaning construction and evolution, taking a perspective informed by Pragmatics and Values.

3 Meaning Construction and Evolution in TNR

Inclusive education teachers provide attendance to children with special needs in order to facilitate their participation in regular classes. A core practice of this attendance is the so-called "case discussion" which comprises elements such as understanding the specific requirements of a child for participating in regular class, the elaboration of an attendance plan, as well as the implementation and evaluation of this plan. At the outset of the project, different understandings of the "case discussion" practice existed. Some of the team members from the Faculty of Education had participated in the creation of the university course offered by the Ministry of Education. The course is a representation of the practice as understood by the course creators. The course attendants in turn constructed their understandings of the practice, which probably differed somewhat from the understanding of the creators, given that the course was delivered via an online learning platform with tools that differed from the tools the participants usually had access to. Furthermore, the course was supported by monitors and tutors as well as by course schedules that e.g., determined when to proceed from one phase of the attendance process to the next. Transitions between phases were linear. In actual

practice, teachers adopt different methods that vary from unstructured ad-hoc methods with limited tool use to more structured approaches with computational support tools.

In order to understand how inclusive teachers would use a collaborative online system for case discussions, we created prototypical practices where teachers explored and evaluated existing systems regarding the way they could support their professional activities. Four practices were created, and each practice discussed a case based on real cases submitted previously by the participants. The 28 participating teachers conducted the case discussions sequentially during a four to six-week period in existing online systems that afforded different styles of textual communication (a question-answer system, a forum-like system, a system with tool support for explicit meaning construction, and a blog-like system with social networking elements). The case discussions were a rich source of information where teachers gave their feedback by: (i) interacting through the systems in order to solve fictitious cases; (ii) answering evaluation questionnaires for each system, pointing out features they liked, disliked, missed, etc.; and (iii) participating in semi-structured online interviews.

Analyses of aspects related to pragmatic meanings of the four prototypical case discussions revealed how the four different systems influenced the case discussion in different ways [6]. A pragmatic function analysis showed that the participants employed a limited set of illocution types in the question-answer system (mainly affirmations), which hints at a conversation style that might be less beneficial to critically analysing a case and to learning from a case discussion than a conversation in which also valuations or inducements occur.

The analyses also revealed individual differences in practice conduction, e.g., a preference towards a linear sequence of discussion phases versus a parallel elaboration of phases [6], and cultural values related to the teachers' practices [11]. Concepts like collaboration, reputation and privacy were clarified and understood as values with meanings substantially different from the researchers' initial views. These values influenced the way teachers reacted to different features of the systems and to others' behaviour promoted or inhibited by each system. E.g., in a system that permitted synchronous and collaborative editing, teachers revealed a strong valuation for authorship, disapproving editing of "their" content by others and requiring the individual contribution to be preserved.

The users did not conclude the case discussion (phase four in the process) in three of the four systems. We attributed this to a certain artificiality of the discussions: although cases were based on actual cases and experience of the participants, there was no real "case owner" who had an interest of pushing the discussion forward.

The four prototypical practices also revealed an evolution of practice ([2, 7] for more detailed analyses). During the last prototypical practice, which was conducted in the least formal blog-like system, the count of "non-substantial" messages with a socializing intent was highest. It is unknown whether this was due to participants getting to know each other better, or due to the lower level of formality of the system.

All the material produced during the previous activities was synthesized and discussed by the researchers and the teachers in a face-to-face workshop. Once a common understanding about the system and its requirements was achieved, participatory practices were conducted to generate different proposals for implementing the solution. These proposals inspired the design of the TNR system, including the development of

“Nossos Casos” (Portuguese for “Our Cases”), an area within TNR to facilitate case discussions. Goals of designing *“Nossos Casos”* included allowing flexible practice and evolution of practice, as well as simplifying the process compared to the discussion taught in the university course. Formulating these goals was a result of the analyses described in the previous paragraph and the follow-up interviews. Although one goal was to enable flexibility, another goal was to provide some structure, since we perceived that the discussions through the previously described systems that provided no or little structure had a tendency to peter out.

Structure is provided by separate tabs for separate moments of the case discussion, clearly demarcated areas for content about the case and comments/discussions of this content, and by some form fields in the content area (Fig. 1). Flexibility is provided by the freedom to fill in and discuss content in the tabs in any order or to even not use some of the tabs. Most of the form fields are optional, and none has restrictions regarding input formats. Furthermore, there are very few explicit, technical norms or rules for conducting the discussion, e.g., the content area can only be edited by the case creator and all registered users can participate in the discussion through non-anonymous comments.

Figure 2 summarizes the meaning evolution of “case discussion”, i.e., the different answers to the question of how to discuss a case. The gray areas symbolize that there

The screenshot shows a web interface for managing case studies. At the top, there's a navigation bar with links like 'Minha conta', 'Contato', 'Carta de Princípios', 'Termos de Uso', and 'Sair'. Below the navigation, there's a search bar. The main content area features a large yellow box labeled 'Tabs for different moments of case discussion' with an arrow pointing to a row of tabs at the top: 'Visão Geral', 'Proposição', 'Elaboração', 'Acompanhamento', 'Relatório', and 'Linha de Tempo'. Below these tabs, there are buttons for 'Ver', 'Editar', 'Quem favoritou', and 'Comentários destacados'. Another yellow box labeled 'Free-form fields' points to a section where a user named 'Paula' has posted a message: 'Idade do aluno: 8 anos', 'Série/Turma: 3º ano', and 'Deficiência: Surdez'. A third yellow box labeled 'Separation of case content and discussion' points to a 'Comentários' (Comments) section where a user named 'ANA MARCIA' has posted a message: 'LP para crianças surdas' and 'Paula,' followed by a detailed response from another user.

Fig. 1. Flexible structure in *Nossos Casos*

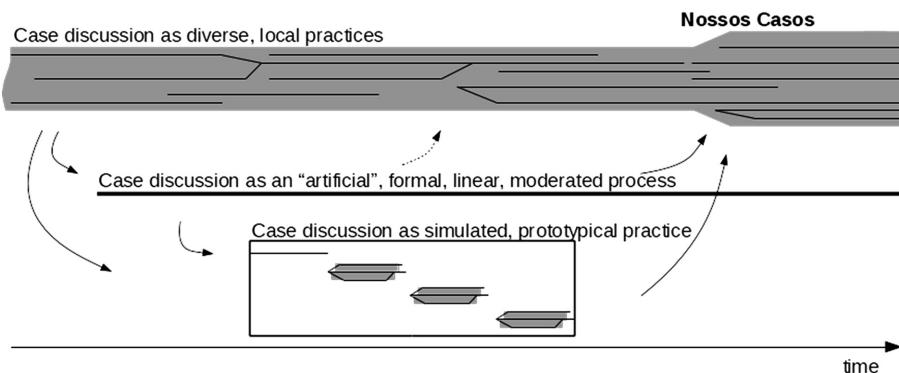


Fig. 2. Timeline of different ways to discuss cases

are many alternative ways to conduct a case discussion. A horizontal line represents a way to discuss a case. Regarding the diverse, local practices at the top and the prototypical practices at the bottom of the figure, different ways might exist in parallel, independent of each other, or be created as a branch or variant of an existing way. It is also conceivable that two ways of discussing a case converge. The introduction of *Nossos Casos* possibly makes new ways to discuss cases possible, hence the expansion of the gray area.

Case discussions in the context of the university course are conducted in exactly one way, as prescribed in the course curriculum (“exactly one way” is a simplification, since instructors and other factors have an influence on the conduction). The definition of this type of case discussion is inspired by the diverse local practices. It probably has an influence on further local practices, although we did not conduct a study to investigate whether this influence exists and how it alters actual practice conduction. The university course practice directly and explicitly influenced the design of *Nossos Casos*. We have no data to answer the question whether it also influenced the use of *Nossos Casos*.

The four prototypical practices existed only during a well-defined interval in time. The practices were informed by the formal, linear process of the university course and the diverse local practices “in the wild”. While the first prototypical practice allowed only one way to discuss a case (an exchange of questions by the case owner and answers by the participants), the other three practices allowed for some variance. The prototypical practices influenced the design of *Nossos Casos*. Since the number of teachers participating in the prototypical practices was small compared to the number of users in the TNR system, the influence of these practices on the use of *Nossos Casos* is negligible if existent at all.

We conducted other activities of explicit shared meaning construction and negotiation during the project, for example during the creation of the “Terms of Use” and the “Charter of principles”. Both Terms of Use and the Charter of Principles were elaborated during an iterative process of discussions among researchers and project participants within the TNR system. The Charter of Principles was a result of the discussion of the Terms of Use. A value-driven analysis of this discussion revealed values such as autonomy or collaboration that the participants felt should be made

explicit in order to influence the constitution of the culture of interaction within the system. The Charter of Principles was also made available as the system home page for non-logged-in users.

4 Discussion

As illustrated by the “*Nossos Casos*” tool presented in this paper, meaning construction and negotiation starts at choosing the theoretical and methodological frame of reference, which in our case is based on and inspired by Organisational Semiotics [9, 13], Participatory Design [12], Activity Theory [8], the Building Blocks of Culture [1, 5, 6, 11]. These frames of reference are compatible with the view that meaning construction is a participatory and bottom-up process. Had we employed other frameworks that for example subscribe to an objectivist world view, the design of *Nossos Casos* would have been different and probably resulted in a tool with less flexibility and more explicit formal and technical norms.

Defining which stakeholders participate in which way and identifying stakeholder representatives has repercussions on meaning construction. Had we recruited teachers from our home state where smartphone diffusion and cell phone signal coverage are considerably higher than in many other parts of the country, the result might have been a mobile platform with dramatically different characteristics regarding meaning construction. Defining the stakeholders also has an influence on which values will be prioritized. For instance, although accessibility affects teachers directly, it was not a concern they manifested, but identified by Education and Computer Science researchers. Similarly, autonomy is another value directly related to teachers, but it was a concern manifested by researchers in the Education field. Teachers are used to adopt a narrow range of activities and approaches to the different cases face; researchers hope that by exchanging ideas and experiences, teachers may become more proactive and creative in their day-to-day work, developing and adopting new practices and activities. Furthermore, it is also desired that teachers become more autonomous using computer technology as they gain experience with the designed system. Had we ignored the existence of other key stakeholders, the results might have been an oversimplified system offering what the teachers already new or learnt during the practices.

Starting with prototyping practices in existing systems instead of prototyping user interfaces contributed significantly to keeping the design space wide open and facilitated the investigation of meaning construction of and about the “case discussion”. This kind of prototyping evidenced explicit and implicit meaning making, explicit during follow-up interviews and implicit during the case discussions. Of course, this kind of prototyping has its limitations, e.g., the cases proposed for the practice within TNR had no case owner in the sense of a person who experienced the situation at the time of the practice and who would have a personal interest in concluding the case. However, the benefit of seeing prototypical practice right at the beginning of the process instead of having to wait to create a working prototype of a system safe enough to discuss the highly sensitive cases of children with special needs greatly outweighed the limitations.

Collaborative meaning construction and evolution does not necessarily result in meanings uniformly shared by all stakeholders. As described in the previous

subsection, *Nossos Casos* permits different ways of conducting a case discussion, and users in fact use the tool in different ways. Interestingly, at the time of writing this paper, many users use *Nossos Casos* in ways that are different from what the team of researchers, designers and end-user representatives understood would be good practice. For example, with very few exceptions, case owners do not post an attendance plan (tab “*Elaboração*” in Fig. 1) or provide feedback about attendance (tab “*Acompanhamento*” in Fig. 1). This does not mean that the teachers do not use attendance plans or do not document the attendance of a child; they just do not (yet) use *Nossos Casos* for these activities. Using a system in a way different than that intended by the designers or developers is called appropriation in HCI vocabulary [4] and often considered a positive phenomenon. In TNR, appropriation is desired to some extent, although the participating researchers desire that eventually as many teachers as possible converge to an understanding of inclusive education and of how to discuss cases similar to theirs.

Inclusive education is a polemical subject and it would most probably not be feasible, much less desired, to design a system that imposes or even enforces the researchers’ views. In terms of affordances and norms, the question arises how to design a system that allows for different understandings of affordances and different, maybe even conflicting norms, but that enables meaning evolution and convergence towards shared norms.

The strategy employed during the design of *Nossos Casos* in order to allow different understandings of affordances and different norms in parallel can be summarized as follows (Fig. 3): involve different stakeholders, conduct participatory design and prototypical practices in order to get a grasp of the diversity of understandings of a case, a case discussion and related concepts; restrict the use of explicit formal norms in order to promote diverse practices; and restrict constraints of the technical system in order to enable diverse practices.

Our strategy for promoting convergence towards shared understandings is anchored at the informal level. It involves dialogue with users within the technical TNR system, e.g., involving discussions in the comment sections of content, as well as outside, e.g., involving personal visits at teachers’ schools and homes. This strategy is in line with the view that meaning construction in TNR is a participatory and bottom-up process.

The success of strategies for allowing different understandings can be evaluated within a relatively small time frame conducting pragmatics-driven content analyses (e.g., [7]) or qualitative analyses of group discussions or interviews (e.g., a comment during a group session: “*These are different realities. And sometimes a small nudge*

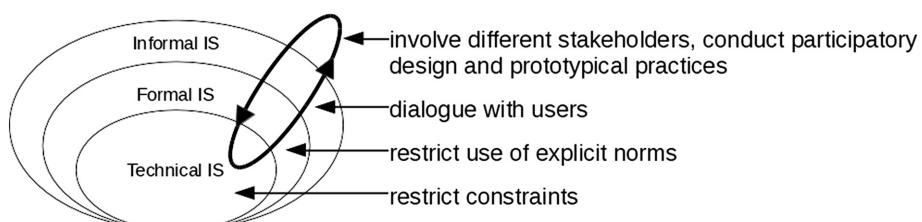


Fig. 3. Strategies for allowing different understandings and promoting convergence [2]

from a colleague who made the comment above yours [in the *Nossos Casos* tool] already makes you think in other things. It's a support. Various ideas."). We believe that in general, these analyses can be conducted by evaluators with little domain knowledge and good knowledge in content analysis methods, e.g., in the TNR case, these evaluations were conducted by HCI-specialists experienced in different qualitative research methods. On the other hand, the success of strategies for promoting convergence of different meanings, at least in the TNR case, requires a much more cost-intensive, longitudinal approach and the involvement of domain experts. In the case of TNR this means to evaluate the success of continuing learning processes, which is a topic with many open research challenges.

Another important open question is how methods for problem understanding can support design for pluralistic meaning constructing and possible convergence more explicitly. In our case, the adoption of Organizational Semiotics and its epistemological position facilitated the consideration of these topics. HCI's "design for appropriation" might also provide some pointers. However, we believe that the design of TNR and *Nossos Casos* might have been more a result of the research team than that of the used methods. Many methods for problem clarification end with a single problem statement. A suggestion might be to investigate whether and how problem clarification might generate diverse or multi-faceted problem statements.

5 Conclusion

We presented a case of a system designed for and with inclusive education teachers, to illustrate how meaning construction and negotiation occurred during design and use, and how user practices and design were interrelated. We illustrated and discussed how pragmatic aspects affected the design of a tool to support teachers' practices.

We illustrated the importance of understanding the stakeholders' cultural context in its broadest sense. When dealing with concepts such as reputation or authorship, the cultural context explains why these concepts are desirable and necessary to different stakeholders. The conducted practices revealed situations where the lack of understanding about why such concepts are important to teachers could have led to the design of features that would not make sense to them, or that would trigger a negative impact on their interaction. They also revealed important and necessary design decisions that would not be made if other stakeholders had not been put into consideration.

We showed how meaning construction and evolution is a bottom-up process, and that at any point different interpretations of an issue might exist. These different interpretations might but do not necessarily have to converge. Designing systems that permit diverging meanings and promoting convergence of meanings poses methodological challenges that start with the problem clarification and definition. Diverging and converging meanings in TNR appeared in different uses of the *Nossos Casos* tool. In general, this problem is relevant to lifelong learning systems and other domains of creative problem solving. We described possible strategies anchored at the different levels of an information system. Further work is required to evaluate and refine these strategies and to identify additional ones.

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